

Input and language acquisition: A comparison of native and non-native signers

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Abstract

The emergence of a language is rarely directly observed in a natural environment. Similar to a phenomenon previously observed in Nicaragua, deaf Dominican children appear to have created a rudimentary form of manual communication in absence of comprehensible linguistic input. The evolution of this communication system over the course of five years (2007-2012) is documented as part of a cross-cultural and cross-generational study in which sign complexity is analyzed. The role of innate and environmental components of language creation and acquisition are discussed using data from hearing children and parents, including the parents of the deaf Dominican children cited above.

Results confirm that a new communication system is indeed slowly emerging in the Dominican Republic, and that this system shows signs of evolution in the period extending from 2007 to 2012. Signs produced by the deaf Dominican children meet the minimal requirements for a communicative symbol, show signs of mutual intelligibility, and differ from the signs of the other implemented Sign Languages in the Dominican Republic. Two cohorts of manual communicators appear to be present, and younger signers seem to have more advanced linguistic competencies in comparison to older signers within the community. The signs that are part of the observed Dominican manual communication system also appear to differ in complexity from those produced by hearing adults and children, supporting the presence of innate abilities for language creation. Specifically, the deaf Dominican children are generally found to have more diversified sign repertoires and to display faster signing rates over time, in comparison to hearing adults and children. Qualitative data and quantitative trends further support a more complex understanding by deaf children of the use of signs as an independent communication system from speech.

Analyses looking at the impact of input on language creation provides some support for the existence of infant-directed signing in a way similar to what is observed with infant-directed speech. The use of repetitions by hearing adults using infant-directed silent gestures could provide support for usage-based theories of language development. That being said, young hearing children with no prior exposure to Sign Language and with minimal relative linguistic experience were found to produce signs equivalent in complexity to those of hearing adults, therefore potentially providing further support for an innate understanding of complex linguistic rules. Deaf Dominican children were further found to surpass the input received by hearing adults over time. In all, this research is consistent with previous studies attesting for children's natural ability for language creation and development.

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Chapter 1

General Introduction

Little is known of how children contribute to language creation and evolution. One assumption is that adults are fully responsible for the development of language (Hockett, 1950; Slobin, 2005). That is to say, that children's language acquisition primarily depends on the adult input provided in their environment. These usage-based theories of language acquisition stipulate that the acquisition of language greatly depends on linguistic exposure during childhood (Goldin-Meadow, 2007). They argue that children formulate their language and specific dialect according to what they have previously heard (Vogt, 2005). One's competence in using a language thus varies according to one's ability to make use of the language in a similar manner to other speakers (Tomasello, 2000). As such, vocabulary and grammatical development are directly associated with environmental exposure to words and their respective function (Anderson, 2006; Hart & Risley, 1997; Lederberg & Everhart, 1998; Spencer, 1993). Through both modelling and shaping, usage-based theories of language stipulate that parental influence constitutes a child's primary source of language input in the first years of life and is therefore responsible for later language adaptability (Goldin-Meadow & Mylander, 1983).

However, unlike spoken languages, sign language acquisition in hearing-dominant homes presents many challenges unknown to hearing children of hearing parents; challenges that call into question some central assumptions of usage-based theories. Chief among these challenges is an often-delayed exposure to interpretable linguistic input (Spencer, 2004). Usage-based theories of language acquisition would argue that this absence of comprehensible linguistic input (i.e. only exposed to oral speech) prevents the deaf child from communicating in a language-like manner, especially when exposure to language is deprived during early childhood; a period

considered to be critical for language development (Goldin-Meadow, 2007). Though debated, evidence supporting the presence of a sensitive period for language acquisition suggests that linguistic properties such as the grammatical structure and phonetic inventory of language must be learned prior to puberty in order for a child to fully master language production and comprehension (Hockett, 1950; Kegl, Senghas & Coppola, 1999; Lenneberg, 1967; Morgan & Kegl, 2006; Werker & Tees, 1984). While modern theories now suggest that different language abilities hold their own different sensitive periods, most researchers agree that native-like language acquisition generally occurs prior to middle childhood (Meisel, 2013). Researchers argue that this allows individuals to consolidate their learning of a dominant language (Friedmann & Rusou, 2015). Input-deprived environments, such as that of deaf children born to hearing parents who do not sign and who are not exposed to Sign Language outside the home, would theoretically not provide the necessary foundation to allow children to acquire all such linguistic properties prior to reaching the end of middle childhood.

Yet, language acquisition persists universally despite varying levels of linguistic input (Gleitman, 2006). This universal human ability to learn a language therefore implies that nature prepares children for relatively effortless language acquisition despite limitations imposed by a sensitive period or impoverished linguistic environments (Bickerton, 1999; Gleitman, 2006). The presence of numerous common structural properties between human languages may be indicative of implicit language skills shared across the species (Coppola & Newport, 2005). Over the course of the last 30 years, the investigation of the creation and evolution of sign languages in natural input-deprived environments (see Coppola & Newport, 2005; Goldin-Meadow & Mylander, 1998; Senghas, 1994, 2003, 2005; Senghas & Coppola, 2001; Senghas, Kita & Özyürek, 2004) has allowed researchers to present evidence of innate aspects of acquisition of

language by children (Chomsky, 1965, 1981). Indeed, children have also been shown to go beyond the passive acquisition of the limited linguistic information provided to them through their environment, and to actively contribute to the creation of language, though in its simplest form.

Language Creation in Input Deprived Environments

Driven by a need to communicate, deaf children raised in input deprived environments have been shown to create manual communication systems within their immediate families (Coppola & Newport, 2005; Goldin-Meadow & Mylander, 1998; Senghas, 1994, 2003, 2005; Senghas & Coppola, 2001; Senghas et al., 2004). Known as homesigns, these systems serve as a primary means of communication only to those responsible for their creation within the family unit (Morford, Singleton & Goldin-Meadow, 1995b). They originate from deaf children (Coppola & Newport, 2005; Goldin-Meadow & Mylander, 1998), independently of Sign Language and gestures (Morford, Singleton & Goldin-Meadow, 1995a) and present a structurally distinct configuration from that of speech (Morford et al., 1995a; 1995b), one that is far less complex morphologically and syntactically. Still, homesign systems do share some similarities with other established communication systems (Goldin-Meadow & Feldman, 1977). For example, they exhibit some elementary semantic and grammatical structural properties (e.g., signs are strung in a specific order to convey meaning). However, these properties can be different from those of the oral languages present in the immediate environment suggesting that they may arise and develop independently from the oral input available to deaf children within their respective families (e.g., word order can differ from that of the oral language present in the immediate family or school environment). This distinction is also observed in fully developed Sign Languages where, for example, the American Sign Language and the British Sign

Language are both used in English oral environments yet use distinct word orders from one another. Homesign systems also often lack abstract properties associated with more advanced communication systems (Coppola & Newport, 2005). Further, the signing space is undefined, thus allowing for body-wide signs, while fully developed Sign Languages typically have signing spaces that are limited to the waist and shoulders. Finally, unlike fully developed Sign Languages, facial expressions are mostly used for affective rather than semantic purposes (Kegl et al., 1999).

Although they share some similarities, homesigns also differ from pantomimes. Pantomimes are defined by Żywicznyński, Wacewicz, and Sibierska (2016) as “a non-verbal, mimetic and non conventionalized means of communication, which is executed primarily in the visual channel by coordinated movements of the whole body, but which may incorporate other semiotic resources, most importantly non-linguistic vocalisations” (p.315). An example of a pantomime according to this definition includes the action of knocking in the air to symbolize a person knocking at a door. As argued by Goldin-Meadow (2005), homesigns are segmental (i.e., their meaning depends on the interpretation and understanding of different parts). Pantomimes on the other hand, are considered to be complete, self-contained communicative acts that express whole propositions and utterances (Żywicznyński et al., 2016). According to this definition, isolated gestures, including imitations of actions, cannot be considered pantomimes since their interpretation provides an incomplete understanding of the event and therefore are not self-sufficient. Similarly, pantomimes are improvised, spontaneous, impromptu, and subjective to the person producing them, and thus do not depend on semiotic conventions (Żywicznyński et al., 2016). Replication may differ from one person to another, or from one production to another even by the same individual depending on the context. Unlike homesigns which share some

conventionalization at the family level (Żywiczyński et al., 2016), pantomimes are considered unreliable as a “system” of communication (Arbib, 2012; Corballis, 2015; Hutto, 2008). Still, as with homesigns, some researchers argue that language may have evolved from pantomime (see Arbib, 2012; Tomasello, 2008). The universality, apparent innateness, and independence of pantomimes from common semantics makes their role in language evolution particularly plausible (Żywiczyński et al., 2016). Nevertheless, one could argue that, unlike homesigns, pantomimes’ suitability for language creation is limited by their lack of pre-established semantic conventions that restrict systematization (i.e., their ability to be conveyed to others for communication purposes).

Suitable for communication between individual deaf children and their hearing family members, homesigns are, however, of little use for communication outside of the immediate family unit. In order to communicate between each other, deaf children from different families of similar input deprived environments must combine their individual homesign systems into a coherent communication system understandable by all parties. In spoken languages, the concept of contact linguistics was first introduced by Uriel Weinreich in 1953, when he proposed that sustained interactions between different languages lead to changes to those same communication systems and, by extension, can lead to the creation of a new common language. Indeed, pidgins and creole languages have been shown to arise in multilingual environments where there exists a need for a common language to be created (Lefebvre, 2004). However, while both pidgins and creoles arise and evolve through a similar process, they each vary greatly in their level of grammatical development, therefore constituting very different communication systems altogether.

Similar to spoken languages, sign language pidgins arise from the combination of two or more languages or communication systems (Vogt, 2005), regardless of their degree of complexity. Their vocabularies generally originate from that of more influential signers and are adopted by signers of lesser authority within a community (Kegl et al., 1999). Such persons may include younger signers as well as members whose sign use may be sporadic. Basic communicative elements (including more rudimentary signs) are first used to analyze and segment events and are later sequenced hierarchically into manual formulations (e.g., A-B-A constructions where an individual repeats a sign to emphasize its relation to another sign such as in run-mouse-run) independent of environmental input as the communication system continues to evolve (Senghas et al., 2004). The grammatical structure of pidgin languages remains rudimentary in comparison to fully developed languages (Supalla & Webb, 1995). Signing space is still rarely delimited though signs are mostly executed using the limbs, head and upper torso (Kegl et al., 1999). Furthermore, grammatical properties start to be associated to facial expressions and can be accompanied by vocalizations to denote emotions (Kegl et al., 1999).

Similar to pidgin languages, creole Sign Languages are marked by the combination of multiple linguistic cultures (Vogt, 2005). However, they arise from the adoption of a pidgin language as a native language by a new generation of deaf children within a community. Through its transmission to new generations of signers and resulting complexification, such sign languages can attain a full linguistic development as characterized by grammatical structures represented by elements such as the fluidity of sign strings, a more restricted signing space, the systematic use of facial expressions and vocalizations, and an increase in noun arguments per sentence (Singleton & Newport, 2004).

The development of rudimentary homesign systems into a comprehensive and stand-alone language (e.g., such as the Nicaraguan Sign Language) is highly influenced by the pressure imposed by the size of the learning population (Vogt, 2005). A language's survival and evolution depend on its acquisition and transmission to other generations (Hockett, 1950; Senghas, 2003). The concept of generational transmission relates primarily to what constitutes the input: the output of others. It refers to the act of conveying linguistic information to the various generations of a same community (including one's own). Information can be transmitted vertically (i.e. from one generation to the next) or horizontally (i.e. between individuals of any generation) (Vogt, 2005). In order for generational transmission to occur, a language must benefit from a population that is large enough to include both younger and older users who share regular contact with one another. A small population with limited new members over time is likely to provide an inadequate environment for language development. This is because the language would not be able to benefit from the individual contributions of each member past what has been learned prior to the sensitive period for language acquisition. In the following studies, the term generational transmission is used broadly and refers to the act of conveying to other members of a community a commonly used means of communication.

However, it is important to note that, as suggested by Senghas et al. (2004), a given communication system does not remain static through the process of transmission and must reflect the nature of the learning mechanism beyond simple reproduction of the input and cultural transmission. For example, Carrigan and Coppola (2017) argue that use alone is insufficient to explain the process by which sign systems evolve into fully developed Sign Languages; a view supported by Brentari, Coppola, Cho, and Senghas (2017) who demonstrated that "the determinants of the initial forms of signs differ from the forces that reshape and reorganize a

system of signs over time” (p. 303). They argue that children learning a language are the forces that drive linguistic development. Indeed, modifications to a communication system’s structure are common following its replication, resulting in variations from the signs of one generation to the next (Senghas, 2003). The emergence of a new sign language, such as the one observed in the al-Sayyid Bedouin tribe in Israel (Sandler, Mei, Padden, & Aronoff, 2005; Senghas, 2005), and most prominently, in Nicaragua (Senghas, 1994, 2003; Senghas & Coppola, 2001; Senghas et al., 2004), results from a younger generation surpassing older, more experienced models by adding complexity to a pre-existing language input, thus providing further evidence for innate abilities for language creation and acquisition (Kegl et al., 1999). Young children can identify the basic elements comprising their communicative input with relative ease, which allows them to detect deficiencies and create remedying elements (Brentari et al., 2017).

Still, a child’s ability to contribute meaningfully to the evolution of language is greatly limited by the natural human process of maturation. In the case of language creation in input deprived environments, the minimum amount of time required for an individual child to regularize a linguistic system may exceed the natural sensitive period for language acquisition (Senghas & Coppola, 2001). Thus, a child’s ability to create language remains, but may be limited by biological limitations. The presence of a sensitive period for language acquisition suggests that multiple overlapping generations of signers are necessary for homesign systems to evolve into a fully developed language. A sensitive period would indicate that children’s contribution to the creation and development of language is limited to the linguistic input they have acquired from their environment prior to the end of such a period. As evidence of this concept, fluency with a given language is strongly associated with the age at which an individual is first exposed to the language and the total amount of exposure time to the language has little

effect if an individual first comes in contact with the language near or past the sensitive period for language acquisition (Kegl et al., 1999; Morford, 1996). As argued by Senghas and Coppola (2001), language creation and development in input deprived environments therefore requires the combination of sensitive periods from one cohort of signers to the next. The continuous transmission of linguistic properties to younger incoming generations of signers increases the available input, thus allowing children to slowly add complexity to the rudimentary language they have been provided with (Kegl et al., 1999). This phenomenon has been extensively documented in Nicaragua, where a community of Deaf individuals has been shown to create a new sign language through successive generations of signers over the last 50 years.

The Nicaraguan Sign Language (ISN)

Language creation by children was first recorded amongst a small community of deaf children in Nicaragua. Prior to 1970, social attitudes that isolated disabled individuals, thus keeping them homebound, had prevented contact between deaf Nicaraguan children (Kegl et al., 1999; Senghas, 2003; Senghas et al., 2004). Born of hearing parents, deaf children were raised in language-deprived environments with no exposure to Sign Language or to deaf adult members of their community. Consequently, most children proceeded in creating their own means of manual communication, consistent with a homesign system, which they used to communicate with family members. The personal nature of homesign systems, however, resulted in the creation of differing linguistic systems by individual signers (Senghas, 2003). Thus, the emergence, development and transmission of a common sign language in Nicaragua remained impossible until a community of deaf individuals came together in Managua.

The deaf community of Managua in Nicaragua, originated from the establishment of both an elementary school for special education in 1977 and a vocational school for adolescents in

1981(Senghas & Coppola, 2001). For the first time in Nicaragua, contact between deaf students, both inside and outside of school, was made possible. Though classes were taught in Spanish, children proceeded in creating their own means of communication among themselves (Senghas, et al., 2004). The resulting pidgin language, called *Lenguaje de Signos Nicaragüense* (LSN), incorporated individual homesign systems into one common coherent, yet rudimentary, pidgin sign language (Kegl et al., 1999; Senghas, 1994). Nevertheless, the Nicaraguan school system persisted, with little success, in promoting the teaching of Spanish and lip-reading, leaving deaf students linguistically disconnected from society.

First comprised of 25 deaf children, Managua's elementary and vocational schools had over 400 students six years after their opening (Senghas, 2003; Senghas & Coppola, 2001). Since 1980, this sudden growth of the Deaf community in Nicaragua thus resulted in the rapid development of ISN (or Nicaraguan Sign Language translated from the Spanish *Idioma de señas Nicaraguense*), a creole language, through its continued transmission and evolution across generations (Kegl et al., 1999; Senghas, 1994). By 1995, the Deaf community in Managua comprised 500 members, already divided into two cohorts of signers (Senghas, 1995). A distinct language in itself, ISN has since been transmitted every year to younger children entering the school system and is now a fully developed Sign Language (Senghas et al., 2004).

From its earlier pidgin form to its later creolization, the Nicaraguan Sign Language has seen many modifications. In a series of studies examining the grammatical structure of ISN in comparison to its preceding pidgin form and other Sign Languages, Kegl et al. (1999) describe in detail the developmental process from which ISN emerged. Using an elicitation task in which Nicaraguan signers from all generations were invited to describe the content of two distinct cartoon stories, Kegl et al. argue in favor of a "continuum of sign fluency and complexity" to

describe the communication systems observed in Nicaragua. This continuum comprises, in order of complexity: 1) the idiosyncratic homesigns used by isolated or older deaf individuals with their respective families, 2) the pidgin resulting from the communal sharing of various homesign systems that leads to a continuously increasing common lexicon and grammatical structure; and 3) the fully developed Sign Language used only by native signers. They come to define LSN as “a peer-group pidgin or jargon between signers” (p.181) which they justify by showing that LSN signers use significantly less spatial inflections than ISN signers despite both languages “being strongly verb-centered” (p. 192), significantly less size and shape specifiers, significantly less object handshape classifiers, and significantly more whole-body signs. Fluency, as calculated in terms of signing rate (or the number of signs produced per minute), was also found to be significantly below that of ISN signers and LSN signers were shown to recount events less accurately and to often omit important details of stories, therefore conveying incomplete messages.

While all three communication systems were simultaneously present within the Deaf Nicaraguan community, it is important to note that grammatical modifications were not shown to be transmitted to or integrated by older signers (Senghas, 2003). The evolution of ISN thus appears to be limited to a downward vertical transmission, where older signers continue to use earlier forms of the language while only the younger signers use new and more complex grammatical structures. Changes to the complexity of the grammatical structure of ISN, have indeed been shown to originate among preadolescent members of the community who then convey these changes to younger signers; this, despite the fact that older signers have had more exposure to the language. Signing proficiency in the context of input-deprived environments therefore depends on the age of language exposure and the year of integration into the Deaf

community, where younger and more recent members benefit from both a richer linguistic environment and a longer period for language acquisition (Kegl et al., 1999; Senghas, 1995).

The case of the Dominican Republic

Similar to the phenomenon studied in Nicaragua by Senghas and others (Senghas, 1994, 2003; Senghas & Coppola, 2001; Senghas et al., 2004), a small group of deaf children in the Dominican Republic appear to have created a rudimentary communication system based on no previous exposure to interpretable language. First documented in 2007 (Drouin, 2008), it was determined that the signs used by individual signers at Santa Maria School met Goldin-Meadow and Mylander's minimal requirements for a communicative symbol (1998). Specifically, signs were directed towards other individuals during exchanges, were used with established eye contact or assurance of the recipient's attention, and mostly excluded the direct manipulation of a person or object. That being said, the signs produced by the deaf Dominican children were still mostly iconic in nature, and the grammatical structure of the communication system (including word order) appeared rudimentary at best. A basic examination of the generational transmission of the language revealed that there was likely only one generation of signers present at the time. Survival of this rudimentary communication system therefore needed the arrival of new, younger children in order to allow for its transmission and elaboration into a more complex pidgin-like communication system. Such a new cohort of children was present in 2010 and prompted the decision to further document the evolution of the Santa Maria Sign Language. Differences and similarities between SMSL and ISN are presented in Table 1. A more global comparison of the developmental context of various relevant manual communication systems is presented in Table 2. It is important to note that, while the name SMSL has been given to this communication system, in no way do I pose judgment on the developmental status of this system based on the

2007 data, or presume its qualification as a language. Instead, data from the 2007 study is included in an exploratory fashion to document a system which could have the potential to provide further information on the language development process.

Defining language

To be considered a language, a communication system must meet certain specific criteria or present characteristics, which I attempt to document in this dissertation. These criteria, although debated, differ somewhat depending on the communication modality (i.e., oral versus manual). For example, while oral languages are considered to be primarily arbitrary (i.e., words and their meanings do not show a direct or natural connection; see Greenberg, 1957; Hockett, 1960; and de Saussure, 1916), this is untrue in the visual-spatial modality of sign language (Perniss, Lu, Morgan, & Vigliocco, 2018; Thompson, 2011). Indeed, iconicity in differing sign languages across the globe is estimated at 33% to 50% of the total lexicon (Boyes Braem, 1986; Zeshan, 2000). Still, arbitrary signs do represent an important portion of the sign repertoire and, as symbols used to denote specific objects and concepts and their meanings, must be interpreted and understood by different individuals, suggesting that mutual intelligibility is an important part of language definition for both oral and sign languages. Further, most researchers agree that language is productive. It presents an infinite potential for creativity in providing meaning to new concepts and expressing new ideas. Still, it is systematic. It follows strict rules, is organised in a set way, and follows specific patterns (e.g., through word order, grammar, segmentation, etc.). Finally, language is non-instinctive, in that it is not spontaneous. We must voluntarily and consciously produce words or signs to express meaning (i.e., as opposed to limiting communication to pointing for example). This does not, however, negate that the need to express oneself is innate. The meaning of individual words or signs are conventional, in that they are

approved by all members of a community, and must be passed on, taught, or transmitted to other generations in order to guarantee the survival of the language.

The definition of language varies according to the school of thought one is considering. That being said, most researchers agree that language is acquired effortlessly, consists of a formal symbolic system, is used for communication or social/pragmatic purposes and is unique to humans. While homesign systems such as the ones in Nicaragua and the Dominican Republic do not meet the minimal requirements to be considered languages due to their lack of shared lexical entries and complex grammatical structure, they constitute communication systems with the potential for further linguistic development. Their longitudinal documentation allows for the unique study of the essence of language creation by children, thus providing insight on the initial stages of language origination and acquisition in light of usage-based theories.

Systems of language

The systems of language, both spoken and signed, have at least four analysis levels: phonology (the organization of contrastive units of sounds), morphology (the forms of words and meaningful word parts, like the plural “s” in English), semantics (the meaning of words) and syntax (the arrangement of words and phrases to create well-formed sentences). At the core of every human language is a set of distinct sound units whose combination forms the basis for the more complex structural systems listed above. Known as phonemes in spoken languages, they refer to the specific units of sound that enable us to differentiate one word from another (e.g., the words cat and bat in which the sounds /c/ and /b/ differ to distinguish both words). While produced manually, phonemes are also found in sign language and are referred to as parameters. Five parameters comprise sign language phonology: handshape, movement, location, palm orientation, and non-manual signal/marker (e.g., facial expressions). Handshape parameter,

refers to the configuration of the hand. This includes finger selection and joint configuration (e.g., extended versus flexed, or crossed fingers). Movement parameter denotes the way in which the hand moves or the motion that is attributed to the hand when signing (e.g., upward, downward, forward, etc.). Location parameter concerns the location of the hand within the signing space. Palm orientation parameter refers to the orientation of the hand (e.g., whether the palm is turned upward or downward, or is facing towards or away from the signer, etc.).

Words and their meaning are formed by the amalgamation of these units or parameters. That being said, a distinction is made on the function of parameters. While individually, parameters represent the smallest units of a sign language, their combination enables the formation of morphemes in the visual-manual mode which results in the addition of meaning. For example, morphological distinctions can be identified by the movement of a sign from one location to another to indicate meaning, such as when inflection is used to indicate agreement between a subject and an object (e.g., “he gave her the book” represented with the sign “give” produced from point A “he” to point B “her”). Another example includes the use of movement repetitions to convey meaning, such as when depicting something that was done over and over again, or done very quickly. Handshape has also been shown to serve as a type of classifier in sign language in which the configuration of the hand is used to express meaning about an object’s position, size or shape, or handling.

Historically, most research about language development in input-deprived environments has focused on the development of morphological structure. For example, even the very first studies of ISN focused on inflectional verb morphology and classifier system (Senghas, 1995). One strong explanation for this high level of analysis, is that the vocational school in Nicaragua where ISN emerged was already 15 years old and already had a Deaf community of 500

members in 1995, enabling a far more developed language to begin analyzing. But phonological development has also been shown to be particularly important to demonstrate language evolution over time. For example, even homesign systems have been shown to have some phonological features, but more complex grammatical structures are solely observed in more developed communication systems.

Still, developmentally, phonology is one of the first language systems to be learned by young babies due to its fundamental role in word learning. For example, hearing babies have been shown to use relevant language sounds to direct word learning (Fennell, Byers-Heinlein, & Werker, 2007; Fennell & Werker, 2003). The categorization of speech sounds has even been shown in babies as young as one month of age (Eimas, Siqueland, Jusczyk, & Vigorito, 1971). In the manual mode, young deaf infants were similarly found to resort to patterns of stringing together units of gestures while babbling as part of the word-learning process (Petitto & Marentette, 1991). Given that language generally develops according to a comparable timeline, or at least a comparable progression, in both hearing and deaf children (Bonvillian, Orlansky, Novack, 1983), we therefore assume that phonology should be similarly important in the first stages of language development in the manual mode, if only due to the significance of parameters for morphological development.

Given the rudimentary nature of SMSL and our desire to document its most basic structure over time, the current dissertation focusses on the study of phonological markers only, while paving the way for future studies on the morphological structure of SMSL and more in-depth comparisons with ISN.

Differentiating gestures and signs

For the purpose of this dissertation, further distinction is made between the signs comprised in a manual communication system and gestures. Here, we distinguish between two definitions for gestures: those that are perceived as a singular entity or form of hand movement, commonly referred to as gesticulations, and gestures used in the broader sense to include all forms of manual representations on the gesture continua (e.g., gesticulations, emblems, which are gestures that have a specific agreed-on meaning such as a closed fist with a raised thumb to indicate that a person is looking for a ride, etc.; see McNeil, 2015). In this dissertation, the term gesture is used in this broader form to include all subtypes of gestures comprised in the gesture continua, with the exception of signs. While we believe that signs derive from gestures and are part of the same gesture continua (Kendon, 2004), we also share Kendon's belief that gestures and signs "may be contrasted with one another in terms of (1) how they relate to speech, (2) the extent to which they have linguistic properties, (3) the extent to which they are conventionalized, and (4) how they contrast in terms of their semiotic properties" (p. 106). We therefore differentiate signs from other manual representations in our own definition given their more complex structure resulting from assuming the full burden of communication. Specifically, gesticulations, unlike signs, constitute a non-linguistic mode of communication (i.e., free of linguistic properties and lexical structure). Gesticulations are further described by McNeil (1992) as being spontaneous, subjective, and non-systematic. This definition is also accurate for pantomimes, as described earlier in this chapter. Gestures can be thought to be able to convey meaning within culturally bound conventions (e.g., the emblem of waving one's hand to communicate "hello"), although the form taken by individual gestures can vary to express the same meaning. However, Emmorey (1999) further added that gestures are holistic, cannot be

broken down into morphological components, and are noncombinatoric. As argued by Goldin-Meadow and Brentari (2017), signs differ from gestures in that they carry the full burden of communication, therefore resulting in distinct formations produced in a consistent order of segmented strings. Similarly, while stemming from a primarily co-speech environment, homesigns assume the full burden of speech and display components suggestive of a stable lexicon, and both a morphological and syntactic structure, therefore falling outside of our broad definition of gestures. The same is also argued for silent gestures which Goldin-Meadow and Brentari more appropriately rename “spontaneous signs”. Note that our definition of gesture distinguishes between pantomimes as the spontaneous and mimetic depiction of actions through holistic hand and body movements described above, and elicited pantomimes or silent gestures which refer to the spontaneous manual representation of events (usually in laboratory studies) (Żywicznyński et al., 2016). Definitions of the specific linguistic terminology used in this dissertation are presented in Table 3.

Goals and hypotheses

The goal of this dissertation was first and foremost to document the emergence and potential evolution of the Santa Maria Sign Language as part of a longitudinal study. In accordance with Senghas et al.’s conclusions (2004), it was believed that, if a language is emerging and developing, younger signers should have more complex language than older signers within the same community. This is contrary to what one would expect in an established language. One would expect, for example, that French-learning older children would have better language skills than younger French-learning children. But, if the language is growing, one would expect the opposite. By comparing the signs produced by deaf children at three distinct times (i.e., 2007, 2010 and 2012), it was argued that we would 1) establish whether SMSL can be

considered a language in becoming, 2) determine whether it is being transmitted to younger generations of signers, and 3) provide further evidence for children's contribution to the development of grammatical structure within SMSL through findings suggesting a more complex use of the language by younger signers, determined by an increase in the overall structural complexity of SMSL over time. As argued by Senghas (2003), the study of early-stage language emergence is beneficial in evaluating children's contribution to language development since fewer modifications have resulted from previous generational transmission.

Follow-up studies aimed to further attest to the innate ability of children to acquire and create language, by comparing the signs of the Dominican deaf community to those produced by their hearing parents, as well as hearing Canadian adults and children. It was hypothesized that the signs produced by hearing adults and children, including those produced by the hearing parents of deaf Dominican children, would be significantly less complex in terms of their formation and execution. Such differences would provide support to previous studies (Goldin-Meadow, 2007; Lenneberg, 1964; Moores, 1974; Sandler et al., 2005; Senghas et al., 2004), concluding that the signs used by the deaf children in our studies do not originate from parental input and go beyond the spontaneous signs created by hearing children with knowledge of a spoken language. Deaf children's influence on their parent's use of signs was also explored by comparing infant-directed and adult-directed signs. Refer to Table 4 for a visual description and explanation of the group comparisons included in the current dissertation.

Chapter 2

Study 1: Documenting the evolution of the Santa Maria Sign Language

Until recently, deaf children in the Dominican Republic had little academic resources available to them. Specialized institutions for the deaf were generally situated in major cities across the Dominican Republic and such schools were, by and large, managed by stakeholders in the private sector. Thus, very few deaf Dominican children were provided with the opportunity to access specialized education. Deaf education in the Dominican Republic formally originated in 1969 with the creation of its first vocational school for the Deaf: *Escuela Nacional de Sordomudos* (Escuela Nacional para Sordos, n.d.). Located in the capital, Santo Domingo, few students nationwide were able to attend classes, leaving many deaf students isolated in their respective communities, unable to afford transportation costs associated with travelling to school. Due to the individual assistance needed by deaf children in order to function in mainstream classes, few public schools allowed such students to attend class in regular classrooms. Deaf students, along with other special needs students, were therefore often left wandering the streets while their hearing peers were in school. Although formal education for deaf students in the rest of the country is now more accessible since the expansion and branching of the deaf vocational school to other provinces, today, many deaf students in poorer or more remote regions of the country continue to struggle with accessing educational services.

The Dominican Sign Language (LESDOM)

Those attending classes at the vocational school originally learned Spanish, through lip-reading. The same is true and continues to be so for most students attending class in public schools or other non-vocational schools across the country. It is only in 1976 that deaf Dominican individuals were first exposed to manual languages (Escuela Nacional para Sordos,

n.d.). Without a formal Sign Language in the Dominican Republic, American Sign Language (ASL) was used in combination with Spanish by staff and children at the vocational school starting in 1974. Fully developed sign languages were not commonly used by deaf children in other regions of the Dominican Republic, nor were they included as part of the educational standards for deaf students. Thus, ASL was not commonly used by most deaf Dominicans.

In 2007, the Dominican State Secretary of Education published a teaching manual describing basic signs for a Dominican Sign Language known as *Lengua de Señas Dominicanas* (LESDOM). LESDOM has been fully integrated into the vocational schools' educational program since 2013 and serves as a native language for all students attending the vocational school across the country. Spanish continues to be used within a bilingual-bicultural (BiBi) education program, where LESDOM is the primary language and Deaf culture is favoured over Spanish which is viewed as a secondary language for speech, reading, and writing (Escuela Nacional para Sordos, n.d.). Despite the efforts of the Dominican government to promote and teach LESDOM to all deaf individuals across the country, the language has yet to be fully accepted by deaf Dominicans who often remain isolated or continue to use their individual homesign systems for communication purposes. Plans from the Dominican State Secretary of Education to publish a series of teaching manuals for LESDOM have since been abandoned. In January 2019, the Director of the National Counsel for Disability (CONADIS) announced the intention to create an "official, consensual and standardized LESDOM dictionary" ("Conadis trabaja en Diccionario", 2019). *Hoy Digital*. Retrieved from <http://www.hoy.com.do>). The publication date for such a document has yet to be announced.

The Santa Maria Sign Language (SMSL)

Established in 1994, Santa Maria elementary school aims to provide an education to children who are otherwise unable to attend school in the regular public schooling system of the Dominican Republic. It offers classes at all levels of education from kindergarten to eighth grade and also offers special education classes to students with various learning disorders and other intellectual or physical impairments, including hearing loss. Classes are taught in Spanish, the official language of the Dominican Republic, and school personnel promote lip-reading among its deaf population of students, though manual communication is not prohibited.

Approximately 10 deaf students were enrolled at Santa Maria school at any given time throughout this study. Because Santa Maria is not a vocational school, it is not entirely reserved for deaf students. The ratio of new deaf students admitted each year is therefore limited and cannot be controlled or predicted by the school's administration. The Santa Maria school is located in a region comprising various communities with a total population that exceeds 35 000. Deaf students may come from any of the region's communities which are sometimes separated by several kilometres with limited public transportation connecting each one. Due to the scarcity of vocational schools across the country, it is also not uncommon for deaf students at Santa Maria school to come from further rural communities falling outside of its immediate service area. For these reasons, it is believed that, with the exception of two sisters, deaf children had little to no contact with one another prior to their enrolment in Santa Maria school. All children have hearing parents and none have been in contact with deaf adults or have received a basic Sign Language education. Further, none of the deaf students uses Spanish as a primary mode of communication (though some were able to read lips with some accuracy and attempted to

reproduce certain words), and all were reported by their parents and school personnel to prefer the use of signs when interacting with other individuals (deaf or hearing).

Despite their reported lack of exposure to formal manual languages, individual deaf children at Santa Maria school appear to have created basic communication systems comprised of deictic signs (i.e., pointing gestures) and strings of individual iconic (i.e., manual representations of object attributes, spatial relationships, and actions) and metaphoric (i.e., symbolic manual representations of abstract concepts) signs that they use within their respective families. Such communication systems are consistent with homesign systems described in other pre-lingual deaf children born to hearing parents, as they show signs of some semantic and grammatical properties (e.g., a consistent lexicon and form-meaning associations, and sequential combinations of atomistic movements to describe whole concepts and events) beyond what would be typically seen in the spontaneous signs produced by hearing individuals, or gestures accompanying speech. Although it could be argued that some of the students' signs resemble those of other Sign Languages (e.g., ASL) or the gestures spontaneously produced by hearing non-signers due to their high iconicity, it is important to note that iconicity has been shown to be abundant within homesign systems. Goldin-Meadow (2012) even argued that "deaf individuals inventing their own homesigns are forced by their social situation to create signs that not only begin transparent but remain so" (p. 605) in order for others to understand the meaning intended from each sign. Shared lexicon between students and attempts at teaching common signs to school personnel and other hearing students, further suggest that deaf students at Santa Maria school may have begun combining their individual signing systems into what has the potential of becoming a coherent, yet rudimentary pidgin sign language.

The 2007 documentation of SMSL as a potentially new and emerging sign language

The Santa Maria Sign Language is probably less than 20 years in the making. It was first documented in 2007 (Drouin, 2008) as part of an Honours research project with the aim of providing further evidence of children's contribution to the development of grammatical structure within languages in natural input-deprived environments. A semi-structured study (i.e. both observational and quantitative in nature) was designed to document and evaluate the natural evolution of SMSL and attempt to establish the presence of one or more generations of signers within the deaf community of Santa Maria school.

Nine deaf Dominican children (5 girls) participated in the original study. Participants were recruited at home, but all were students at Santa Maria school. Hearing loss in all participants exceeded 40 dB and was evaluated by an independent professional prior to this study and documented in the children's academic files. At the time of testing, participants ranged in age between 4 and 19 years, with a mean age of 13 years. Age of entry into the school system varied between 3 and 10 years ($M = 6$ years, 2 months). Participants had been exposed to the school's deaf community for 1 to 9 years ($M = 6$ years, 7 months). Two sisters were included in this initial set of participants. No other students were believed to have had contact with one another prior to starting school at Santa Maria.

Two cohorts of signers were created based on the age of participating children and their classroom attribution (Table 5). Other factors contributing to this distribution of participants included the number of years spent in school as well as peer groups observed prior to the testing. The first cohort comprised children between 14 and 19 years of age. All, except one participant, were exposed to the Santa Maria deaf community for nine years. Children in the second generation of signers ranged in age from 4 to 13 years and had been exposed to the deaf

community between 1 and 8 years. The age of entry into school of one of the participants of the first cohort was unknown as the child in question had started school in another establishment and only later transferred to Santa Maria.

Testing was completed in two parts. The first part of the experimental session required that each participant describe the content of a story book to a deaf peer using signs. The story book, entitled ¿Dónde está Max? (Where is Max?) and written by Mary E. Pearson (2000), contained 24 pages. Aimed for children aged 4 to 8 years, the story book contained few words. The participants were asked to look at the pictures in the book and to use their hands to describe what they perceived as the story intended by the author. The goal was to observe a diversity of signs as produced by the various participants, rather than studying a limited number of signs as repeated by each participating signer. In the second half of the experiment, participants were encouraged to freely converse with their peers in a controlled setting. Paper, crayons, paint and brushes were available to the participants in the hope of initializing a conversation topic. Collected data was evaluated in terms of fluency and spatial modulation (See Figure 1 and refer to the coding procedure described later in this chapter for more details). Vocabulary size was also calculated in order to offer insight on the use of specific signs over non-specific ones (e.g., pointing).

A series of Student's independent sample t-tests were conducted to compare each a priori assigned cohort of participants on signing rates, vocabulary size and the number of spatial modulations produced, and to establish the presence of one or more generations of signers amongst the deaf community of Santa Maria school. Results revealed no statistically significant differences between individual cohorts. Still, basic qualitative analyses of the documented signs thought to comprise SMSL found that signs met the minimal requirements for a communicative

symbol as described by Goldin-Meadow & Mylander (1998) and appeared to go beyond basic manual symbols (such as pantomime) and other body movements. For example, rudimentary signs appeared to be segmented and conventionalized; characteristics that previous research (see, Goldin-Meadow, 2005; Żywicznyński et al., 2016) identified as distinguishing homesigns from pantomime. Specifically, individual signs appeared to be combined into sign strings meant to explain and describe whole events, and mutual intelligibility appeared to be developing as demonstrated by the consistent use of individual signs by different signers and the apparent understanding and responding seen in the back-and-forth exchanges between signers. Additional behavioral particularities observed in SMSL signers included the use of facial expressions, and references to both immediate and abstract concepts. At the same time, SMSL signers were also found to use eye contact inconsistently when signing, to sometimes produce signs using both hands or to change hands when signing, and to have a largely undefined signing space with signers sometimes standing up to use their whole body for executing a sign. Although definitive conclusions could not be deducted from these structural particularities, it provided some insight on the likely linguistic stage of development of SMSL.

Ultimately, it was suggested that SMSL's structure most resembled that of a rudimentary pidgin-like language though it did not yet appear to have attained a complete pidgin structure equivalent to that of LSN. It was further suggested that only one generation of signers was present at Santa Maria school in 2007. The lack of statistical differences between each a priori assigned generation of signers supported this conclusion. Upon further analysis, nothing distinctively suggested the presence of two generations of signers amongst the deaf population of Santa Maria school other than peer groups as observed prior to testing and it is possible that

seemingly insignificant differences between the age, the number of years spent in school and the classroom attribution of individual participants were overestimated.

An alternative explanation includes the possibility that, as originally hypothesized, two distinct generations of signers were present at Santa Maria school in 2007. This can be explained by the absence of significant differences between the two studied generations of signers despite the less mature cognitive and language development of members of the younger cohort of signers. Indeed, it could be argued that a complex use of the language was found in younger signers, as their signing performance appeared to be equal to that of more experienced signers. As such, it would only be a matter of time before visible changes to the grammatical structure of SMSL can be studied and chronicled, as children of the second generation of signers slowly improve the linguistic input received.

Possibility of further development

When originally studied, deaf students at Santa Maria school varied in their ability to use and to understand their common manual language. Because the school's deaf population had remained mostly unchanged over the previous five years (i.e., the school had not received any new deaf student), questions had arisen in regards to the adequacy of the environment provided by the Santa Maria school in terms of SMSL's potential for development through generational transmission (i.e., the language cannot evolve without the arrival of new younger deaf children). Still, with each incoming cohort of deaf children, SMSL was presumed to have the potential to slowly be transmitted from one generation of signers to the next and to subsequently evolve into a fully developed sign language independent of the existing, yet limitedly implemented LESDOM. The arrival of new deaf children to the school in 2010 renewed interest in

documenting the evolution of SMSL therefore prompting the longitudinal study described in this chapter.

Part 1: Looking for signs of generational transmission

Part 1 of this study aimed to continue documenting the possible evolution of SMSL through its transmission to younger incoming deaf students at Santa Maria school. In conformity with the proposed evolution of homesign systems into a fully developed Sign Language (see Coppola & Newport, 2005; Senghas, 1994, 2003; Senghas & Coppola, 2001; Senghas et al., 2004 for examples of specific grammatical development in manual communication systems), and as previously argued above, it was hypothesized that the emergence and long-term development of SMSL would result in younger signers making use of a more complex language than older signers of the same community. It was expected that the younger generation of signers would surpass experienced and developmentally more advanced students in terms of the complexity of their signs (i.e., spatial modulation) and overall fluency producing sign strings. Specifically, younger signers were expected to have faster signing rates (defined as the production of individual morphemes per minute) and to produce more signs in non-neutral locations (i.e., outside of the immediate space between the neck and hips of an individual signer) in order to add meaning to the events depicted by individual sign strings (refer to the coding procedure later described in this chapter for further details). Such variables were selected for their ability to provide clues as to the gradual evolution of SMSL from individual homesign systems to a more complex pidgin sign language as observed in Nicaragua by Senghas and others. Specifically, fluency and spatial modulation were meant to document the introduction and use of segmentation, hierarchy, and basic phonological elements in the grammatical shaping of SMSL

as a manual communication system. Vocabulary size was also analyzed as an added indication of increasing fluency in using specific signs over non-specific ones such as points.

The handshapes of two students present at all three data collection times were further analyzed in the second part of this study to examine specific qualitative signs of phonological complexity in a manner similar to Coppola and Brentari (2014). Specifically, handshape type, finger group, and joint configuration were explored in order to detect signs of a developing phonological structure within SMSL over time. Phonological development was chosen over other linguistic properties due to its comparable developmental timeline to spoken languages, which suggests that it should be one of the first linguistic elements to be observed within rudimentary communication systems. This exploratory analysis of SMSL did not aim to assess phonological development within homesign systems but rather to simply document whether or not phonological structure may be present within SMSL as displayed by two deaf children over a five-year period. Participants were selected as a convenience sample, as they were the only two individuals who participated in the longitudinal study at all three times of testing.

As stated previously, a more complex use of SMSL by younger signers is the opposite of what one would expect in an established language such as ASL, French or English. Typically, younger children have more immature language. Differences attesting for a more complex use of the language by younger signers (i.e., a faster signing rate, less neutral signing, and more diversified signing repertoire) would be attributable to an increase in the overall structural complexity of SMSL through remodelling following generational transmission. These differences were expected to increase with time as more children contribute to SMSL's development and build on the linguistic structure provided by older signers. Differences, or a lack thereof, between groups of older and younger signers would assist with identifying the

responsible population for the evolution and development of the observed language (Senghas & Coppola, 2001). Specifically, the original students and creators of the Santa Maria Sign Language (who had mostly completed their schooling at Santa Maria school by 2010 and no longer had consistent contact with the rest of the deaf students) would be determined responsible for the development of their language if their overall linguistic abilities surpass those of younger students entering the community between 2007 and 2012. Inversely, the second and younger group of signers would be declared responsible for the evolution and development of the language by surpassing experienced and developmentally more advanced students. The absence of such differences over time would allow for the conclusion that all children contributed equally to the development of their language and would negate the presence of two distinct cohorts of signers within the Santa Maria community.

Participants

Nine deaf Dominican children (5 girls) participated in the original 2007 study. This participant sample fluctuated over the span of our longitudinal study and of these, only four were either still registered at Santa Maria School or agreed to participate in the study despite having completed their schooling at the first follow-up in 2010 (2 girls). That number decreased to three in 2012 (2 girls). In total, our participant sample in 2010 consisted of ten deaf Dominican children (6 girls). Six deaf participants (girls) were recruited in 2012, but only four (2 girls) participated in the study. Over the years, deaf children either completed their studies at Santa Maria School or relocated and were attending school in other locations in the Dominican Republic. Table 5 presents a distribution of participants across all three testing periods included in this longitudinal study. Overall, the population of SMSL signers is hypothesized to have two cohorts of signers. Participants were distributed across these two possible cohorts according to

the hypothesis from the original study completed in 2007. The first cohort comprises children aged 16 to 19 years in 2007 who had been exposed to the deaf community of the Santa Maria school for a minimum of nine years. Children thought to be in the second generation of signers ranged in age from 4 to 10 years in 2007, had been exposed to the deaf community between 2 and 5 years at the time of the original testing, and were still attending school at Santa Maria at the time of subsequent testing in 2010 and 2012. New students who had started attending school at Santa Maria between 2007 and 2010 were also considered to be in this second cohort of students. It is important to note that the older students, comprising the first cohort of children, had graduated and were no longer attending school at Santa Maria at follow-up in 2010 in 2012. No further assessment of their linguistic abilities was completed. Hypothesized cohorts of children are based on the age of individual children in relation to the sensitive period for language development. The cohorts presented in Table 5 for the 2010 and 2012 testing periods are slightly different from those originally hypothesized in 2007 and are no longer defined according to the children's classroom attribution, number of years spent in school, and peer groups. The decision to modify the hypothesized cohorts believed to be present at Santa Maria school was made based on the results from the original 2007 study, as well as on a desire to further emphasize the role of the sensitive period for language acquisition estimated to end before puberty. Concomitantly, the years of exposure of individual deaf children to the Santa Maria deaf community and manual language must not be overlooked in the generational transmission process (if applicable in this context). It is therefore important to keep in mind that cohorts cannot be defined solely on the times of testing, which explains why two of the original participants from the 2007 study are believed to be part of a possible cohort of younger children.

Overall, the average age of deaf participants at all three testing times was approximately 13 years. In 2007, participants ranged in age between 4 and 19 years. Age range varied between 7 and 19 years in 2010, and 9 to 18 years in 2012. Exposure to the Santa Maria deaf community varied between 1 and 7 years ($M = 6$ years and 7 months) in 2007, 2 and 10 years ($M = 4$ years and 6 months) in 2010, and 4 and 9 years ($M = 6$ years and 4 months) in 2012. Hearing loss in all deaf participants exceeded 40 dB, as evaluated by an independent professional prior to this study and documented in the children's school records.

An additional 110 hearing children were recruited to participate in the 2010 study. Of these, only 57 would actually take part in the study. Only the hearing students within 2 months of age of the deaf children were retained as participants in this study to serve as controls for the standardized quantitative assessment. All children were recruited at home via recruitment letters they received during their participation in the Santa Maria summer school program. All were current students of Santa Maria School. Additional recruitment letters were sent to 32 hearing students of Santa Maria school not taking part in the summer school program because of their age and eligibility to take part in the study.

Because the total deaf population studied is estimated to have no more than 15 to 20 members (including past students of the school and deaf adults in the community), the statistical power of this study is therefore greatly limited. The diversified characteristics of participants further hinder the probability of obtaining significant results in this study. However, this sample is considered to be representative of the total Santa Maria deaf population, considering its size. Of note, while we hypothesized that two cohorts of signers were present within the studied population, our statistical analyses did not specifically control for these cohorts. Data was

therefore analyzed by testing time only without dividing our sample of participants according to hypothesized cohort.

Procedure

Permission for testing was obtained from authorities at the Santa Maria school and a first follow-up visit following the 2007 study took place in the summer of 2010 when both a standardized assessment and observational study were completed. Consent forms were sent home via students in order to obtain informed parental consent. Assent was obtained from each student at the time of testing. Interested parents were met on an individual basis to answer questions before signing. Testing was also repeated with deaf students in 2012 but, this time, only included an observational study. Table 6 describes the timeline for the longitudinal study of SMSL, including the completion of standardized assessment tools.

Standardized quantitative assessment. In 2010, the parents of each deaf child currently enrolled at Santa Maria school were asked to complete the *MacArthur-Bates Inventario del Desarrollo de Habilidades Comunicativas II: Palabras y Enunciados* (Inventario II). The Inventario II is a parent report instrument used to assess a child's language abilities, including vocabulary comprehension, production, signs, and grammar. Two copies of the Inventario II were completed by the parents of each child: the first, in regards to the child's production of Spanish words and phrases, and the second in regards to his production of SMSL signs. Originally intended for hearing children ages 16-30 months, the Inventario II was used in this study as a guide to help parents in reporting their child's use of language (both spoken and signed) through a recognition format rather than have them spontaneously recall a sample of their child's lexicon. Because the deaf children included in this study had limited access to either spoken or manual languages, it was believed that the 588 items listed in the Inventario II would likely represent an appropriate vocabulary pool for these children who were noted beforehand by

both their parents and school personnel to have very limited use and knowledge of the Spanish language (for example, Lederberg and Beal-Alvarez (2011) showed that the vocabulary development of deaf children exposed to environments in which both a spoken language and a manual variant of that language are used simultaneously (i.e., Simultaneous Communication) was severely delayed – on average more than two standard deviations below those of same-aged hearing children by the end of preschool – and that this gap increased with age). Further, while an adapted version of the questionnaire was created in English for ASL native learners (see Anderson & Reilly, 2002), translation of this tool (with its 537 items) for the purpose of this study did not suggest any necessary added value given that 1) the ASL adapted version included fewer vocabulary items, 2) there were no Dominican norm available for either of these questionnaires and no equivalent and valid sample of participants was available to create local norms, and 3) the questionnaire was not used in this study for comparison purposes with hearing participants but rather as a simple elicitation tool for parental report of the deaf children's estimated expressive vocabulary. The parents of three older deaf children included in the 2010 study did not complete this questionnaire as these children were no longer attending class at Santa Maria school, although they still visited the school on a regular basis and maintained contact with other deaf students, and were invited to join the study at a later time. This measure was also not administered to parents of hearing children as the linguistic abilities of these children were expected to surpass those of the intended audience. The results obtained with this measure were used (along with the results of the standardized quantitative and observational studies explained below) to determine each deaf student's overall linguistic knowledge and abilities. Completion of the Inventario II and the standardized quantitative assessment was only

done once, in 2010, as these results were expected to remain stable over the span of this dissertation (see Cattell, 1963; Schaie, 2005).

Additional standardized testing with deaf and hearing students took place at the Santa Maria school, in a room free of all furniture and other potential distractions with the exception of a table and two chairs. Both the *Test de Vocabulario en Imagenes Peabody* (TVIP) and the *Leiter International Performance Scale-Revised* (Leiter-R) were administered consecutively to individual participants by the experimenter. Both tests were administered according to the guidelines described in their respective manuals. Spanish was used to communicate with hearing participants and a mixture of Spanish and signs were used with deaf students. The TVIP is a standardized assessment tool of receptive vocabulary and was used to assess deaf children's understanding of Spanish. The Leiter-R is a measure of nonverbal intelligence that has been shown to be suitable for use with deaf individuals. It was used to verify that the cognitive abilities of deaf students at Santa Maria School were within the normal range of children of the same age; thus, suggesting normal capacity to contribute to the emergence and possible evolution of SMSL. Because no norms exist on both the TVIP and the Leiter-R for Dominican children, the results of hearing children on the TVIP and the Leiter-R were used to replace normative scores for analyzing the results of the deaf children on the same test and are considered to be "local norms". The results of ten hearing children, aged within two months of each deaf student were retained for this purpose. Testing sessions lasted a maximum of two hours. Participants were allowed to take breaks as needed during the testing.

Observational study. This phase of the study took place in a classroom at the Santa Maria school during a summer school program on two separate occasions (in 2010 and 2012). Free play sessions between deaf children were videotaped using a Sony Handycam. No

directions were given to the participants by the experimenter although they were aware that they were being filmed. Deaf children were seated randomly in a classroom reserved for their use and they were accompanied by a maximum of three hearing camp counsellors who lead a variety of arts and crafts activities with the children. No hearing children were present. No specific instructions were provided to deaf students by the experimenter. The goal was to observe a diversity of signs as naturally produced by the various participants in order to obtain a more accurate perception of their signing repertoire and abilities. This data, when coded, was used to determine each deaf child's overall knowledge and use of SMSL over time.

Coding Procedures

Standardized quantitative assessment. The results of all participants were coded according to the guidelines specific to each measure. Deaf students' results on the Inventario II were tallied and the total number of words and signs reported to be produced by individual children were added to obtain a broad estimate of their individual vocabulary size in both Spanish and SMSL. A raw score on the TVIP was obtained by subtracting the total number of errors of each student to the number of the final item administered after making 6 errors in a series of 8 items (i.e., ceiling item). These results were indicative of deaf students' receptive linguistic abilities in Spanish (assessed through lip-reading which is consistent with the teaching style at Santa Maria School). A global raw score on the Leiter-R was obtained by adding the raw scores obtained for all age-appropriate subtests. The process by which raw scores are obtained for individual subtests varies from one test to the next. A description of these procedures can be found in the Leiter-R testing manual (Roid & Miller, 2002). The standardization of this measure assures the validity of the obtained raw scores. Scores, interpreted in terms of intellectual quotients (IQ), were indicative of deaf students' overall cognitive abilities.

The results of hearing children on both the TVIP and the Leiter-R were paired according to age group. These “local norms” were used in lieu of normative data to compare the results of the deaf children on the same tests. Such comparisons were used to determine whether the deaf children presented linguistic and cognitive abilities equivalent to those of hearing children of the same age. It is important to note that the results obtained by hearing participants on both the TVIP and the Leiter-R were not considered to be normative. As such, this study does not imply, in any way, to be conducting a validation of either the TVIP or the Leiter-R for a Dominican administration. Under no circumstance should the hearing participants be considered a general normative sample outside of this study.

Observational study. Goldin-Meadow and Mylander’s minimal requirements for a communicative symbol (1998) were used in order to distinguish communicative gestures produced by the participants from other movements. These requirements include the direction of the gesture towards another individual with established eye contact or assurance of the partner’s attention and an absence of direct manipulation of a person or object while executing the gesture. Two independent coders determined if signs met these criteria and coded the signs observed as part of this study. The principal coder, who is also the experimenter conducting the study, coded 100% of the data collected, whereas the second coder, an undergraduate research assistant, coded 25% of all video material. Both coders had broad knowledge of Sign Language structure. An agreement criterion of .80 or higher as assessed by a covariance analysis was considered satisfactory in attesting for the reliable overall interpretation of observational data.

As explained by Goldin-Meadow, McNeil, and Singleton (1996), and based on categories established by Supalla (1982) as part of his codification system for signed languages, the form of individual signs was identified through an analysis of the handshapes and motion used to

produce them. A disruption in the production of either of these identifiers (e.g., a change in the configuration of the hand or a pause between the original hand configuration and motion) served to dissociate signs into two distinct units. Sign strings were identified based on the continuous flow of the motion connecting the handshape and the directionality of the signs during production. As such, a retraction of the hands or pause between the production of two signs distinguished them as being independent from one another. Meaning was attributed subjectively to individual signs based on our interpretation of the intended purpose of a sign, based on the experimenter's knowledge of SMSL and available clues (e.g., if while talking about a plane a child uses the sign "plane" at head-level in combination with a forward motion from right to left and followed by the sign "see" we deduced that the child was referring to the object "plane" that he, the subject, saw, the action, flying in the sky).

The evolution of SMSL was evaluated by both coders from the retained signs in terms of fluency and spatial modulation at each time point (Figure 1). Similar to Senghas and Coppola (2001), fluency was analyzed in terms of signing rate, defined as the total number of morphemes produced per minute. Each distinct sign produced by individual signers was counted as one morpheme. The addition of any phonological element to a sign that modified its form and meaning from the neutral form (i.e., variations in location, movement or handshape that add semantic reference) was counted as an additional morpheme. Individual signs could therefore be counted as including several morphemes. All morphemes produced by each participant were counted and attributed one point. The sum of each participant's points was therefore equivalent to a signer's overall number of morphemes produced. The total signing time of each signer was calculated in terms of minutes spent signing. The signing rate of each participant was determined

by dividing the overall number of morphemes produced by individual participants to the total signing time.

Spatial modulation was evaluated in terms of the location and movement of each sign produced by individual participants. As described by Senghas and Coppola (2001), spatially modulated signs constitute signs produced in non-neutral locations or incorporating movement towards or from a non-neutral location for the purpose of conveying additional grammatical information relevant for the intended meaning (e.g., indicating a person or number, providing deictic, locative, or temporal information, or indicating grammatical relationships). A neutral position is defined as being located directly in front of the signer's body in a space confined between the neck and the hips (Bellugi & Fisher, 1972). Consequently, signs produced in a location that differed from its neutral form (e.g., on the side of the body or at arm's reach) were considered as manifesting spatial modulation and were attributed one point. Signs produced in motion (e.g., from side to side, outward, etc.) were also considered as manifesting spatial modulation and were attributed one point. Signs were counted as exhibiting two spatial modulation criteria if they meet the criteria for a non-neutral signing position as well as for motion. Semantic reference for each spatially modulated sign was determined through a comparison of their immediately preceding sign. Signs were coded as having a shared reference if their proceeding sign was produced in a common non-neutral location. Signs who did not share reference with their proceeding sign were coded as using spatial modulation for other purposes.

A total of 180 minutes of video recordings were collected in 2007 for all participants combined, 300 minutes in 2010, and 240 in 2012. Overall, 897 signs were analyzed for all participants combined in 2007, 4261 in 2010, and 1680 in 2012.

Statistical Analyses

Standardized quantitative assessment. One Sample t-tests were used to identify the presence of significant differences between the cognitive and linguistic abilities of deaf participants in comparison to the norms of the hearing controls. Results on the Leiter-R were expected to show comparable intellectual abilities between deaf and hearing participants, suggesting that deaf students have sufficient abilities to use and understand language structure at an age-equivalent level. Results on the TVIP were expected to support parental and school reports of deaf children's extremely low understanding of the Spanish language.

Observational study. Inter-rater reliability was assessed by a covariance analysis from which a Pearson correlation coefficient of 0.9682 was obtained and considered acceptable for attesting for the reliable overall interpretation of observational data.

A series of linear regressions were completed in order to determine whether deaf children's knowledge of the Spanish language (as evaluated by the Inventario II and the TVIP) influences their knowledge of SMSL in terms of signing rate, the number of new or different signs produced, the number of spatial modulations produced, the number of signs produced, and the number of morphemes produced.

Because SMSL is believed to be a pidgin sign language, paired sample t-tests were conducted in order to identify evidence of the generational transmission and evolution of the language over time. Data collected in 2012 was not included in these analyses given the limited sample available for comparison (i.e., only four deaf students remained at the school and participated in this study). Paired Sample t-tests were chosen despite some variations in the overall sample over time given that 1) half of the sample was the same in both 2007 and 2010 and 2) participants are believed to be part of the same small population of deaf individuals. The

generational transmission of SMSL over time was evaluated in terms of signing rate, vocabulary size and spatial modulation. Discrepancies in sign production between 2007 and 2010 would indicate a more complex use of the language over time, and would support hypothesis of children's contribution to language development. Further, it would provide evidence for the expected presence of two generations of signers within the community.

Results

Standardized quantitative assessment. Deaf participants' cognitive abilities (or IQ), as assessed with the Leiter-R, were found to be generally comparable to those of the local norms obtained from same-age hearing peers, $t(7) = -1.44$, $p = .201$ (Table 7), although a visual examination of the individual scores shows that one child appeared to have lower nonverbal cognitive abilities in comparison to same-aged peers. Their knowledge of Spanish, as assessed by the TVIP, was significantly below age expectations for all deaf participants tested, $t(7) = -14.74$, $p = .000$ (Table 8). On average, deaf participants were found to have an understanding of the Spanish language equivalent to that of three-year-old hearing children ($M = 3.23$, $SD = 1.10$). Overall, these results suggest that deaf students at Santa Maria generally had the cognitive abilities to use and understand language at an age-expected level but displayed extremely limited understanding of the dominant language in their community (i.e., Spanish).

Quantitative data. A simple linear regression was calculated to predict SMSL proficiency based on Spanish knowledge as assessed by the Inventario II (Table 9). Results suggest that deaf children's estimated Spanish vocabulary did not impact their competence in SMSL; thus supporting the independent nature of SMSL from the environmentally dominant Spanish. Specifically, results on the Inventario II did not influence signing rate ($F(1,7) = 0.3435$, $p = .5762$, with an R^2 of .0469), the number of new or different signs produced ($F(1,7) = 1.313$, p

= .2896, with an R^2 of .1579), the number of spatial modulations produced ($F(1,7) = 1.124$, $p = .3242$, with an R^2 of .1384), the number of signs produced ($F(1,7) = 0.9810$, $p = .3549$, with an R^2 of .1229), or the number of morphemes produced ($F(1,7) = 1.056$, $p = .3383$, with an R^2 of .1311).

Similarly, the impact of expressive Spanish skills as assessed by the TVIP on SMSL proficiency was not significant in terms of signing rate ($F(1,5) = 0.5186$, $p = .5037$, with an R^2 of .09398), the number of new or different signs produced ($F(1,5) = 0.01912$, $p = .8954$, with an R^2 of .003809), the number of spatial modulations produced ($F(1,5) = 0.02573$, $p = .8788$, with an R^2 of .005120), the number of signs produced ($F(1,5) = 0.06174$, $p = .8136$, with an R^2 of .01220), and the number of morphemes produced ($F(1,5) = 0.04277$, $p = .8443$, with an R^2 of .008482).

Since Spanish knowledge was not found to impact deaf children's competence in SMSL, within-sample t-tests were completed in order to evaluate the generational transmission of SMSL over time. Results revealed that signing rate ($t(8) = -2.97$, $p = .017$) varied between times of testing, suggesting that when tested in 2007 ($M = 94.9$, $SD = 11.79$) deaf students were significantly slower at signing and producing sign strings than they were in 2010 ($M = 144.9$, $SD = 37.61$). Signers in 2007 therefore produced significantly less morphemes per minute than they did three years later, suggesting some evolution in the use of SMSL by deaf students over time. Vocabulary size also approached significance ($t(8) = -2.20$, $p = .059$), with signers in 2007 displaying a far less diverse array of signs ($M = 39.7$, $SD = 23.70$) than in 2010 ($M = 149.6$, $SD = 141.44$), suggesting that their ability to communicate their specific thoughts and needs in 2007 was far more restricted and more greatly depended on other means such as pointing. However,

caution is necessary when interpreting these results given large standard deviations and a small sample size.

No significant differences were observed between the total spatial modulation produced by deaf students in 2007 ($M = 84.3$, $SD = 63.49$) in comparison to that produced by students in 2010 ($M = 325.2$, $SD = 347.19$), $t(8) = -1.94$, $p = .089$. Again, large standard deviations may have impacted results and caution is required when interpreting these results given the small sample size. A difference of over 200 points between the total amount of spatially modulated signs produced by each group suggest that deaf children observed in 2007 show a tendency to produce fewer complex signs than their peers in 2010.

Additional analyses compared the total number of signs and the total number of morphemes produced by deaf students at the two time points. While Paired Sample t-tests did not reveal significant differences, results neared significance for both the total amount of signs produced ($t(8) = -2.15$, $p = .064$) and the total amount of morphemes produced ($t(8) = -2.05$, $p = .074$) by deaf students at each time of testing. Specifically, signers appeared to produce more signs ($M = 381.4$, $SD = 361.01$) and morphemes ($M = 706.7$, $SD = 706.28$) overall in 2010 than they did three years earlier in 2007 ($M = 99.7$, $SD = 73.96$ total signs and $M = 184.0$, $SD = 136.17$ total morphemes); suggesting some increased complexity in sign production over time.

Observed variations between sign productions at each testing time are presented in Figure 2, while individual signers' performances are depicted in Tables 10 to 14.

Qualitative data. Overall, children comprising the deaf community of Santa Maria school were found to use communicative gestures in both 2010 and 2012 according to the minimal requirements for a communicative symbol described by Goldin-Meadow & Mylander (1998). These requirements include: the direction of the sign towards another individual with

established eye contact or assurance of the partner's attention; and the absence of direct manipulation of a person or object while executing the sign. Additional behavioral particularities of SMSL were also noted during the codification of the data. Consistent with observations from the 2007 study, noted structural behaviors included: the use of facial expressions, and ambidextrous qualities in signing (i.e., some children used both hands to produce certain one-handed signs). Still, children were also at times observed manipulating objects while signing and using objects to compensate for a lack of sign (e.g., pointing to a colored pencil to refer to the colour). Similarly, contrary to fully developed Sign Languages, SMSL does not appear to have developed signs to signify "yes" and "no". Instead, deaf students at Santa Maria School were observed using head nods and shakes to communicate their agreement and disagreement. Mouthing was also used by some students in combination with signs (e.g., one student made the sign for "mother" all the while saying the name of her mother), and pointing continues to be used predominantly by all students (e.g., to signify places and people, etc.) rather than more specific signs. Although definitive conclusions cannot be deduced from these basic structural particularities, it can provide insight on the likely linguistic stage of development of SMSL. When comparing SMSL to earlier structures of the Nicaraguan Sign Language (see Kegl et al., 1999), it can be theorized that the current basic linguistic properties of SMSL continue to show some resemblance to that of rudimentary pidgin sign language, though SMSL still does not appear to have fully attained a structure equivalent to that of LSN. Specifically, SMSL shows evidence of the direct combination of the different homesigns used by individual deaf children in a way to create a common lexicon. Table 15 presents a list of common lexical items observed in our participant samples. Evidence for the presence of mutual intelligibility has been found in the repeated use of identical signs by various signers within the community (Figure 3). Many objects

and people are referred to by one commonly accepted sign, and such signs, included into a narrative, can be unanimously understood by all parties implicated. However, SMSL continues to lack many complex grammatical structures and does not yet serve as a native language to the deaf community (as demonstrated by the high level of variance between individual deaf signers' sign production).

Finally, a rudimentary qualitative comparison of the signs produced in the current study to those of the American Sign Language, the most commonly used sign language in the Dominican Republic, and the lesser-known Dominican Sign Language revealed similarities below 50%, providing support for the idiosyncratic composition and, thus, origin of SMSL. Figure 4 presents some of the signs that appear to be specific to SMSL. We argue that the Santa Maria Sign Language can therefore be considered a newly arising manual communication system in the Dominican Republic.

Discussion

The present comparative study aimed to explore the possible emergence of a new manual communication system in the Dominican Republic in a manner similar to that previously reported by Senghas and others in Nicaragua. The first part of this study intended to document the development of this communication system over a five-year period, and to concurrently demonstrate children's innate ability to create language. It was argued that deaf children at Santa Maria School would possess cognitive abilities comparable to those of same-aged hearing peers, but that their linguistic abilities and knowledge of the Spanish language more specifically would show significant delays. As expected, despite their significant hearing impairments, deaf students' intelligence quotient, as assessed by the Leiter-R, did not deviate from our local norms. This suggests that deaf students, unsurprisingly, have the cognitive capability to understand and interpret the world around them with the same sophistication as other hearing children in their

community. That being said, their Spanish receptive vocabulary was found to be extremely below that of their hearing peers. It is therefore possible to propose that deaf children at the Santa Maria School do not master the Spanish language, and likely received incomplete linguistic input from their environment. Their rudimentary knowledge of Spanish was not found to influence the development of SMSL.

With regards to SMSL, it was hypothesized that an emerging and developing manual communication system would have signs that meet the minimal requirements for a communicative symbol described by Golden-Meadow and Mylander (1998), as well as manifest evidence of mutual intelligibility. Importantly, development would result in a more complex use of the language in question by signers over time. Consistent with what was originally expected, the qualitative results support the emergence of SMSL as a new manual communication system, and data collected from each deaf participant met Goldin-Meadow and Mylander's minimal requirements for a communicative symbol (1998). Furthermore, mutual intelligibility of the system's signs was present across participants, and those signs were shown to differ from both the official Dominican Republic Sign Language and American Sign Language, most commonly used in the country by Deaf individuals. Further, quantitative analyses showed a significant increase in signing rate between 2007 and 2010, suggesting an increased fluency in sign production over time. Vocabulary size and the total number of signs produced overall by deaf participants also approached significance, providing further support for an increased proficiency with manual communication by signers over time. Specifically, signers in 2007 appeared to use fewer complex signs and to be less efficient signers overall than they were three years later. That being said, the number of deaf children observed as part of this study is small, despite representing approximately half of the total deaf population comprising this community,

therefore greatly limiting statistical power in our analyses. Elevated standard deviations were also observed suggesting some variations in the sign production of individual children. Caution is necessary when interpreting these results.

Overall, results suggest that a new manual language may be developing in an isolated community of the Dominican Republic. Indeed, evidence supports a gradually more complex use of this language over time, suggesting that young children may be developing a more fluid use of signs for communicational purposes (i.e., combining sign strings more rapidly and using more diverse and specific signs over non-specific signs such as pointing). Two cohorts of signers may even be present, given this more complex use of SMSL between 2007 and 2010. At the very least, it can be argued that generational transmission is successfully taking place to the extent that new incoming children at Santa Maria school have managed to learn and to effectively use the basic properties of this rudimentary manual communication system to a level that is comparable (if not superior) to older children already attending school at Santa Maria for several years. The sign production of two participants present across all testing times was further analyzed in part 2 of this study in order to explore the specific grammatical development of SMSL over time.

Part 2: Identifying the presence and evolution of specific phonological markers

First demonstrated by Stokoe (1960), sign languages have been found to share grammatical properties similar to those of spoken language. For example, fully developed sign languages have been shown to have a syllabic and prosodic structure (Perlmutter, 1992; Sandler, 2010), to produce complex sentences including relative clauses (Golden-Meadow & Brentari, 2017), and to make use of reduplication (Meir, 2012). Part 1 of this study already documented the presence of some grammatical structure within SMSL (i.e., the use of phonological markers in the context of spatial modulation and sign complexity). The second part of this study, aimed to

further explore the phonological structure of SMSL. The exploration of phonological acquisition was chosen given its comparable developmental time course in the manual mode in comparison to spoken languages (Brentari et al., 2017). Three parameters comprise sign language phonology: handshapes, locations, and movement. While globally the phonological features of SMSL were not found to be significantly different between 2007 and 2010, part 2 of this study focused on the specific evolution of handshape structure in two Dominican signers over a five-year period in order to detect possible variations between the specific phonological development of individual SMSL signers over time.

As described by Brentari et al. (2017), “handshape is one of the sublexical phonological units of sign languages and can be thought of as a natural class, the way that obstruents (stops and fricatives) form a natural class in spoken languages” (p.284). It is guided by morphosyntax, and has several subcomponents, including joint configuration and finger selection, which in turn impact morphophonology (Brentari, 1998, Brentari et al., 2017).

Brentari, Coppola, Mazzoni, and Goldin-Meadow (2012) distinguish two types of handshapes. Object handshapes (also known as “hand-as-object” handshapes) manually portray the object as a whole or depict a physical aspect of the object they represent (e.g., its shape, size, appearance, etc.). Handling handshapes (or “hand-as-hand” handshapes) depict the manipulation of the object. Both types of handshapes are considered to be iconic in nature and are therefore accessible to both gesturers and signers. Overall, object handshapes are considered to be more complex than handling handshapes, although they have been found to be produced earlier by children (Coppola & Brentari, 2014). Handshape complexity is defined according to the number of fingers selected for their production and the configuration of the joint. Complexity is determined based on the frequency with which individual handshapes are observed, the structure

of the phonological structure, and the age at which a particular handshape is acquired by children. Overall, handshape complexity is correlated with sign language acquisition and a higher complexity is generally attributed to a more adultlike and diverse handshape inventory (Brentari et al., 2017). Similarly, more complex handshapes are generally less frequent cross-linguistically.

Handshapes with a low level of finger group complexity are those that include all fingers, the index finger, or the thumb. Medium finger group complexity is attributed to handshapes including a second finger on the radial side of the hand (i.e., closest to the thumb), or using a finger that is not on the radial side. Handshapes with a high level of finger group complexity include all other finger selections. Joint complexity is determined according to the configuration of the fingers. Fully extended and fully flexed handshapes present the lowest level of complexity, while handshapes presenting stacked or crossed fingers share the highest level of complexity. Refer to Figure 5 for examples of handshapes displaying different levels of joint and finger group complexity.

Through her studies, Brentari has shown that individuals in input-deprived environments can develop homesign systems featuring some elements of morphophonology and morphosyntax (e.g., Coppola & Brentari, 2014 and Brentari et al., 2017). Coppola and Brentari's Distributional Model (2014) proposes the linguistic development of handshapes in 4 stages. At one end, individuals merely recognize that handshape type (i.e., object handshapes and handling handshapes) can be used for grammatical purposes. The opposing end of the continua sees a systematic use of handshape types to mark linguistic contrasts (specifically as it relates to the depiction of agentive and non-agentive events).

Using Brentari's research as a guide, this study aimed to explore the presence of basic phonological elements within SMSL. The goal was to define the types of handshapes used by SMSL signers and to document whether their level of overall complexity varied over time. This was done in a qualitative manner and a more detailed investigation into the specific elements of SMSL's phonological structure (e.g., morphophonology) was not completed. As such, we did not look into the use given by SMSL signers to different handshape types and merely focused our investigation on reporting the frequency with which various handshapes are produced.

Handshape type and complexity were documented for two Dominican deaf children at three testing times in order to further explore the long-term composition and evolution of SMSL. These two signers were selected based on their continued participation in the longitudinal study at all three times of testing. It was hypothesized that deaf children in the Dominican Republic would produce few complex signs overall, and that, consistent with previous research (Coppola & Brentari, 2014), they would produce a greater number of object handshapes than handling handshapes. Some increase in overall complexity was expected over time, consistent with the possible evolution of SMSL as a rudimentary pidgin sign language.

Participants

The productions of two deaf sisters registered at Santa Maria School at all three testing times and thought to belong to a second or younger generation of signers were analyzed for the second part of this study. Data was collected from the youngest child at ages 4, 7, and 9 years, while data for the other child was collected when she was 7, 10, and 12 years old. Both live in the same household with their biological parents. Their mother, who was studying to be a teacher at the time, served as their main common homesign communication partner. Their mother had no specific knowledge of SMSL and had not completed any formal training in LESDOM, although

she did take a few classes on the learning patterns and academic particularities of deaf children. Lip-reading was favoured at home for communication with the sisters but signs were also used at times to enhance understanding.

Procedure

Data was collected as part of the longitudinal study presented in Study 1 of this chapter and comprises all signs produced spontaneously by the sisters in the context of the semi-structured study completed in 2007, and the free play sessions videotaped in 2010 and 2012.

Coding Procedure

As described in Study 1, Goldin-Meadow and Mylander's minimal requirements for a communicative symbol (1998) were used in order to differentiate movements from communicational gestures.

Similar to Coppola and Brentari (2014), and Brentari et al. (2017), signs produced by each child were coded in terms of the handshape(s) used to depict them. Specifically, handshapes were categorized according to two types: object handshapes and handling handshapes. Handshapes who did not meet these criteria were classified as "other" and included signs such as points, signs that appeared to trace the shape or path of a referent, and whole-body signs.

Using Eccarius and Brentari's coding system for the transcription of phonological markers in sign language (Eccarius & Brentari, 2008), the complexity of individual handshapes was then coded in a way similar to Brentari et al. (2017) and Coppola and Brentari (2014). Complexity scores of 1 to 3 points (i.e., 1 for low complexity and 3 for high complexity) were given to handshapes for both joint configuration and selected finger group based on the classification system presented in Figure 5 and described in more detail earlier in this chapter.

An extra point was awarded to signs presenting dimensional changes (i.e., changes from one complexity level to another).

Qualitative Results

Figure 7 shows the average finger group and joint configuration for both SMSL signers at all three testing times. Figure 8 presents a summary of some of the handshapes produced at all three testing times.

Overall, the two deaf Dominican signers used non-specific signs approximately half of the time when communicating manually. As expected, object handshapes represented the most common form of iconic signs used by our deaf participants and handling handshapes were used less than one quarter of the time. This pattern varied minimally over time contradicting results from the first part of this study which suggested some possible evolution in the use of signs by deaf students at Santa Maria school. Figure 6 highlights the handshape types produced by both SMSL signers at all three testing times.

Similarly, signs produced by both participants displayed a minimal level of complexity both in terms of finger group and joint configuration. Specifically, signs mostly exploited fully extended and fully flexed handshapes, and involved all fingers or the specific selection of the index finger.

Discussion

The second part of this study aimed to document the evolution of phonological structure, and more specifically handshape use, of two Dominican signers over the span of five years. While spatial modulation was not found to be evolving with the global population of SMSL signers studied between 2007 and 2010, it was hoped that an evaluation of the specific handshape inventory of two individual signers at three different time points would reveal signs of

increasing complexity. Specifically, the use of more complex handshapes was expected to be observed over time. Signers were expected to produce more iconic signs (i.e., object and handling handshapes rather than pointing and other non-specific signs), and to produced handshapes with more intricate joint and finger configurations.

Contrary to what was expected, no such differences were observed and the two deaf participants studied here mainly produced low complexity handshapes in terms of both finger group selection and joint configuration. These results are consistent with the more general use of spatial modulation by SMSL signers described in part 1 of this study. Still, these results are also consistent with previous research that suggest that lower complexity is typical in younger populations of signers (Brentari et al., 2017), and that object handshapes are typically used by children before Handling handshapes (Coppola & Brentari, 2014).

While the presence of some phonological features suggests the commencing development of phonological structure within SMSL, results from the second part of this study are powerless with regards to documenting specific changes to SMSL's suspected phonological system. However, it is important to note limitations imposed by the methodology used in this study. Mainly, the documentation of signs produced in a natural, non-restricted, and non-solicited manner.

Given that the sole objective of this part of the study was to document the nature of handshapes use by SMSL signers over time, it may be beneficial in the future to evaluate the specific development of phonology within this manual communication system by looking at the morphosyntactic and morphophonological structures present (if any) within SMSL, including handshape's role in communicating grammatical contrast. A second study was designed to

further document the development of SMSL by exploring the influence of input on sign production.

Chapter 3

Study 2: Clarifying the role of input on the acquisition and production of signs

Gestures are common to every culture and every language (Goldin-Meadow, 2015). Gesture use can be observed in individuals of all ages, and even individuals who suffer from congenital blindness can be observed gesturing when they speak despite never having observed this behaviour in others (Iverson & Goldin-Meadow, 1998). Indeed, some argue that gestures came first in the evolution of human language development, although this is open for debate (see Kendon, 2017 for a review). The fact that babies typically use gestures before they learn to speak (Bates, 1976) leads some researchers to believe in the evolutionary superiority of gestures over speech. Still, others argue instead that speech and gestures evolved simultaneously and are part of the same linguistic process, based on evidence suggesting the presence of intricate connections between speech and gestures (Kendon, 2004; McNeil, 2000, 1992). For example, the structure and organization of gestures produced by hearing individuals have been shown to be influenced by speech (McNeill, 1987). Gestures have also been shown to extend children's communication after the onset of speech (Greenfield & Smith, 1976). Most researchers agree that gestures constitute a resilient component of language; an ability that humans are born ready to develop.

This ability for innate gesture production is believed to form the basis of deaf children's ability to create sign systems in input deprived environments. Just as hearing children first use gestures to express their desires and needs (e.g., pointing, or moving the hands near the mouth to mimic eating), young deaf children in input deprived environments develop a series of points, descriptive gestures, and markers to communicate with their immediate family members. These basic gestures in both hearing and deaf children are thought to be influenced by the input

received from their parents through co-speech gestures (i.e., gestures produced in combination with speech). Specifically, parents have been shown to provide models of gesture production to their children in terms of exposing them to different gesture types and gesture combinations (Özçalışkan & Goldin-Meadow, 2005). As such, parents' use of gestures encourages the use of similar gestures by their children in early childhood in terms of quantity and style (Özçalışkan & Dimitrova, 2013). Hearing children will use more gestures if their parents also frequently produce them (Iverson, Capirci, Longobardi, & Caselli, 1999; Liszkowski, Brown, Callaghan, Takada, & de Vos, 2012), and they are more likely to produce the same types of gestures as their parents (Iverson, Capirci, Volterra, & Goldin-Meadow, 2008).

Iverson and Goldin-Meadow (2005) argue that gestures allow for practicing the expression of meaning prior to being able to do so through speech. For example, mothers have been shown to “translate” or provide verbal feedback to their child's gestures (i.e., if a child points to an object, parents are likely to respond by saying the name of that object), therefore facilitating learning and the development of vocabulary (Goldin-Meadow, Goodrich, Sauer, & Iverson, 2007). Parents have also been shown to modify the way they communicate with young children to meet their needs and abilities (Özçalışkan & Dimitrova, 2013). Specifically, parents have been found to simplify the way they speak to their child by using simpler vocabularies, by slowing down their speech production, by extending vowels, by using a higher pitch and intonation, by increasing pauses, by producing shorter and grammatically simpler sentences, and by using repetitions more frequently (Fernald, 1992; Gleitman, Newport, & Gleitman, 1984); a process known as infant-directed speech (IDS) or motherese.

This is problematic for deaf children born to hearing parents. First, because gestures carry the full burden of communication for this population. Parental input cannot serve as “practice”

for developing meaning, but rather is the only means to acquiring a symbolic understanding of the world around them. As such, gestures cannot be used to reinforce, clarify, or add to the message conveyed with speech (e.g., pointing to a toy and asking the child to pass it). Second, the hearing parents of deaf children typically learn Sign Language at the same time as their child. They are therefore less likely to translate their child's gestures (e.g. name desired objects identified through pointing), since they have a more limited gesture repertoire (Hunsicker & Goldin-Meadow, 2012), and are also less likely to exclusively use gestures or signs to communicate with their children. Indeed, most gestures produced by hearing parents are paired with speech (McNeil, 1992, Özçalışkan & Dimitrova, 2013). Further, because of their limited knowledge of Sign Language, the hearing parents of deaf children are more likely to depend on their child to introduce new rudimentary structural properties to their gestures, such as combining gestures to create more complex sentences (Goldin-Meadow & Mylander, 1998). Overall, the combination of gestures and speech can influence hearing children's language development and gesture production in a way that is different from deaf children who are confined to manual communication.

Consistent with the overall goal of this dissertation to document a potentially newly developing manual communication system, this study aimed to explore the possible influence of input on the development of SMSL. Specifically, we asked whether SMSL differed from 1) the environmental input available to the deaf population studied (i.e., the co-speech gestures produced by hearing parents), and 2) the signs spontaneously produced by hearing adults and children in absence of speech (i.e., silent gestures). The intent was to further clarify whether SMSL indeed constitutes a manual communication system beyond what would be expected of functional communicators and homesigners, by demonstrating its independence from input, and

its status as a separate communicational entity. By doing so, it was also our hope to provide further evidence of children's contribution to language development.

Because ninety per cent of all gestures produced by hearing individuals are in combination with speech (McNeil, 1992; Özçalışkan & Dimitrova, 2013), and because deaf children are rarely exposed to a complete and consistent language input until their admission into the school system (Goldstein & Bebko, 2003), we questioned in the first part of this study whether co-speech gestures were adequate to convey to deaf SMSL signers the rudimentary linguistic properties observed and documented in Chapter 2. In Part 2 of this study, we looked into possible distinctions between the signs produced by deaf children and those produced by hearing Canadian adults (who are also the parents of hearing children) in absence of speech in order to document the similarities and differences between SMSL and silent gestures. Distinctions between infant-directed and adult-directed signs were also explored to decipher the possible influence of manual motherese on language acquisition. Finally, Part 3 of this study provided insight on the spontaneous production of signs by hearing children in absence of speech in an attempt to identify whether SMSL possesses linguistic properties that go beyond those of the silent gestures naturally produced by children when signs must assume the full burden of communication.

Part 1: Differentiating parental input in the acquisition and production of signs

Little is known of the influence of parental input relative to the creation and acquisition of rudimentary sign systems which in turn may develop into languages. The study of sign production by young children has demonstrated the resiliency of some linguistic properties (e.g., segmentation and hierarchical properties). Children naturally produce sign systems that include some rudimentary language-like elements. Similar linguistic properties have also been found in hearing adults' signs when produced in absence of speech (Goldin-Meadow, 2006a; 2006b;

Goldin-Meadow et al., 1996). However, gestures produced in combination with speech generally fail to comprise language-like properties at the phrase level (Goldin-Meadow & Mylander, 1983; Goldin-Meadow et al., 1996). The gestural input received by deaf children from their hearing parents therefore rarely includes the linguistic properties found in homesigns. Thus, evidence suggest that the signs produced by deaf children differ from those of their hearing mothers (Goldin-Meadow, 2006a; Goldin-Meadow et al., 1996; Goldin-Meadow & Mylander, 1983). Further, evidence also suggests that the gestures produced by hearing mothers of deaf children are in fact no different than those produced by hearing individuals in combination with speech.

Unlike the signs constituting Sign Languages, gestures produced in combination with speech do not assume the full burden of communication and therefore are bound by the constraints of speech (Goldin-Meadow et al., 1996). Gestures produced in combination with speech tend to be more iconic in nature, thus lacking the segmentation essential of all spoken languages as they provide meaning in their general form rather than through a combination of meaningful parts (Goldin-Meadow, 2003a). Still, gestures produced in combination with speech have been shown to convey linguistic information (such as meaning) independent of the verbal content of speech (e.g., manually indicating how objects move in relation to one another while stating with words that objects move more generally) (Goldin-Meadow, 2006a). Further, the gestures used by hearing parents to communicate with their deaf infants have been shown to provide some structural input at the gesture level (e.g., handshape and movement) (Goldin-Meadow & Mylander, 1990). It is possible that such rudimentary properties are conveyed to deaf children by their hearing parents. Could it be, that the linguistic properties provided by hearing adults through the gestures they produce in combination with speech, are sufficient for children to create developing sign languages? Assuming that parents are equivalent to first generation

signers and that their use of gestures is similar to what would be seen with rudimentary generational transmission, this could explain why the signs produced by children surpass those of their parents (Goldin-Meadow & Mylander, 1990).

Yet, similar studies comparing the signs of deaf children to those of hearing adults (e.g., Goldin-Meadow 2007; Goldin-Meadow & Mylander, 1998; 1990; 1983) have consistently shown the non-effect of parental input on language development and instead support children's contribution to the creation of structural regularities within a language, even in input-deprived environments, through the development of syntactic (at the sentence level) and morphological (at the gesture level) rules.

Following the first study described in Chapter 2, and in relation to establishing the linguistic status of SMSL as a developing manual communication system, the current study aimed to specify whether and how SMSL differs from the gestures produced by the hearing parents of our deaf Dominican sample. Documenting such differences, in addition to providing further evidence of children's role on the creation and evolution of language, would assist with defining SMSL as a developing manual communication system independent from input.

Given previous evidence of the mainly differing structure of gestures produced by hearing adults, parental input was not expected to significantly impact deaf children's contribution to the creation and evolution of SMSL as a rudimentary pidgin sign system. The gestures produced by hearing parents were generally not expected to resemble those of their deaf children. As reported by Senghas (2003), parents were not expected to have native-like competencies in their children's suspected pidgin language. Instead, they were expected to have a limited manual vocabulary and to use gestures as complementary to speech when communicating with their deaf child. Still, some rudimentary similarities were expected to be

found between the gestures produced by hearing parents and the signs of their deaf children (Goldin-Meadow & Mylander, 1990). Mainly, similarities were expected at the gesture level, in the phonological properties of gestures and signs produced (i.e., in terms of movement, handshape, and location). Because hearing parents are expected to depend on speech when communicating manually, their gestures were not expected to be combined into ordered strings or to show signs of internal structure, independent from speech. The presence of such similarities would instead support the role of downward generational transmission for the evolution of language and would therefore negate previous evidence for the sole innate creation of language by children. In light of a sensitive period for language acquisition, evidence supporting the role of parents in the creation and evolution of language, would require the use by hearing parents of complex linguistic properties equal to or better than those of the deaf homesigners, in order to comply with the proposed downward directionality of generational transmission. Accordingly, only the hearing adults would have had the opportunity to fully acquire such linguistic properties prior to puberty through their knowledge of Spanish.

Participants

One hearing parent for each deaf student registered at Santa Maria School in 2011 took part in the present study, for a grand total of 8 parents. They were accompanied by their respective deaf child. Deaf children did not have a participatory role in the present study but nonetheless facilitated it. Participants were recruited at home by the experimenter.

Procedure

The experimenter visited prospective participants (i.e., parents) at home in order to introduce the goals of this second study in relation to the longitudinal research already underway with their respective child. Testing procedures were explained. Consent and assent were obtained

from both adult and child participants prior to testing. A date for the testing session was assigned to the participants in accordance to their availability.

Testing took place at the Santa Maria school, in a room free of all furniture and other potential distractions with the exception of a chair and a Sony Vaio laptop with a 17-inch screen. Each participant was presented with 40 video segments of one to two seconds in length each. Film segments were originally created by JPL Production with the collaboration of the Quebec Ministry of Education (1977-1998) for the production of a television show aimed at children aged 4 years. Each video segment featured simple actions performed by either children or adults (e.g., riding a bicycle, watering a plant, fishing, etc.) and involved either one standalone object or one object moving in relation to another one. Similar video segments have been previously used effectively in studies conducted with non-signers and signers using varying Sign Languages (Brentari et al., 2017, Coppola & Brentari, 2011, Goldin-Meadow et al., 1996; Singleton, Morford & Goldin-Meadow, 1993). While parents viewed the videos, deaf children remained seated opposite their parent in such a way that they were unable to see the videos on the screen. After each video segment, participants were asked by the experimenter to describe orally the events depicted in the film (although the use of gesticulations was not prohibited). Participants were then presented with the same video segment a second time, after which point they were instructed to describe to their deaf child the content of the same video segment using only their hands and no speech. While not specifically requested, it was assumed that Dominican parents would opt to depict the content of the video segments using the same gestures used at home to communicate with their deaf child. Sessions were videotaped in their entirety by a video camera that was temporarily installed in the room in a way to face both the participant and the deaf child. The data collected was also used to assess the hearing parents' competence in SMSL. The

gestures produced by hearing Dominican parents were compared to the signs produced by their deaf children (i.e., the participants from Study 1 of this dissertation) in order to identify possible distinctions between homesigns and the gestures produced by hearing individuals within the same environment. This in turn allowed to clarify whether the linguistic properties provided by hearing adults through the gestures they produce in combination with speech, are sufficient for children to create fully developed sign languages even in input deprived environments.

Coding Procedure

As described in Study 1, Goldin-Meadow and Mylander's minimal requirements for a communicative symbol (1998) were used in order to confirm the production of gestures by participating parents and to differentiate gestures from other movements. These gestures were evaluated in terms of their complexity and spatial modulation by two independent coders, as defined in Part 1 of Study 1.

Statistical Analysis

Inter-rater reliability was assessed by a covariance analysis from which a Pearson correlation coefficient of 0.9581 was obtained. This was considered acceptable in attesting for the reliable overall interpretation of observational data.

An independent sample T-test was completed in order to evaluate the presence of similarities and differences in the signing competence of hearing parents and their deaf children (according to the data collected in Study 1). Each group of participants was compared in terms of signing rate, vocabulary size, and the number of spatial modulations produced.

Results

Qualitative data. The Dominican parents of deaf children varied in their use of gestures to communicate with their child. As expected, all used a combination of gestures and words,

consistent with the cultural expectation for deaf individuals to use lip-reading for communication with hearing individuals. Two of the parents stated that they do not use signs to communicate with their child at home and questioned their child's knowledge of SMSL. Interestingly, all parents produced minimal gesticulations when describing the videos orally. Yet, they rarely produced their gestures in absence of speech when asked to describe the same videos using only their hands.

Overall, the Dominican parents did not use facial expressions to add meaning to their gestures or to create emphasis, did not appear to consistently use the same gestures to convey the same meaning or refer to the same objects/concepts, and sometimes used props to enhance their gestures. Very few parents produced sufficient gestures to fully explain what they had seen in the video stimuli and many referred to a child's personal life events to try to explain the content of the videos. Their oral descriptions of the video segments were, however, complete, with mentions of the subject, object and action depicted.

Quantitative data. No analysis of parental gesticulations (i.e., gestures produced in relation to accompanying speech) was completed given limited production by individual participants. The following analyses therefore solely focus on the gestures produced by parents when describing video segments "manually" to their deaf children. The term gesture is used to describe these manual productions as speech often accompanied parents' descriptions, so the manual production was not fully assuming the burden of communication.

Contrary to expectations, independent sample t-tests aiming to identify similarities and differences between the signs of deaf Dominican children and the gestures of their parents revealed the production of mostly similar signs and gestures by both groups. Specifically, Dominican parents' signing rate ($M = 151.7$, $SD = 39.19$) was equal to that of their deaf children

in 2010 ($M = 144.9$, $SD = 39.72$), $t(16) = -0.36$, $p = 0.72$ and in 2012 ($M = 185.5$, $SD = 44.36$), $t(10) = 1.35$, $p = 0.21$. That being said, parents were found to have a greater signing rate than their children in 2007 ($M = 94.9$, $SD = 11.80$), $t(15) = -4.15$, $p = 0.01$. These results are consistent with the significant difference observed between deaf students' signing rate in 2007 and 2010 as reported in Study 1 of this dissertation. No differences were found between the gesture repertoire of the Dominican parents ($M = 78.3$, $SD = 69.45$) and the signs repertoire of the deaf children in 2007 ($M = 39.7$, $SD = 23.70$), $t(15) = -1.57$, $p = 0.14$, and 2010 ($M = 149$, $SD = 133.36$), $t(16) = 1.36$, $p = 0.19$. However, deaf children displayed a significantly greater diversity of signs in 2012 ($M = 198.8$, $SD = 117.07$), $t(10) = 2.27$, $p = 0.05$, suggesting possible evolution of their sign repertoire over time in comparison to that of their hearing parents. That being said, is it important to remember that only four deaf students were tested in 2012, resulting in a limited pool of participants and rendering inferential statistics difficult to interpret. Elevated standard deviations must also be considered and caution is necessary when interpreting these results. An analysis of the total amount of spatial modulation produced by both groups did not reveal any significant difference between the complexity of gestures produced by the Dominican parents ($M = 183.8$, $SD = 158.01$) in comparison to the complexity of the signs produced by their deaf children in 2007 ($M = 84.3$, $SD = 63.49$), $t(15) = -1.74$, $p = 0.10$, 2010 ($M = 358.7$, $SD = 344.03$), $t(16) = 1.33$, $p = 0.20$, or 2012 ($M = 322.8$, $SD = 180.17$), $t(10) = 1.38$, $p = 0.20$. It should, however, be noted that differences of 99, 175, and 139 points respectively between the mean of each groups at all testing times suggest a trend towards a greater complexity by deaf children over time in comparison to their parents. Specifically, the observed discrepancies suggest that hearing parents used more complex gestures than their children in 2007 but that deaf children's sign complexity generally surpassed the gesture complexity of their parents by 2010

and remained greater than that of their parents in 2012. Observed variations between the sign production of deaf Dominican children and the gesture production of their hearing parents are presented in Figure 9.

Discussion

This study aimed to evaluate the presence of similarities and differences between the signs produced by deaf children and the gestures of their hearing parents in order to identify the role of input on language acquisition and development, and to further clarify our understanding of SMSL in terms of its origin and linguistic status.

Consistent with previous research, it was hypothesized that the hearing parents' gestures would generally differ from those of their deaf children and that the input provided by the parents would not significantly impact the deaf children's use of SMSL or their contribution to the creation and evolution of this suspected communication system. Specifically, parents were not expected to have native-like competencies in SMSL. Instead, they were expected to have smaller sign repertoires, and to use gestures complementary to speech. Gestures produced by the hearing parents were not expected to be combined into ordered strings or to show signs of internal structure, independent from speech.

Certainly, qualitative observations from this study confirm that the Dominican hearing parents of deaf children did not primarily encourage the use of signs with their children. All parents used words while gesturing to favour lip-reading, and two of the eight parents observed admitted to using only speech when communicating with their deaf child at home. The parents' apparent mastery of manual communication varied and some parents chose to manipulate objects and to produce intended actions rather than use gestures to depict meaning (e.g., using a pencil to write on a piece of paper rather than using their hands to symbolize the same action). Further,

parents did not appear to display a common or shared gesture repertoire (i.e., different parents did not use the same gestures to represent the same objects); suggesting an absence of within-group mutual intelligibility. It can therefore be argued that the co-speech gestures produced by the hearing Dominican parents in our experiment were most likely those of the independent homesign systems used within their respective households. Some differences were also observed between the signs produced by individual deaf children and the gestures of their respective parents (i.e. signing rate and the diversity of gestures); suggesting that the parents' gestures did not reflect the suspected rudimentary vocabulary of SMSL as a pidgin language, therefore supporting our hypothesis that SMSL forms a rudimentary, yet developing, manual communication system separate from environmental input.

However, contrary to our hypotheses, quantitative analyses did not reveal the presence of significant differences between deaf children's sign production and the gestures of their hearing parents, putting into question the linguistic status of SMSL and its development beyond homesigns. While SMSL's sign repertoire appears to have increased over time and to surpass that of hearing parents by 2012, signing rate and the use of spatial modulation did not appear to differ between both groups. It is important to note that lexicon is not in itself a criterion of complexity and that it was explored in this dissertation as an additional means of documenting general changes to SMSL over time. Observed lexical differences in this context could be attributable to variations in the methodology employed in this study and could reflect the effect of free speech over structured elicitation in the production of a more diverse sign repertoire. Overall, deaf children in our experiment displayed a comparable signing proficiency to that of their hearing parents using co-speech, and both SMSL and the gestures produced by hearing parents appeared to include some rudimentary phonological properties as explored through

spatial modulation. Based on these results, it is impossible to pose judgment as to the origins of SMSL's rudimentary linguistic properties, and we cannot dismiss the possibility that SMSL has yet to surpass the structure of homesigns.

Still, it could be argued that our data suggests a possible trend towards a more complex use of signs by deaf children starting in 2010 in that deaf children appeared to catch up to their parents in terms of signing rate. This could be representative of an increasing ease and fluidity with producing sign strings over time and is consistent with the significant rise in signing rate within SMSL described in Chapter 2, although further research would be needed to evaluate whether such a trend persists to this day. If present, such differences would be consistent with previous studies (e.g., Goldin-Meadow 2006; 2003; Goldin-Meadow & Mylander, 1998; 1990; 1983; Goldin-Meadow et al., 1996) and could provide some support for children's innate abilities for language creation and development by demonstrating that deaf children's sign production in input-deprived environments can evolve to surpass the model received from their parents in the context of co-speech.

At the same time, we cannot ignore the fact that the hearing parents studied appeared to produce gestures in a way similar to those of their deaf children in terms of signing rate and complexity, even though previous research has demonstrated that co-speech gestures typically do not include language-like structure and therefore should not have included segmentation and basic phonological elements. One explanation could be that, by focusing on demonstrating statistical discrepancies between the gesture and sign production of both groups, our investigation failed to attend to specific qualitative differences present at the word and sentence level (e.g., the stability of sign form, the presence of semantic categories, consistent word order, the presence of predicate frames, etc.). Such a qualitative assessment was, however, beyond the

span on the present dissertation which aimed primarily at documenting the manual communication system observed in the Dominican Republic. Future investigations of SMSL would certainly be useful to document the presence and possible development of other more specific linguistic properties such as morphology, morphophonology, and syntax to name a few. Parts 2 and 3 of this study were designed to further evaluate the role of input on children's production of signs by comparing SMSL to the spontaneous signs produced by hearing individuals in absence of speech.

Part 2: The production of signs by hearing adults in the context of infant-directed versus adult-directed communication

As previously stated, research has demonstrated that the signs produced by hearing adults in absence of speech generally include linguistic properties similar to those naturally produced by deaf children in absence of a usable model of conventional language (Goldin-Meadow, 2006a, 2006b; Goldin-Meadow et al., 1996). This is unlike co-speech gestures, typical of the input received by deaf children in hearing environments (Goldin-Meadow & Mylander, 1983; Goldin-Meadow et al., 1996). Differences should therefore exist between the gestures produced with speech by the hearing parents of deaf children and those of hearing individuals creating signs spontaneously in absence of speech. For example, hearing individuals producing gestures in combination with speech have been shown to rarely combine their gestures into strings and to omit using their hands grammatically (e.g., using handshapes phonologically to convey information pertaining to a specific object such as its shape or size) (Goldin-Meadow et al. 1996). This is explained by the limitations imposed by speech in a co-speech setting and the tendency of co-speech gestures to be bound to the structure of speech. Co-speech gestures share the burden of communication and therefore most often convey unspoken information

complimentary to what is spoken aloud (Goldin-Meadow, 2006b). Spontaneous signs produced in absence of speech instead assume the full burden of communication, and therefore require the use of structural properties in order to convey an intended message in its entirety.

Several studies have been conducted to evaluate the production of spontaneous signs by hearing individuals in absence of speech. Researchers agree that signs elicited in such a way constitute elicited pantomimes and the term “silent gestures” is also often used to describe them. As discussed in Chapter 1, pantomimes share some structural similarities with homesigns. However, their spontaneity and lack of conventionalization particularly differentiates them from homesigns and classifies them as a less complex form of manual communication (Żywiczyński et al., 2018).

Part 2 of this study first aimed to compare the signs produced spontaneously by Canadian hearing adults to those of the parents of deaf children described in the first part of this chapter. This was completed in order to clarify whether the gestures produced by our parent sample did in fact differ from silent gestures, known to display linguistic properties similar to those of deaf children’s sign systems. The signs produced by deaf signers were similarly compared to those of hearing adults in absence of speech in order to determine whether SMSL surpassed silent gestures in terms of complexity; therefore suggesting a linguistic structure independent from the demands imposed by the environment (i.e., the production of signs that assume the full burden of communication in an environment deprived of a usable model).

Our interest into the possible influence of input on sign production further led us to question whether the hearing parents of deaf children perhaps adapted their gestures and signs in a way to accommodate for their children’s hearing impairments. The role of the audience was therefore explored. Indeed, gesture production has been found to be simplified to facilitate

understanding and learning by children. For example, parents have been found to modify the way they gesture to their infants in comparison to when they communicate with other adults (Masataka, 1992). Specifically, hearing parents have been observed using simpler gesture forms (e.g., pointing) and gesture–speech combinations (e.g., repeating the same information and meaning across both modalities) when communicating with their hearing infants (Özçalışkan & Dimitrova, 2013). Deaf parents have also been found to sign at a slower pace, to use more frequent repetitions, and to exaggerate their movements when signing with their deaf infants (Masataka, 1992). This suggests the possible presence of infant-directed signing or manual motherese.

Given previous evidence of the presence of structural distinctions between gestures produced with speech and spontaneous signs produced without speech (Goldin-Meadow et al., 1996; Singleton et al., 1993), hearing Canadian adults were expected to produce spontaneous signs in a way similar to that of deaf children. Specifically, they were expected to display some grammatical properties observable both qualitatively (e.g., segmentation and the production of sign strings) and quantitatively through an analysis of spatial modulation. However, the extent of the differences was unpredictable given our incomplete understanding of SMSL, its complexity, and developmental stage. Signing rate and vocabulary size were not expected to be comparable due to deaf children's familiarity with manual communication. Assuming that hearing parents' signs did in fact resemble those of co-speech, it was hypothesized that hearing Canadian adults would produce spontaneous signs that were dissimilar from those of the hearing parents of deaf children. Distinctions consistent with infant-directed signing were expected between the signs produced by hearing adults signing to an infant in comparison to those signing to another adult. Specifically, adults signing to a young child were expected to use more sign repetitions, to slow

down their signing speed, and to exaggerate signs to create emphasis. It was unclear whether the gestures produced by the hearing parents of deaf Dominican children showed characteristics similar to manual motherese, thus we can use the condition where hearing adults are gesturing to hearing children as a comparison to the Dominican adult sample. Distinctions between infant-directed and adult-directed signs, and the use of motherese by the hearing parents of deaf children could suggest some parental influence on deaf children's ability to learn and create new signs.

Participants

Twenty hearing adults (both men and women) with no prior knowledge of Sign Language were recruited for the present study. Participants were recruited via an advertisement posted in community centers and public libraries in Canada's capital region, as well as through an advertisement posted on the search engine *Google*. All were the parent of a hearing infant between the ages of 4 and 24 months. Half of the participants were accompanied by their infant child, while the other half were accompanied by their spouse. Infants and spouses did not have a participatory role in the present study but did nonetheless facilitate it by their presence. Canadian adults were selected for this investigation, despite being from a different linguistic and cultural environment, in order to facilitate testing and minimize travel to the Dominican Republic, as a large amount of international travel was not feasible with the resources available to the researcher. Given the demonstrated universality of language and linguistic development (Christiansen, Collins, & Edelman, 2009), it was assumed that Canadian and Dominican adults would not differ in terms of the signs they produce.

Procedure

The task took place in a testing room belonging to the Language Development Laboratory at the University of Ottawa. Consent was obtained prior to testing. Participants were

asked to sit on a chair facing a wall-mounted video monitor that was approximately three metres away. They were presented with the 40 animated film segments described in Part 1 of this study. While participants completed the experiment, infants or spouses remained seated in the testing room, facing away from the video monitor in a way that prevented them from seeing the stimuli. After each video segment, adult participants were asked by the experimenter to describe to their infant or spouse the events depicted in the film using their hands and no speech. Sessions were videotaped in their entirety by a video camera located beneath a cloth-covered table located at the front of the testing room, below the video monitor. The lens peeked out of a hole made in the cloth approximately 60 centimetres below the monitor. Originally, our intention was to also obtain a sample of co-speech gestures from the same hearing participants and the first few participants were asked to describe the video segments orally after using their hands to describe the same videos to their infant or spouse. By doing so, we hoped to compare the co-speech gestures produced by hearing adults in Canada to those of the Dominican parents and the deaf children's homesigns. However, this was abandoned since the majority of Canadian hearing participants did not produce sufficient gestures while talking, therefore rendering impossible any statistical analysis.

Coding Procedure

The minimal requirements for a communicative symbol described in Study 1 were used in order to identify communicational gestures. Signs produced by the participants were evaluated by two independent coders in terms of their complexity and spatial modulation, as defined in Study 1.

Statistical Analysis

Inter-rater reliability was assessed, as in Study 1 and Part 1 of this study, by a covariance analysis from which a Pearson correlation coefficient of 0.9892 was obtained and considered satisfactory in attesting for the reliable overall interpretation of observational data.

Independent sample *t*-tests were completed in order to evaluate the presence of similarities and differences between the signs produced without speech by Canadian hearing adults, and the co-speech gestures of the hearing Dominican parents of deaf children when describing the same video segments. Comparisons were also completed between the signs of hearing Canadian adults and the homesigns of deaf Dominican children. Finally, an independent sample *t*-test was completed to compare the production of adult-directed signs to that of infant-directed signs by the hearing Canadian adults. Each group of participants were compared in terms of signing rate, the number of new or different signs produced, and the number of spatial modulations produced.

Results

Qualitative data. Hearing adults, independent of whether or not they were signing to a hearing infant or an adult, were predominantly similar in terms of how they produced signs. Specifically, very few used facial expressions to add meaning to their signs or to create emphasis. Their signing space was largely undefined and they often stood up or used their whole bodies to produce a sign (e.g., standing up and jumping on one foot instead of using their hands to represent someone jumping on one foot). Some parents, even used props to create their signs, including using their infants when signing and one participant even moved her head towards her hands while signing, instead of moving her hands toward her head. Most importantly, very few adults produced sufficient signs to fully convey the content observed in individual visual stimuli. The production of sign strings was rare and most hearing Canadian adults, regardless of who

they were signing to (i.e., their infant versus their spouse), only gestured the actions/verbs (e.g., driving) portrayed in the video stimuli without specifying how these actions related to other objects (e.g., a tractor versus a car), or who/what was the subject completing the action (e.g., a man versus a child). Most hearing adults also used signs inconsistently, using two different signs to convey the same meaning or using the same sign to convey two different meanings (Figure 10). Finally, signs produced by different hearing adults to convey the same meaning differed from one participant to the next, therefore suggesting an absence of conventionalization consistent with silent gestures.

Quantitative data. A series of independent sample t-tests were completed to identify if and how the signs produced by Canadian hearing adults differed from the homesigns of deaf Dominican children and the co-speech gestures of their hearing parents.

Overall, hearing Canadian adults signing to another adult were found to produce signs in a way similar to the co-speech gestures of the Dominican parents of deaf children. The only independent sample t test showing a significant difference between both groups' use of their hands to describe the video segments was the one comparing signing rate. Specifically, Dominican parents ($M = 151.7$, $SD = 39.19$) produced more morphemes per minute than hearing Canadian adults signing to their spouse ($M = 103.4$, $SD = 24.65$), $t(15) = 3.08$, $p = 0.008$. Dominican parents ($M = 78.3$, $SD = 69.45$) appeared to have a vocabulary size equivalent to that of Canadian hearing adults signing to another adult ($M = 86.7$, $SD = 29.14$), $t(15) = -0.33$, $p = 0.74$. The total amount of spatial modulation produced by the Dominican parents ($M = 183.8$, $SD = 158.01$) was also comparable to that of Canadian hearing adults signing to another adult ($M = 205.00$, $SD = 67.75$), $t(15) = -0.01$, $p = 0.99$.

Independent sample *t* tests aimed at comparing the signs produced by the deaf children at all three testing times to that of Canadian hearing adults signing to another adult revealed that the signing rate of deaf children was significantly greater than that of hearing Canadian adults signing to their hearing spouse ($M = 103.4$, $SD = 24.65$) starting in 2010 ($M = 144.9$, $SD = 39.72$), $t(17) = 2.69$, $p = 0.02$, and remained so in 2012 ($M = 185.5$, $SD = 44.36$), $t(11) = 4.36$, $p = 0.01$. Signing rate was found to be the same when compared to that of deaf Dominican children in 2007 ($M = 94.9$, $SD = 11.80$), $t(16) = -0.94$, $p = 0.36$. Vocabulary size was also found to be greater for hearing Canadian adults signing to another adult ($M = 86.7$, $SD = 29.14$) in comparison to the Dominican children tested in 2007 ($M = 39.7$, $SD = 23.70$), $t(16) = -3.75$, $p = 0.02$. However, vocabulary size was equivalent in 2010 ($M = 149$, $SD = 133.36$), $t(17) = 1.37$, $p = 0.19$ and, by 2012, deaf Dominican children ($M = 198.8$, $SD = 117.07$) displayed a greater vocabulary size than the hearing Canadian adults signing to another adult, $t(11) = 2.83$, $p = 0.02$. Similarly, hearing Canadian adults signing to a hearing spouse were found to produce a greater amount of spatial modulation ($M = 184.5$, $SD = 91.01$) than deaf Dominican children tested in 2007 ($M = 84.3$, $SD = 63.49$), $t(16) = -2.75$, $p = 0.01$, while spatial modulation was comparable in 2010 ($M = 358.7$, $SD = 344.03$), $t(17) = 1.55$, $p = 0.14$, and 2012 ($M = 322.8$, $SD = 180.17$), $t(11) = 1.95$, $p = 0.08$, although results approached significance and deaf children showed a trend towards the use of more complex signs with a difference of 138 points in 2012. Again, caution is necessary when interpreting these results.

In an exploratory analysis, the signs produced by hearing Canadian adults signing to a hearing infant were compared to those produced by hearing Canadian adults signing to another adult in an attempt to see whether parents modify how they sign to young children in a way similar to infant-directed speech. Consistent with evidence provided in other studies, an

independent sample t test revealed significant differences between both groups that may account for the presence of manual motherese. Specifically, hearing Canadian adults were found to have a greater signing rate when signing to an infant ($M = 143.3$, $SD = 34.80$) than when signing to another adult ($M = 103.4$, $SD = 24.65$), $t(17) = 2.85$, $p = 0.01$. Hearing Canadian adults signing to another hearing adult ($M = 86.7$, $SD = 29.14$) were found to have a larger vocabulary size than those signing to a hearing infant ($M = 48.9$, $SD = 14.93$), $t(17) = 3.61$, $p < .001$. An analysis of the total amount of spatial modulation produced by both groups of hearing Canadian adults revealed no significant difference between the complexity of signs produced by the hearing adults signing to hearing infants ($M = 219.1$, $SD = 85.13$) and those produced by hearing adults signing to hearing adults ($M = 184.5$, $SD = 91.01$), $t(17) = 0.88$, $p = 0.39$. Observed variations between the sign production of deaf Dominican children and those of hearing Canadian adults are presented in Figure 9.

Discussion

Part 2 of this study aimed to further clarify the influence of environmental factors on deaf children's sign production. It was hypothesized that signs produced by hearing Canadian adults would share some similarities with those of deaf children as observed through segmentation and basic phonological markers, and would differ from the co-speech gestures produced by the hearing parents of deaf children.

To our surprise, minimal differences were found between the signs of hearing Canadian adults and the co-speech gestures of the hearing parents of deaf children. Following a similar absence of statistical differences between the signs produced by hearing parents and their deaf children in part 1 of this study, we question whether methodological limitations (i.e., the use of an elicited task and the fact that deaf children did not have a participatory role in the task) may

have influenced our parent sample to produce gestures more similar to silent gestures over co-speech. Assuming that this is true, it would explain why phonological properties found within the gestures of hearing parents resembled those found in the signs of their deaf children. Still, we question whether the elements of spatial modulation produced by hearing parents of deaf children share the same functions as those of deaf children and the silent gestures of hearing Canadian adults (e.g., would a study of the specific handshapes used by hearing parents reveal the presence of morphological or morphophonological structure?). We think not. A long-standing history of exposure to manual communication, and accompanied practice effect could explain the discrepancies observed between the Dominican parents and the hearing Canadian adults in terms of signing rate.

Instead, the biggest argument in favour of SMSL's idiosyncrasy and linguistic development over time comes from our comparison of the signs produced by hearing Canadian adults and deaf Dominican children. Specifically, data from our investigation suggest that the structure and complexity of the signs produced by SMSL signers surpasses those of silent gesture. While deaf children displayed significantly less complex and less varied signs than hearing Canadian adults signing to another adult in 2007, their signing rate was faster and their signing repertoire more varied by 2012. Spatial modulation also showed a trend towards significance even despite a small sample size and elevated within-group standard deviations.

Our exploration into the possible influence of audience on input modification reveals evidence that could suggest a phenomenon similar to motherese in the manual mode, and differences are observed to support the influence of audience on adults' sign production. Specifically, hearing Canadian adults appear to modify how they sign when signing to an infant. They produce more sign repetitions, resulting in a less varied sign repertoire, which in turn

affects the speed with which they produce signs; repetitions being faster to produce than strings of varying signs. That being said, it is important to note that results from our study suggest that infant-directed signing may present differently than infant-directed speech. Rather than slowing down sign production similar to hearing parents talking to a hearing infant, the rate at which hearing parents communicate to children in the manual mode appears to be greater; something that we attribute to their tendency to use a less varied vocabulary which they repeat in loop. Still the purpose of motherese appears to remain the same in the manual mode: parents tailor their signing style to the needs of their infants in order to facilitate learning and comprehension. Despite the fact that none of the Dominican children studied were babies or toddlers at the time of testing, it is possible that their hearing parents continued to use motherese with their deaf child in an attempt to facilitate language learning in an input-deprived environment. However, another explanation may be that the hearing Canadian adults signing to their infant did not expect their hearing children to extract any meaning from their manual communication, and so did not make a concerted effort to provide detailed information about the video stimuli they looked at.

While the existence of manual motherese could provide support for usage-based theories and ultimately challenge children's innate ability to create language in input-deprived environments (i.e., it could suggest some parental influence on deaf children's ability to learn and create new signs), deaf children in our study demonstrated a use of signs that differed from that of hearing Canadian adults in important ways. Specifically, deaf children, starting in 2010, showed signs of a more diverse use of signs than hearing Canadian adults and appeared to catch up to their parents in terms of their familiarity with manual communication. Overall, our results suggest that, by 2012, deaf children in the Dominican Republic surpassed the input provided by both silent gestures (i.e., the signs produced by our hearing Canadian adults) as well as the

constraints imposed by their environment (i.e., the co-speech gestures of their hearing parents), therefore supporting their role on the development of SMSL. This is true even when controlling for motherese, and deaf children's use of signs appears generally more complex than that of hearing Canadian adults signing to another adult. Qualitative data further supports the presence of important differences in terms of sign complexity and overall understanding and use of signs as part of a communication system independent from speech. Sign production by children prior to reaching the sensitive period for language acquisition will be further explored in the third part of this study to further elucidate the presence of native abilities for language creation.

Part 3: The production of signs by hearing children prior to the sensitive period for language acquisition

Assuming that deaf children do surpass the manual input provided to them by their parents, part 3 of this study was designed to document the specific signing abilities of young children prior to reaching the end of the sensitive period for language acquisition. It aimed to 1) determine young children's ability to produce complex manual communication systems as demonstrated through the use of grammatical elements such as spatial modulation and segmentation for example, 2) compare young children's sign production to that of adults to establish whether hearing children produce spontaneous signs that are similar to adults in absence of speech or rather copy the co-speech gestures available in their linguistic environment, and 3) establish whether young hearing children's sign production is different from that of our deaf Dominican sample. Sign production by hearing children was specifically studied over that of young deaf children in order to control for prior sign exposure which could have impacted the reliability of our observations in terms of obtaining a representative sample of spontaneous sign production.

Overall, no studies had previously been completed to evaluate distinctions between the signs produced by young hearing and deaf children with the specific goal of evaluating the role of the sensitive period for language acquisition on language development. It therefore remained uncertain whether the signs produced by hearing children would resemble or differ from those of deaf homesigners. Still, a clear distinction between the signs produced by both populations would provide evidence for the innate ability of children to contribute meaningfully to the creation of language by supporting our assumption that SMSL signers have already surpassed the input received by their hearing parents. Consistent with results from part 2 of this study, it was expected that young hearing children, similar to the deaf Dominican children tested in 2007, would produce incomplete signs that are of minimal complexity even in comparison to infant-directed signs.

Participants

Sixteen hearing children (6 girls) aged between 3 and 6 years ($M = 5$ years, 1 month) with no prior knowledge of Sign Language were recruited for the third part of this study. Because the sensitive period for language acquisition is believed to start closing at 7 years (Hoff, 2013), younger children were recruited in order to control for this period and obtain a sample suspected of having developing linguistic abilities. A control group of older hearing children was not recruited since research in favour of the sensitive period for language acquisition suggest that their signs should be similar to those of hearing adults. Canadian children were recruited instead of Dominican children to control for possible exposure to SMSL through contact with deaf children at school or in the community. Participants were recruited via advertisements posted in community centers and public libraries in Canada's capital region, through an advertisement posted on the search engine *Google*, as well as through collaborations with the Childhood

Cognition and Learning Laboratory at the University of Ottawa who informed some of their participants about this study. Participants were accompanied by their primary caregiver who did not have a participatory role in the present study but did nonetheless facilitate it by his/her presence.

Procedure

Children were met in the same testing room as described earlier in this chapter. Parental consent and assent were obtained prior to testing. Each participant was presented with the 40 video segments described in Part 1 of this study. While participants completed the experiment, their caregivers remained in the testing room, seated in a chair facing away from the video monitor. Parents were instructed not to guide their child through the task. After each video segment, children were asked to describe the events depicted in the film using their hands and no speech. Sessions were videotaped in the same way as described in the second part of this study. As with the hearing adults in Part 1 of this study, the first few children to take part in this study were originally asked to first describe orally the content of the 40 video segments in an attempt to obtain a sample of co-speech gestures. This was, however, abandoned given the limited amount of usable data collected.

The goal was to compare the signs spontaneously produced by hearing children in absence of speech to those of deaf children and hearing adults (both hearing parents of hearing children and hearing parents of deaf children). Sign production was analyzed according to signing rate, number of new or different signs produced, and number of spatial modulations produced by each individual group of participants.

Most importantly, the objective of the third part of this study was to detect the presence of developmental variations between the signs produced by individuals before and after the

critical period for language acquisition by comparing the spontaneous signs of hearing children to those of hearing adults. Such differences could provide further evidence of the innate ability of children to create language and to contribute to its overall development, thus providing support to results from the first study of this dissertation.

Coding Procedure

As described in Study 1, Goldin-Meadow and Mylander's minimal requirements for a communicative symbol (1998) were used in order to confirm and identify the production of communicational gestures by participating children. Signs produced by participating children were evaluated by two independent coders in terms of their complexity and spatial modulation, defined in Study 1.

Statistical Analysis

Inter-rater reliability was assessed, using the same procedure described in Study 1. A Pearson correlation coefficient of 0.9877 was obtained and considered satisfactory in attesting for the reliable overall interpretation of observational data.

A series of independent sample t tests were completed in the same way as described in the first and second parts of this study to evaluate the presence of variations in the signs produced by hearing children and adults. The signs of hearing children were also compared to those of deaf homesigners in the Dominican Republic. It is important to note that, as with all previous studies in this dissertation, hearing children did not produce sufficient signs when describing orally the content of the video stimuli. It was therefore impossible to complete any statistical analyses comparing signs produced with speech.

Results

Qualitative data. Young hearing children, similar to the Canadian hearing parents of hearing children, had a largely undefined signing space, often stood up or used their whole

bodies to produce a sign, did not use facial expressions to convey meaning or emphasis, and rarely produced sufficient signs to fully convey the content observed in individual video stimuli. That being said, contrary to the Canadian hearing adults, hearing children did not use props to create their signs. Also, one child was observed using her finger to represent her shoe in combination with a “tying” sign, a complexity in sign production that was not observed in hearing adults (Figure 11).

Quantitative data. A series of independent sample *t* tests were completed to clarify whether the signs produced by hearing children prior to reaching the sensitive period for language acquisition are more complex than the signs of hearing adults. Similarly, an independent sample *t* test was completed to establish whether or not the signs produced by hearing children share any similarities with the homesigns of deaf Dominican children.

Results from a first independent sample *t* test indeed revealed some significant differences between the sign production of hearing children and deaf Dominican children over time. Specifically, hearing children ($M = 141.4$, $SD = 26.22$) produced sign strings at a faster rate than deaf Dominican children in 2007 ($M = 94.9$, $SD = 11.80$), $t(17) = -4.89$, $p = 0.00$. That being said, no such difference was found between the signing rate of deaf Dominican children in 2010 ($M = 144.9$, $SD = 39.72$) and that of hearing children, $t(18) = 0.23$, $p = 0.82$. By 2012, deaf children’s signing rate ($M = 185.5$, $SD = 44.36$) was greater than hearing children’s, $t(12) = 2.34$, $p = 0.04$. Vocabulary size also varied between groups, and while deaf children in 2007 displayed a comparable sign repertoire ($M = 39.7$, $SD = 23.70$) to that of hearing children ($M = 53.4$, $SD = 9.50$), $t(17) = -1.69$, $p = 0.11$, deaf children produced more new or different signs in both 2010 ($M = 149$, $SD = 133.36$), $t(18) = 2.26$, $p = 0.04$, and 2012 ($M = 198.8$, $SD = 117.07$), $t(12) = 4.16$, $p = 0.01$. An analysis of the total amount of spatial modulation produced by both groups revealed

a similar pattern of differences. Hearing children appeared to produce more complex signs ($M = 192.4$, $SD = 51.70$) than the deaf Dominican children tested in 2007 ($M = 84.3$, $SD = 63.49$), $t(17) = -4.09$, $p = 0.01$. However, deaf children appeared to gradually increase the complexity of their signs over time, and no differences were found with the group of Dominican children tested in 2010 ($M = 358.7$, $SD = 344.03$), $t(18) = 1.51$, $p = 0.15$. The complexity of signs produced by deaf children in 2012 surpassed that of the hearing children by 2012 ($M = 322.8$, $SD = 180.17$), $t(12) = 2.19$, $p = 0.05$.

A second independent sample t test revealed no significant difference between the signing rate of the hearing children ($M = 141.4$, $SD = 26.22$) and that of the hearing Dominican parents of deaf children ($M = 151.7$, $SD = 39.19$), $t(16) = 0.66$, $p = 0.52$. Hearing children and the Dominican parents therefore produced an equal number of morphemes per minute. Similarly, no differences were found between the vocabulary size of the hearing children ($M = 53.4$, $SD = 9.50$) and that of the Dominican parents ($M = 78.3$, $SD = 69.45$), $t(16) = 1.13$, $p = 0.28$. Finally, an analysis of the total amount of spatial modulation produced by both groups revealed no significant difference between the complexity of signs produced by the hearing children ($M = 192.4$, $SD = 51.70$) in comparison to the Dominican parents ($M = 183.8$, $SD = 158.01$), $t(16) = -0.16$, $p = 0.87$.

Similarly, hearing children's signing rate ($M = 141.4$, $SD = 26.22$) did not significantly differ from that of hearing Canadian adults signing to an infant ($M = 143.3$, $SD = 34.80$), $t(18) = 0.13$, $p = 0.90$. The hearing children were therefore as fast at producing signs as hearing adults using manual motherese. Similarly, the vocabulary size of the hearing children ($M = 53.4$, $SD = 9.50$) did not differ significantly from that of the hearing Canadian adults using infant-directed signing ($M = 48.9$, $SD = 14.93$), $t(18) = -0.80$, $p = 0.43$, and both groups used a similar amount

of new or differing signs. Finally, no differences were found between the total amount of spatial modulation produced by hearing children ($M = 192.4$, $SD = 51.70$) and that of hearing Canadian adults signing to an infant ($M = 219.1$, $SD = 85.13$), $t(18) = 0.85$, $p = 0.41$, suggesting that both groups of participants produced signs similar in terms of their complexity.

In comparison significant differences were observed between the signing rate of hearing children ($M = 141.4$, $SD = 26.22$) and hearing adults signing to an adult ($M = 103.4$, $SD = 24.65$), $t(17) = -3.25$, $p = 0.01$. Hearing children were faster signers than hearing Canadian adults signing to a spouse and overall produced more morphemes per minute despite their young age. That being said, hearing children produced more sign repetitions than the hearing adults using adult-directed signing, which could explain their faster signing rate. Indeed, a significant difference between the vocabulary size of hearing children ($M = 53.4$, $SD = 9.50$) and that of hearing adults signing to another hearing adult ($M = 86.7$, $SD = 29.14$), $t(17) = 3.42$, $p = 0.01$ suggest that, despite a slower signing rate, adult-directed signing involves a more diverse sign repertoire than that of young hearing children. An analysis of the total amount of spatial modulation produced by both groups of participants revealed no significant difference between the complexity of signs produced by the hearing children ($M = 192.4$, $SD = 51.70$) and that of the hearing Canadian adults using adult-directed signs ($M = 184.5$, $SD = 91.01$), $t(17) = -0.24$, $p = 0.81$. Observed variations between the sign production of hearing children and those of deaf Dominican children and hearing adults are presented in Figure 9.

Discussion

Part three of this study aimed to clarify children's role in the development of language. Demonstrating children's innate ability for language creation was thought to be possible by observing statistically significant differences in the signs produced by young hearing children in

comparison to those of deaf Dominican children and hearing adults. Specifically, it was expected that hearing children's signs would mostly resemble those of deaf Dominican children tested in 2007 and would differ from those of signers tested later, in 2010 and 2012 respectively. As such, and based on the results from part 2 of this study, we therefore expected young hearing children's silent gestures to be less varied and complex than those of hearing adults given young children's developing linguistic abilities and less mature language experience.

Contrary to what was originally expected, hearing children's production of spontaneous signs differed from that of SMSL signers in 2007 and suggested greater complexity (i.e., signing rate and spatial modulation) by hearing children. In fact, hearing children's signs mostly resembled those of hearing adults signing to their hearing infant; suggesting that hearing children's production of silent gesture might be influenced by the available input (i.e., motherese). Similar to hearing adults signing to hearing infants, hearing children appeared to produce many repetitions of the same signs and displayed a limited sign repertoire overall. While we cannot be sure as to how much exposure to motherese in the manual mode hearing children may have received, our results question whether infant-directed speech might have guided hearing children in the production of linguistic features when their signs needed to assume the full burden of communication.

Interestingly, if the results of this study provide some support for usage-based theories, suggesting that parental input may play a role in children's sign production, they also provide further evidence of SMSL's linguistic development and suggest that young children innately possess the ability to use and understand complex language rules even in input-deprived environments. Consistent with the results presented in the second part of this study, vocabulary size and signing rate were found to be greater in deaf children starting in 2010, and deaf children

surpassed hearing children in terms of spatial modulation by 2012. This suggests, that despite their minimal knowledge of a formal language, deaf children were able to surpass the production of silent gesture in its expected basic spontaneous form.

We argue that the signs produced by the hearing children in this study surpass those of first generation SMSL signers in 2007 because of their exposure to and familiarity with a formal spoken language input; something that is ultimately delayed for deaf children in input-deprived environments whose parents learn to sign at the same time as they do and who only become truly immersed in spoken language upon their entry in school. This would in turn explain the presence of significant differences between the signs produced by the hearing children and the deaf Dominican children in this study, who with time, appear to increase the overall complexity of their signs thanks to a second generation of signers who contribute to the evolution of SMSL based on the input received by their peers.

Ultimately, this explanation supports the presence of resilient abilities for language creation in children and our findings corroborate the production of more advanced and complex signs by the deaf Dominican children over time who, despite theoretically receiving the same infant-directed input as the hearing children in this study, come with time to produce signs that are distinct from that very input.

Part 4: Combined results

While the overall results from the studies in this chapter provide interesting data regarding the role of input on the acquisition and production of signs by children, results must be interpreted with caution, given the increased probability of Type I error resulting from our completion of multiple t-tests. Each study was independent, but the multiple comparisons across studies could cause statistical issues. Therefore, we ran omnibus ANOVAs for key (and common

across groups) dependent variables comparing all groups in the thesis. Even though there was some overlap amongst the deaf children groups, we treated the groups as independent to be conservative in our power.

These ANOVAs, conducted in order to better control for error, confirmed that signing rate ($F(6,53) = 6.202, p < .001$), vocabulary size ($F(6,53) = 4.774, p = .001$), and spatial modulation ($F(6,53) = 2.481, p = .034$) differed between groups. Tukey HSD post hoc tests for each of the above dependent variables confirmed that deaf children tested in 2007 (94.89 ± 11.80 morphemes per minute) were significantly slower at producing sign strings than their hearing parents (151.66 ± 39.19 morphemes per minute, $p = .010$), hearing adults signing to a hearing infant (143.25 ± 34.80 morphemes per minute, $p = .027$), and hearing children (141.44 ± 26.22 morphemes per minute, $p = .038$). On the other hand, deaf children in 2012 (185.47 ± 44.36 morphemes per minute) had a greater signing rate than hearing adults signing to an adult (103.43 ± 324.65 morphemes per minute, $p = .001$). Hearing Dominican parents (151.66 ± 39.19 morphemes per minute) were also found to have a faster signing rate than hearing adults signing to an adult (103.43 ± 324.65 morphemes per minute, $p = .044$).

Tukey HSD post hoc tests also confirmed that deaf children in 2010 (149.00 ± 133.36 distinct signs) displayed a significantly larger sign repertoire than hearing adults signing to an infant (48.90 ± 14.93 distinct signs, $p = .030$), and hearing children ($53.40 \pm 9.50, p = .044$). The vocabulary size of deaf students in 2012 (198.75 ± 117.07 distinct signs) was also greater than that of hearing adults signing to an infant (48.90 ± 14.93 distinct signs, $p = .009$), and hearing children (149.00 ± 133.36 distinct signs, $p = 0.12$).

Finally, no significant differences were observed between groups of deaf and hearing children and adults, and the significant ANOVA results obtained rather resulted from a

comparison of the spatial modulation produced amongst SMSL signers (i.e., between the 2007 and 2010 signers).

Overall, these results confirm the presence of some variation between the sign production of deaf children and that of hearing adults and children over time, especially in terms of deaf children's growing fluidity with producing sign strings. That being said, the production of basic phonological markers did not appear to vary between groups, therefore putting into question our previous discussion on the possible influence of input on sign production. Specifically, while deaf children appear to be increasingly eloquent when signing, they appear to produce signs that are in no way different from those of silent gesture. The existence of motherese in the manual mode is also challenged by these analyses. Having said that, we used a conservative approach in the analyses above and we faced the issue of low sample sizes across our group. Perhaps these differences would re-emerge with larger samples.

Chapter 4

General Discussion

The present dissertation aimed to explore and clarify the processes and origin of language development by looking at children's role in the creation and evolution of language in input-deprived environments. Very few studies have been able to document the birth of a potential new language and doing so provides unique information about the universal components of language (i.e., those that humans are born with) and the prerequisites needed for more complex structure to be applied to a language. Study 1 of this dissertation aimed to record the birth and evolution of the Santa Maria Sign Language (SMSL) in the Dominican Republic, in order to better understand how linguistic complexity takes shape and to identify those responsible for the introduction of more complex language components. Study 2 aimed to further clarify the innate ability of children to acquire and create language, by comparing the signs of deaf Dominican children to those produced by their hearing parents, as well as hearing Canadian adults and children. This dissertation is also one of few to look into the possible existence of motherese in the manual mode, similar to infant-directed speech, in order to clarify whether children's sign production is influenced by the way their parents communicate with them. The following sections summarize SMSL's contribution to our understanding of language development by children. We first review SMSL's suitability for the study of language creation.

SMSL as an example of language emergence

First studied in 2007, SMSL has consistently demonstrated composition and use of formal communication symbols by all of its signers. Signs in SMSL are used for the specific purpose of exchanging information and receiving information from others, and generally do not depend on the manipulation of objects to convey meaning. All this occurs despite the absence of a consistent linguistic input and lack of a defined deaf community outside of the Santa Maria

School. Individual deaf children in the Dominican Republic appear to have created homesign systems within their individual families and proceeded to share and combine their respective signs with one another for the purpose of communicating as a group. The creation of a common language was not imposed or suggested by teachers or parents, and lip-reading is favoured and promoted with the children both at school and at home. Lessons are provided in Spanish and children are expected to follow the same curriculum as other hearing children without the use of support or accommodations. Still, as argued previously by others (see Coppola & Newport, 2005; Goldin-Meadow & Mylander, 1998; Senghas, 1994, 2003, 2005; Senghas & Coppola, 2001; Senghas et al., 2004), deaf children's natural desire to communicate prevailed and, given their limited understanding of Spanish, deaf children at the Santa Maria School proceeded to create a basic communication system. A comparison of the signs comprised within SMSL to those of the American Sign Language, the most commonly used sign language in the Dominican Republic, and the official Dominican Sign Language suggests minimal overlap or influence on sign formation. The Santa Maria Sign Language can therefore be said to be a possible newly arising sign language in the Dominican Republic, independent and unique from any other Sign Languages in the country. It represents a suitable linguistic sample for the study of language creation and children's role in the conception and development of language.

Over the course of five years, what SMSL allowed us to observe, is deaf children's gradual contribution to the development of their language, replicating in part a phenomenon studied by Goldin-Meadow, Senghas, and others, and providing some support for the existence of innate abilities for language creation. Specifically, the deaf children in the Santa Maria School were observed commonly using and understanding the same specific signs, suggesting the developing presence of mutual intelligibility over time and confirming the transmission of the

language to new incoming deaf students at the school. Objects, people, and actions are not only referred to by one commonly accepted sign, but such signs, included into a narrative, are unanimously understood by all deaf members within the school community, no matter their age or their time of entry at the school. Consistent with observations from the 2007 study, SMSL signers in 2010 and 2012 were again observed making use of facial expressions to convey meaning, and producing gradually less whole-body and non-specific signs (e.g., pointing), suggesting a progressively more complex understanding of signs and their use for communication purposes. Most suggestive of SMSL's gradual evolution over the course of the five years it was documented, is the apparent trend towards a more fluid and varied use of signs by younger signers starting in 2010 in comparison to data collected in 2007 from older signers. Indeed, results from this dissertation suggest the presence of significant differences in the quality and complexity of signs used by younger signers in 2010 and 2012, suggestive of the likely presence of two generations of signers in the period documented.

That being said, contrary to fully developed Sign Languages, SMSL has yet to develop all of the linguistic components necessary for a fluid and fully consistent use of the language for communication purposes. For example, it does not appear to include signs to signify "yes" and "no". Instead, deaf students at Santa Maria School were observed using head nods and shakes to communicate their agreement and disagreement with each other. Similarly, it does not appear to have signs to symbolize colours and students were often observed pointing to a coloured pencil to describe a colour in a narrative. Mouthing was also used by some students in combination with signs (e.g., one student made the sign for "mother" all the while saying the name of her mother), and pointing continues to be used predominantly by all students (e.g., to signify places and people) rather than more specific signs. Some students also showed ambidextrous signing

abilities and could produce the same sign with both hands independently and at different times. An examination of two students' production of handshapes also revealed limited phonological complexity within SMSL and an absence of noteworthy evolution in phonological structure over time.

Ultimately, the current structure of SMSL appears to be in transition from a homesign to a pidgin-like language in its very early stages. It does not appear to have fully attained a structure equivalent to that of LSN in Nicaragua, which is perhaps unsurprising considered the smaller community and sample involved in the current work. However, it can be argued that generational transmission is not static and that no set amount of generations is needed for a language to attain a higher level of complexity. As such, while studies of the Nicaraguan Sign Language have documented a rapid evolvement from homesigns, to its now fully developed form, language evolution appears to be a matter of the size of individual generations of signers and is dependent on the combination of the influence of all individual signers within a generation. Although SMSL provides a suitable dataset for the study of language creation, its evolution is likely to be slow given its small generations of signers and the limited influx of new deaf students registering for school each year. SMSL's survival and potential for future development is further put into question by the age of signers in the second generation and the absence of new incoming deaf students since 2012. Nonetheless, it provides an opportunity for clarifying what we know about the impact of input on children's understanding and use of language.

While a new rudimentary communication system was shown to be recently under creation in the Dominican Republic, the next section will discuss how input may have influenced the creation of signs and favoured the introduction of more complex linguistic characteristics over time.

Input and the argument for innate language abilities

Theories of language development disagree with regard to how language is created. They further disagree on whether children or adults are responsible for the creation of language. While Study 1 appears to support children's role in the development of SMSL, usage-based theories of language would argue that it is the input received by the deaf children that made possible the creation of this communication system. If true, parents and teachers in regular contact with the deaf children of Santa Maria School should be responsible for the sign repertoire and grammatical development of SMSL. Two explanations are therefore possible to describe the origins of SMSL according to this model. In the first, parents and teachers create new signs and impose a structure to how signs are produced and combined. In the second, the gestures produced by parents and teachers in combination with speech serve as a signing repertoire for the deaf children and sign strings are created to reflect what is observed during lip-reading.

Both explanations pose many challenges. For the first, we would need to assume that the hearing parents of deaf children possess prior knowledge of Sign Language and choose to prioritize signing over lip-reading with their deaf child. This is rarely the case for most families, and certainly is untrue of the deaf Dominican children included in this dissertation. The second explanation is more conceivable but would leave deaf children with an incomplete linguistic input. For example, hearing adults in our studies rarely produced sufficient signs to convey the content of video stimuli in their entirety, leaving to their audience the responsibility to make do with the missing information. Usage-based theories of language acquisition would argue that this incomplete input prevents the deaf child from communicating in a language-like manner. Interestingly, previous studies have shown that the production of sign strings (or segmentation), essential to meaningful and comprehensive communication, is in fact present only when signs

are produced in absence of speech (Gerkshkoff-Stowe & Goldin-Meadow, 2002; Goldin-Meadow et al., 1996). This is true for both hearing adults asked to produce signs without speech, and of the signing systems used by deaf children in input-deprived environments (Goldin-Meadow 2003b; McNeill 1992). Yet, it is inconsistent with the input received by deaf children according to the second explanation, since deaf children's exposure to language is assumed to be limited to the gestures their hearing parents and teachers produce while talking. Usage-based theories of language appear unable to account for how the homesign systems used by deaf children in input-deprived environments come to acquire language-like structural properties such as segmentation. Instead, language acquisition has been shown to persist universally despite varying levels of linguistic input (Gleitman, 2006). The universal human ability to learn a language implies that nature prepares children for relatively effortless language acquisition despite limitations imposed by a sensitive period or available linguistic input (Bickerton, 1999; Chomsky, 1965, 1981, Gleitman, 2006).

Consistent with previous studies of newly developing sign languages in input-deprived environments (see Coppola & Newport, 2005; Goldin-Meadow & Mylander, 1998; Senghas, 1994, 2003, 2005; Senghas & Coppola, 2001; Senghas et al., 2004), this dissertation provides some evidence of this innate acquisition of language by children. Indeed, the deaf Dominican children included in this dissertation were shown to be slowly but gradually surpassing the passive acquisition of their limited linguistic input, and to actively contribute to the creation of language, albeit still in a relatively simple form. Specifically, the deaf Dominican children studied at Santa Maria school were shown to have greater sign repertoires than their hearing parents. Similarly, they were found to have greater vocabulary sizes and to display faster signing

rates than Canadian hearing adults. They also displayed a greater sign repertoire than hearing children.

That being said, these results must be interpreted with caution to account for Type 1 error resulting from the completion of multiple t-test, large standard deviations within each group of participants, and small sample sizes. Still, qualitative data obtained for each group provides more corroborating support for children's role on the development of their language. For example, the co-speech gestures produced by the hearing parents of deaf Dominican children did not demonstrate signs of mutual intelligibility, meaning that individual parents did not use the same gestures to convey the same meaning. Some parents were even found to inconsistently use gestures across various narratives when referring to the same object or subject. Each parent appeared to use gestures respective to their own family's homesign system, and their gestures ultimately were not consistent with those used by their deaf children and assumed to be part of SMSL.

Hearing adults did not vary in terms of their sign production: Canadian hearing adults with no previous sign exposure produced signs mostly equivalent to the co-speech gestures of the Dominican parents, although Dominican parents appeared to be faster than hearing adults signing to another adult. Qualitatively, hearing adults' overall use and understanding of signs for communication purposes is most telling of children's innate role for language production. In comparison to the deaf Dominican children observed as part of this dissertation, hearing Canadian adults often stood up or used their whole bodies to produce signs or used props when signing. Most representative of hearing adults' limited understanding of sign's role for communication is the fact that very few produced sufficient signs to fully convey their message.

Most only produced signs to refer to actions, without specifying how those same actions relate to other objects or subjects. This was true for both the Dominican and Canadian parents.

In all, the deaf Dominican students at Santa Maria school appear to have surpassed the input received from the gestures produced by their hearing parents and teachers while talking. Not only do they appear to have greater vocabularies and to produce sign strings more fluidly, they ultimately appear to have a greater understanding and integration of signs' role within a communication system. Despite their young age and limited exposure to formal language, deaf children are able to understand complex linguistic rules, including the need for segmentation to convey complete and significant messages. That being said, input does play a role on deaf children's acquisition of language and this will be discussed further in the next section.

Arguments in favour of infant-directed signing

While evidence from this dissertation further supports the theory that humans are born with a natural ability to learn and create language even in input deprived environments, results from Study 2 also suggest that humans may be simplifying gestural linguistic input to infants, and this simplified exposure to language could influence young children's language production.

Specifically, gestures produced by young hearing children in absence of speech did not differ significantly from those of hearing adults in general. More importantly, young hearing children's signs appeared to more closely resemble those of manual motherese, suggesting possible parental influence on sign production. For example, both hearing children and hearing adults signing to an infant tended to produce more sign repetitions, resulting in a slightly greater signing rate but smaller vocabulary overall when compared to hearing adults signing to another adult.

In comparison, similar behaviour has been documented for oral communication between parents and young infants. Known as infant-directed speech (IDS) or motherese, parents have been shown to simplify the way they speak to their child by using a more restricted vocabulary, producing words more slowly, extending vowels, using a higher pitch and intonation, increasing pauses, producing shorter and grammatically simpler sentences, and repeating words and sentences several times (Fernald, 1992; Gleitman et al., 1984).

The purpose and outcome of IDS have been documented extensively (see Gallaway & Richards, 1994; McLeod, 1993), and hearing children have been shown, even from an early age, to replicate features of IDS in their own vocalizations and speech (Masataka, 2003). Given that the early years of language development are meant to discover and learn the patterns and structures that govern language, it is not surprising that children's first attempt at communication include clear reproductions from the input they receive in their immediate environment.

Studies looking at an IDS equivalent in sign language remain sparse, but the universal presence of IDS across oral languages leads to believe in the existence of a similar concept in the manual mode. Indeed, an exploratory study conducted by Masataka (1992) revealed that deaf parents appear to modify the way they sign to their deaf infants in comparison to when they communicate with other deaf adults. Specifically, deaf Japanese mothers were found to produce signs at a slower pace, to repeat the same signs frequently, and to slightly exaggerate the movements associated with each of their signs when exchanging with their infants.

While the signing style produced by hearing Canadian adults in this dissertation varied from that described by Masataka (1992), parents did appear to simplify their signing in order to facilitate learning and comprehension by their infants. Hearing adults' unfamiliarity with Sign Language could account for the differences observed between the results from this dissertation

and Masataka's study. Still, despite minimal Sign Language understanding and familiarity, hearing adults and children did manage to produce signs in a similar manner, therefore suggesting the presence of possible parental influence on sign production and a learned pattern of manual communication (in this case with hearing children recreating elements of IDS in the manual form). That being said, this data may be subject to Type 1 error and the existence and influence of motherese on manual communication must be interpreted with caution

Still, assuming that this is true, it is therefore possible to propose that, similarly, deaf children's early production of signs, is influenced by the input provided to them by their parents, even in input deprived environments. Indeed, minimal differences were found between the gestures produced by the Dominican parents and the signs of their deaf children. Still, deaf children did appear to catch up to their parents in terms of signing rate over time and ultimately surpassed their parents' sign repertoire by 2012. Deaf SMSL signers further appeared to come to surpass hearing adults and children in terms of the complexity and diversity of their signs, and overall proficiency with manual communication.

These results provide further evidence for the presence of resilient abilities for language creation in children, as findings corroborate the presence of more advanced and complex signs by the deaf Dominican children who, despite theoretically receiving the same infant-directed input as the hearing children in this study, produced signs that are distinct from that very input.

Implications for our understanding of language development

Previous research, in particular that completed by Ann Senghas and Susan Goldin-Meadow in Nicaragua over the last 30 years, has extensively documented the birth and development of language in input deprived environments. Studies have shown how semantic and grammatical components come to arise within a language from the ever-growing development

and elaboration of the complexity of pidgin languages into fully developed communication systems. That being said, children's role in the creation and development of language remains unclear. While some research appears to support the direct participation of children in the language creation process through generational transmission, proponents of usage-based theories continue to question environmental influences, such as linguistic input, which they argue could facilitate children's ability to contribute to language development.

Studying and comparing SMSL to other Sign Languages is important for several reasons. First, we can confirm the current status of SMSL and clarify its developmental progression. Second, it allows us to identify common linguistic structures between different languages and to clarify language components and abilities that are innate to humans. Overall, as with other isolated Deaf communities in the world, SMSL supports children's ability to learn language from minimal comprehensible input; contradicting usage-based theories of language that question children's ability to become proficient in a language in absence of comprehensible input. The suggested presence of two generations of SMSL signers, and apparent development of the language between 2007 and 2012 further provide support for the existence of innate human abilities for language creation and acquisition. Specifically, results from this dissertation appear to suggest that children surpass the linguistic input received from their parents in early childhood and then contribute actively to the further development of language until reaching the age of puberty.

Limits and avenues for future research

Context is of utmost importance when trying to document a language and obtain a representative sample from individual participants. This proved challenging for this dissertation in that, not only did we want to be able to look at language globally from different groups of

participants, we also hoped to obtain a varied but comparable vocabulary sample from each participant in order to quantify their specific linguistic abilities. Unstructured speech observations were selected for the studied deaf population in order to counter the influence of environmental context on linguistic production. Spontaneous language was observed in the natural context of free speech conversations with the aim of obtaining a wider and more diverse linguistic sample of communication from each participating student at Santa Maria School, something we hoped would have been a more representative estimation of their true linguistic abilities. Yet, despite providing deaf children with the flexibility of exchanging about the topics of their choice, it is unlikely that the unstructured experimental method favoured in the first study succeeded in evaluating the true extent of individual participants' language abilities. Rather, their linguistic competence was limited by individual children's interactions with their peers and the obtained vocabulary samples were dependent on the topics addressed at the time (e.g., observed discussions about farm animals does not mean that the deaf children do not have additional vocabulary for other types of animals, such as zoo animals, insects, sea animals, etc.).

Our attempt at documenting the development and structure of SMSL further impacted our results in that the selected experimental design in Study 1 led to very different linguistic samples from those obtained from other groups of participants through a structured experiment in study 2. These differences must be accounted for when interpreting comparisons between each group. Specifically, because results were dependent on the experimental context, it could be argued that observed vocabulary size and sign complexity for each group of participants could have been different if: 1) the deaf children would have been subject to the same topic limitations as the other groups in Study 2, or 2) hearing participants had been provided the opportunity to discuss topics of their choice using signs to communicate. A more accurate comparison of sign

production by all groups of participants should have included the use of a common structured experimental methodology in order to limit analyses to a more defined set of target vocabulary and topics, albeit providing a less representative overview of SMSL. This would have allowed us to include an additional comprehension test in which common comprehensibility or mutual intelligibility could have been assessed by inviting deaf students to identify the correct video segment based on the signed description of a deaf peer using SMSL to communicate. Such a methodological approach would have also made possible more representative comparisons between our population of deaf Dominican signers and the Deaf community of Managua in Nicaragua, where elicited narratives have been studied and compared since 1989 with Kegl and Iwata's original study of NSL.

That being said, the use of a structured experimental design, such as that described in Study 2, poses other challenges likely to impact results. For example, performance can be influenced by social desirability, and we cannot exclude the possibility that the signs produced by individual signers in the structured experiment were chosen to meet the participants' perceived expectations of the task. In other words, it is possible, as suggested by Goldstein and Bebko (2003), that the video stimuli used in study 2 suggested the intended signs to produce or the way to produce them (e.g., through imitation of the actions seen), thus limiting participants' use of individuality and creativity in their spontaneous production of signs. It is indeed one of the reasons why we opted against repeating with our sample of deaf participants the elicited task used in 2007, which required signers to describe to a peer the content of a storybook. In the Dominican Republic, a structured experimental design, such as the one used in 2007 or in Study 2, poses additional challenges, as demonstrated in Drouin (2008). Specifically, deaf children were found to produce more iconic signs when limited by the experimental context and appeared

to depend on the experimental stimuli to guide their signs. Effects of social desirability in this case are likely and possibly limit our ability to detect true developmental changes in the use and structure of SMSL signs. Social desirability may have similarly played a role in the results of our parent sample who produced gestures that were mostly contrary to what previous research would have suggested. That being said, we do acknowledge the potentially confusing verbal instructions that were provided to Dominican parents (i.e., to describe the content of the video segments using only their hands), and suggest that more appropriate instructions should have asked parents to “describe the videos to their deaf child using the same communication methods used at home”, therefore ensuring the use of homesigns to describe the video segments.

Overall, our studies differed from those completed in Nicaragua in important ways. Notably, and as previously stated, they differed in the way by which data was collected (i.e., as part of an elicited task versus in an unstructured manner), but also in the variables selected for analysis (i.e., morphological versus phonological structure). Our decision to focus on phonological structure, while less informative in terms of linguistic development, was primarily motivated by: 1) our desire to document the use of SMSL longitudinally, and 2) our appreciation of the rudimentary nature of SMSL to begin with. Not only did our population have no more than 20 known members, unlike NSL which already had 500 members when it was first studied, we also had no previous study on which to base our understanding of SMSL in terms of its composition, function, and use. While more in-depth analyses could have been completed as part of this dissertation (e.g., verb spatial inflections or handshape classifiers such as in Senghas, 1995), the suitability of such analyses as a starting point for our studies of SMSL is questionable. For example, ISN was much more developed grammatically when it was first studied by Kegl and Senghas in the 1990s, and the same could not be assumed of SMSL. Further, the first

published studies of the grammatical structure of ISN already aimed to compare components that are present and “fully mastered only by native speakers” of ASL (Senghas, 1995); components that are, in other words, only present in manual languages that approach full development, and are likely still absent in SMSL. It was our goal to postpone such grammatical studies until after it was determined whether or not SMSL offered a suitable environment for investigations such as these ones, given that we had not ruled out the possibility that SMSL was no more than the product of functional communicators gesturing in a cohesive manner.

It is also important to note our decision to compare signs produced by hearing individuals from two different countries and linguistic environments. While this was done to facilitate testing and limit back-and-forth travel to the Dominican Republic, we cannot exclude the possibility that variations between the linguistic structure of Spanish and English (e.g., Spanish verbs have more inflections) may have influenced sign production. Still, the demonstrated existence of linguistic universals suggests that sign production should be comparable for both groups. More important in terms of potential cultural variations is the unfamiliarity of Dominican participants with scientific research which may have resulted in alterations of their demeanour or actions in such a way to meet what they believed to be the researcher’s desired outcomes. Participants’ acquaintance with the researcher may have assisted with controlling for this limitation.

Ultimately, neither experimental methods used in this dissertation allow for an accurate understanding of participants’ use of signs for communication purposes. True mastery of SMSL and signing overall by individual participants remains unknown. Small sample sizes and the limited number of participants observed further limit our ability to fully test assumptions on the developmental stage of SMSL, and children’s apparent role on language development more generally. However, it is important to reiterate that the deaf population of Santa Maria School

and its surrounding community is very limited and the sample included in this dissertation is considered representative of the population at each testing time.

Conclusion

The study of an emerging language is a unique experience in its own right. Few have witnessed the birth of a new language, let alone evaluate children's ability to acquire this new language in a natural environment. The Santa Maria school may have provided such an opportunity. Though rudimentary, the longitudinal study of SMSL provides a database for language acquisition that has the potential to serve as a comparison to that of Nicaragua in regards to the Nicaraguan Sign Language (ISN).

So far, SMSL has yet to develop a complete pidgin structure from its current basic combination of homesign systems although it appears on its way to doing so. Deaf students at Santa Maria school vary in their ability to use and to understand the common language but mutual intelligibility has been demonstrated for multiple signs. Unlike Nicaragua which has benefited from a rapid growth of its deaf population, the deaf population of Santa Maria School remained mostly unchanged over the seven years during which this dissertation research was conducted. Because language development is influenced by the size of the communicating population (Vogt, 2005), Santa Maria School has a limited ability to provide the environmental context favorable for language evolution. In fact, most deaf children have now completed their studies at Santa Maria School and few new deaf students have since registered for school at Santa Maria. Contact between past deaf students in the community is also inconsistent and distance does not necessarily favour the continued development of SMSL. Still, the limited data presented in this dissertation suggests that SMSL was slowly being transformed over time by

younger signers at Santa Maria School who seemed to have a generally more fluent use of the language in terms of their signing rate and use of more specific signs.

Our results further suggest that deaf children may surpass the limited linguistic input provided by their hearing parents through the gestures they produce in combination with speech. Through an exploratory examination of infant-directed signs, this dissertation showed that hearing parents are potentially changing the way they gesture and sign to their young deaf children in a way similar to infant-directed speech in oral communication. These gestures serve as a basis for language understanding amongst deaf children who later tailor the received input to their specific needs for communication which are limited to the manual modality.

In all, this dissertation complements the research already completed on ISN and other languages produced in input-deprived environments by providing insight on the initial stages of language origination and acquisition. Most importantly, it provides some support to theories in favour of children's capacity to contribute meaningfully to the evolution of language.

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Table 1

Similarities and differences between SMSL and ISN.

	Santa Maria Sign Language	Idioma de Señas Nicaragüense
Environmental context	– Community of 15-20 deaf individuals – Deaf children born of hearing parents – Isolated from other deaf individuals – No exposure to Sign Language – Development of a homesign system within the family context	– Community of over 500 deaf members – Deaf children born of hearing parents – Isolated from other deaf individuals – No exposure to Sign Language – Development of a homesign system within the family context
School System	– Classes are taught in Spanish – Lip-reading is promoted – Gestural communication is not prohibited on school grounds	– Classes are taught in Spanish – Lip-reading is promoted – Gestural communication is prohibited on school grounds
Sign Language	– First stage: creation of idiosyncratic homesign systems	– First stage: creation of idiosyncratic homesign systems

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- | | |
|--|---|
| <ul style="list-style-type: none">– Second stage: beginning evidence of combination of homesign systems into a common coherent pidgin language | <ul style="list-style-type: none">– Second stage: combination of homesign systems into a common coherent pidgin language– Third stage: first generation of native speakers of the pidgin language leading to creolization– Fourth stage: establishment of a fully developed Sign Language |
|--|---|
-

Table 2

Social conditions under which signed communication systems emerge.

	Ay-Sayyid	Homesign	Nicaraguan	American	Optimal	Santa Maria
	Bedouin		Sign	Sign	situation	Sign Language
	Sign		Language	Language		
	Language					
Number of people	10 in first generation; 150 to date	1	50 in first cohort; 800 to date	Hundreds of thousands	High	Approximately 20
Number of generations	3	1	1 (in 3 cohorts)	8	High	1 (with two possible cohorts)
Number of years	70	Individual lifespan	25	200	High	Maximum 25
Learners age at first exposure	Birth	Birth	5	Variable	Low	Variable
Input to current learners	2 nd generation signing	Co-speech gesture	2 nd cohort signing	Full language	Full language	Co-speech gesture and homesign
Hearing status of interlocutors	Deaf and hearing	Hearing	Deaf	Mainly deaf	Unknown	Deaf and hearing

Context for	Multi-	None	School and	Family	Frequent	School
transmission	generational		urban	home,	close	
to new	family		community	school, and	contact;	
generations	home			larger	older to	
				community	younger	

* Adapted from Senghas (2005).

Table 3

Definitions of the specific linguistic terminology used in this dissertation.

Term	Definition
Language	A communication system consisting of symbols and rules used by a particular community in a structured and conventional way. This includes both oral and manual communication systems.
Signs	Hand movements produced in the absence of speech that carry the full burden of communication (including homesigns and silent gestures).
Gestures	The collection of hand movements produced with or without speech (including gesticulations, pantomimes, and emblems) to represent specific objects, actions or ideas without assuming the full burden of communication.
Homesign	A manual representation, part of a rudimentary communication system, created by deaf individuals independently of Sign Language for the sole purpose of communication within their immediate families.
Pantomime	A mimetic and non-conventionalized gesture produced spontaneously by an individual for the purpose of communicating a complete and self-contained idea with/without the use of speech.
Silent gesture, elicited pantomime, or spontaneous sign	A spontaneous manual representation often elicited and produced in a laboratory setting in the absence of speech.

Table 4

Description and purpose of the comparisons conducted in this dissertation

Conducted Comparisons	Purpose
Dominican homesigners	– To document the evolution of SMSL and identify signs of generational transmission between 2007 and 2010
X	
Dominican homesigners	– To detect evidence of a more complex use of signs over time by two individual homesigners across a 5-year span
Dominican homesigners	– To differentiate SMSL from the co-speech input received
X	
Hearing Dominican parents	
Dominican homesigners	– To differentiate SMSL from the silent gestures produced by adults and further demonstrate its independence from input
X	
Hearing Canadian adults signing to an adult	
Dominican homesigners	– To differentiate SMSL from children's innate signing abilities (i.e., silent gestures)
X	
Hearing Canadian children	
Hearing Dominican parents	– To clarify whether the input received by deaf homesigners was more similar to co-speech or silent gestures
X	
Hearing Canadian adults signing to an adult	

Hearing Dominican parents	–	To explore whether children's silent
X		gestures differ from the input received
Hearing Canadian children		by deaf homesigners
Hearing Canadian adults signing to an adult	–	To explore whether signing is adjusted
X		for different audiences and whether this
Hearing Canadian adults signing to an infant		could influence deaf children's sign
		production
Hearing Canadian adults signing to an adult	–	To explore whether silent gestures
X		differ when produced by adults versus
Hearing Canadian children		children
Hearing Canadian children	–	To explore whether motherese
X		influences children's sign production
Hearing Canadian adults signing to an infant		

Table 5

Distribution of participants across all three testing periods.

Time of testing	Hypothesized cohort	Participant	Age	Years spent at Santa Maria school	Classroom attribution
2007	1	1	19	9	Spec. Ed. 4
	1	2	16	9	Eighth
	1	3	16	9	Spec. Ed. 4
	1	4	15	6	Spec. Ed. 4
	1	5	14	9	Spec. Ed. 4
	2	6	13	8	Spec. Ed. 3
	2	7	13	8	Spec. Ed. 2
	2	8	7	2	Second
	2	9	4	1	Kindergarten
2010	1	3	19	10	Out of school
	1 ¹	7	16	9	Out of school
	2	8	10	5	Fifth
	2	9	7	4	Second
	2	10	9	2	Third
	2	11	10	2	Third
	2	12	11	2	Spec. Ed. 2
	2	13	10	2	Spec. Ed. 2
	2	14	10	2	Third

¹ This student was reassigned to the suspected first cohort of SMSL signers following the original 2007 study due to his age in relation to the sensitive period for language acquisition.

	1	15	19	9	Out of school
2012	2	7	18	9	Out of school
	2	8	12	7	Seventh
	2	9	9	6	Fifth
	2	12	13	4	Spec. Ed. 3

Table 6

Timeline for the longitudinal study of SMSL.

	Standardized quantitative assessment	Observational study
2007		- Semi-structured assessment of gesture production by SMSL signers
2010	- MacArthur-Bates Inventario del Desarrollo de Habilidades Comunicativas II: Palabras y Enunciados (Inventario II) - Test de Vocabulario en Imagenes Peabody (TVIP) - Leiter International Performance Scale-Revised (Leiter-R)	- Unstructured observation of SMSL gesture production by SMSL signers
2011		- Structured assessment of gesture production by the hearing parents of SMSL signers
2012		- Unstructured observation of SMSL gesture production by SMSL signers

Table 7

Deaf Dominican children's level of intellectual abilities (IQ) and local norms as assessed by the Leiter International Performance Scale-Revised (Leiter-R).

Participant	Overall IQ	Local norm
8	79	67.9
9	79	73.7
10	58	73.7
11	68	68.2
12	44	73.3
13	67	68
14	64	71.4

Table 8

Deaf Dominican children's understanding of the Spanish language as assessed by the Test de Vocabulario en Imagenes Peabody (TVIP).

Participant	Age equivalent	Local norm	Z score
8	3.33	8.99	-1.54
9	2.50	7.28	-3.19
10	2.50	9.18	-2.40
11	2.50	9.87	-1.92
12	5.42	10.60	-2.16
13	2.50	10.51	-2.46
14	3.83	9.17	-1.50

Table 9

Deaf Dominican children's knowledge of the Spanish language as estimated by their parents on the Inventario del Desarrollo de Habilidades Comunicativas II: Palabras y Enunciados (Inventario II).

Participant	Estimated Spanish vocabulary (in number of words)
3	2
7	107
8	267
9	86
10	100
11	90
12	568
13	2
14	331

Table 10

Signing rate of individual SMSL signers at each testing time.²

Participant	2007	2010	2012
1	91	--	--
2	90	--	--
3	108	95	--
4	111	--	--
5	74	--	--
6	101	--	--
7	96	196	180
8	83	137	133
9	100	171	188
10	--	116	--
11	--	169	--
12	--	168	241
13	--	100	--
14	--	101	--
15	--	196	--

² Signing rate was calculated in terms of the number of morphemes produced per minute.

Table 11

Vocabulary size of individual SMSL signers at each testing time.

Participant	2007	2010	2012
1	23	--	--
2	42	--	--
3	44	32	--
4	90	--	--
5	17	--	--
6	59	--	--
7	36	336	240
8	33	66	300
9	13	96	225
10	--	48	--
11	--	312	--
12	--	360	30
13	--	48	--
14	--	48	--
15	--	144	--

Table 12

Spatial modulation of individual SMSL signers at each testing time.³

Participant	2007	2010	2012
1	37	--	--
2	81	--	--
3	75	28	--
4	179	--	--
5	15	--	--
6	200	--	--
7	74	888	405
8	58	242	315
9	40	208	495
10	--	64	--
11	--	624	--
12	--	792	76
13	--	64	--
14	--	17	--
15	--	660	--

³ Spatial modulation refers to the point-based system attributed to signs produced in non-neutral location or incorporating movement.

Table 13

Number of signs produced by individual SMSL signers at each testing time.

Participant	2007	2010	2012
1	45	--	--
2	118	--	--
3	80	48	--
4	240	--	--
5	17	--	--
6	195	--	--
7	84	912	495
8	80	353	450
9	38	288	630
10	--	64	--
11	--	792	--
12	--	816	105
13	--	96	--
14	--	64	--
15	--	828	--

Table 14

Number of morphemes produced by individual SMSL signers at each testing time.

Participant	2007	2010	2012
1	82	--	--
2	199	--	--
3	155	76	--
4	419	--	--
5	32	--	--
6	395	--	--
7	158	1800	900
8	138	585	765
9	78	496	1125
10	--	128	--
11	--	1416	--
12	--	1608	181
13	--	160	--
14	--	81	--
15	--	1488	--

Table 15

Glossary of common lexical items observed in SMSL.

2007	2010	2012
Airplane	After	After
Beautiful	Afraid	Basket
Big	Come	Beautiful
Book	Crazy	Come
Catch	Done	Computer
Come	Eat	Eat
Cut	Fly	Everything
Dead	Guitar	Jump
Done	Hear	Know
Eat	Hit	Later
Everything	Hug	Money
Family	In	Quiet
Far	Know	Spell
Five	Later	Tall
Fly	Leave	Think
Four	Love	Wait
Give	Nothing	What
Glasses	Open	Where
Hair	Poop	Write
Hear	Quiet	
In	See	
Know	Signing	
Leave	Slow	
Long	Strong	
Money	Stupid	
Motor	Talk	
Mouse	Together	
One	Us	
Photo	What	
Pilot		
Quiet		
Read		
See		
Scream		
Search		
Seatbelt		
Slide		
Small		
Stop		
Swinging		
Talk		
Tall		

Telephone Think Three Ticket Tomorrow Two Up Wait Walk What Writing		
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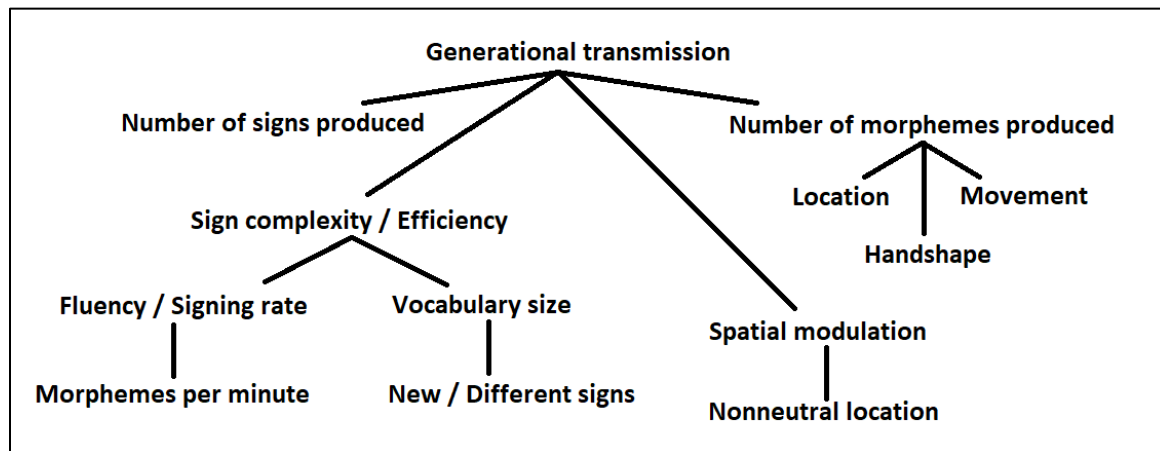


Figure 1. Factor distribution of the concept of generational transmission.

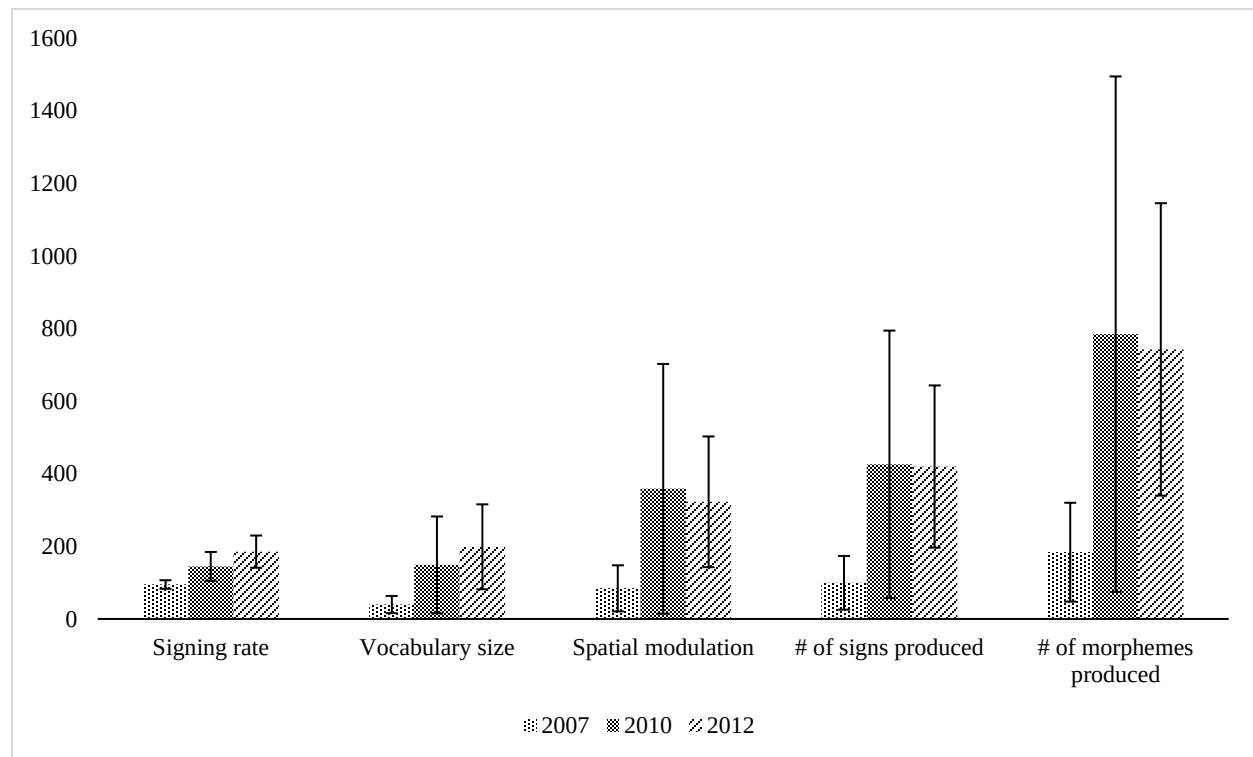


Figure 2. Mean signing rate, vocabulary size, spatial modulation, number of signs produced, and number of morphemes produced by SMSL signers at each time of testing with standard deviations.



Figure 3. Examples of observed mutual intelligibility within SMSL for the verbs “writing” produced by children in 2007 and 2012 (Plot A), and “knowing” in 2010 and 2012 (Plot B).

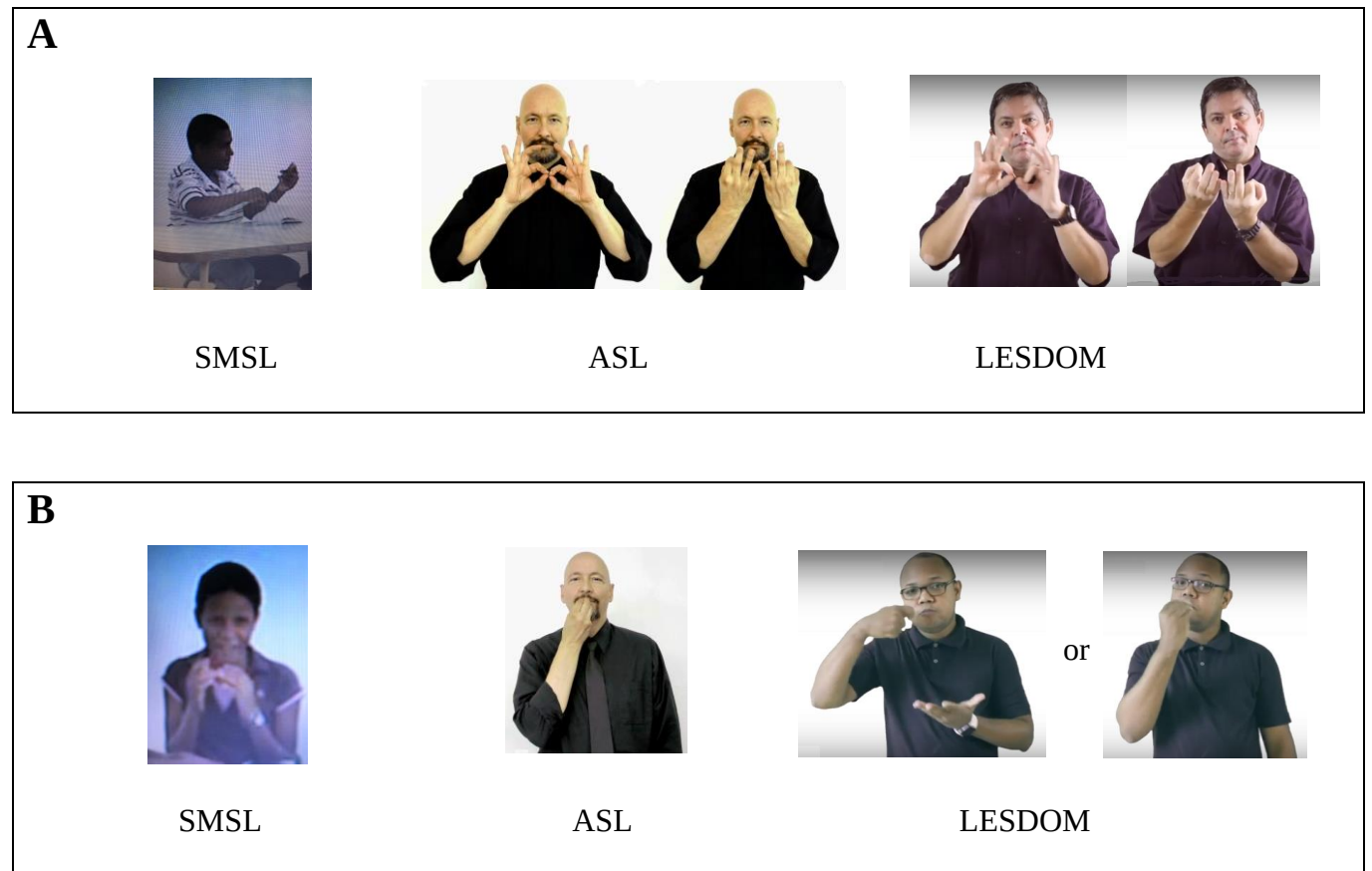


Figure 4. Examples of observed differences between the signs of SMSL, ASL, and LESDOM for the words “family” (Plot A), and “eat” (Plot B).

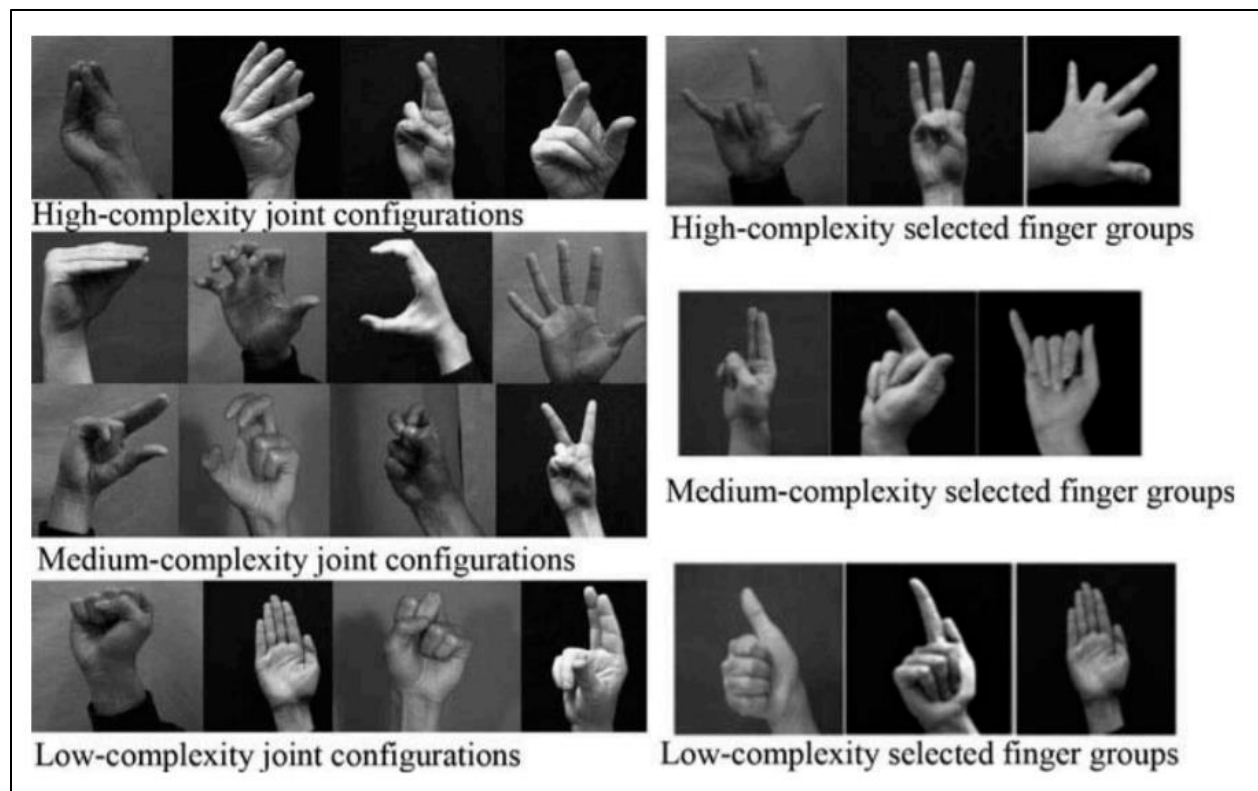


Figure 5. Examples of handshapes exhibiting different levels of joint complexity (left) and finger group complexity (right) taken from Brentari et al. (2017).

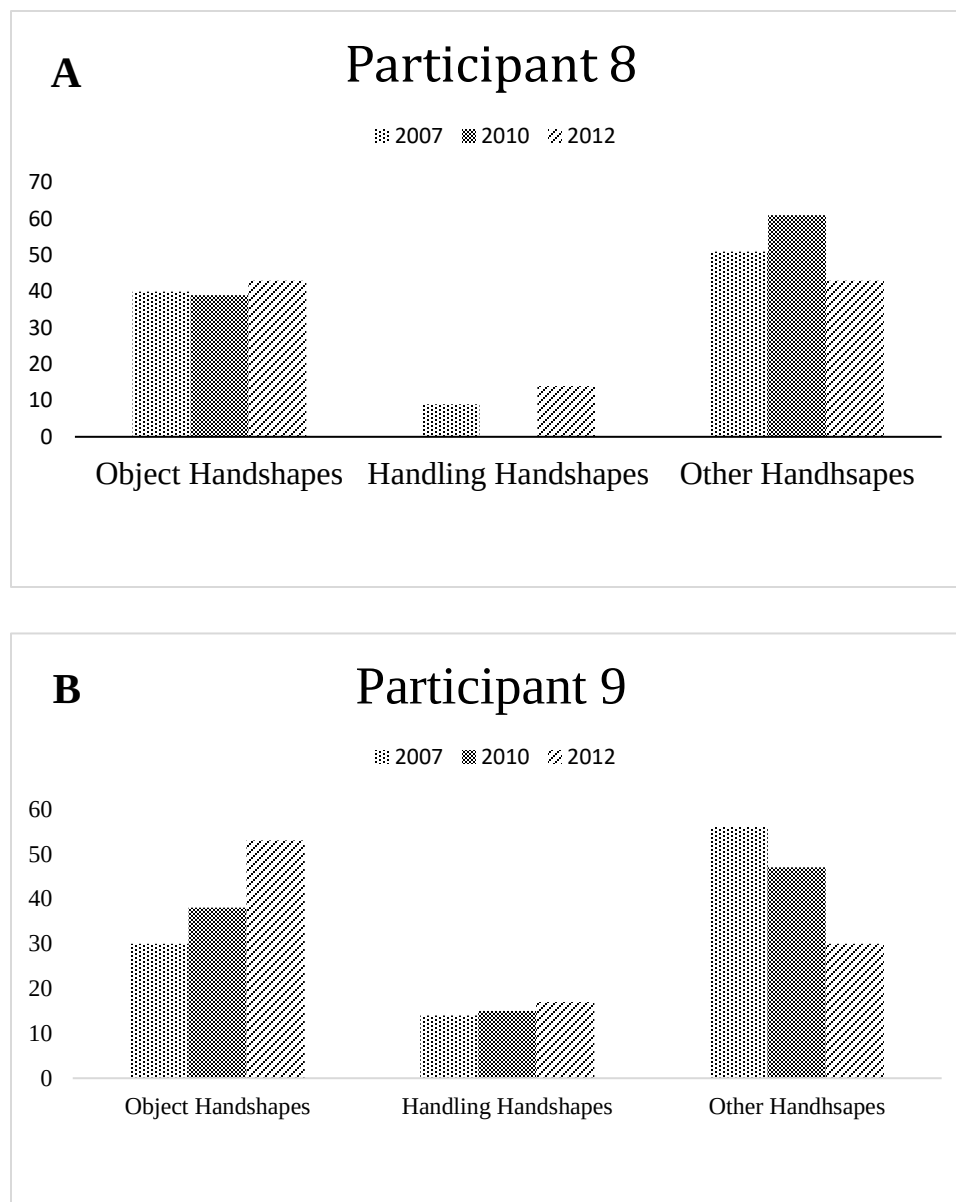


Figure 6. Use of handshape types (in percentages) by two SMSL signers at three testing times.

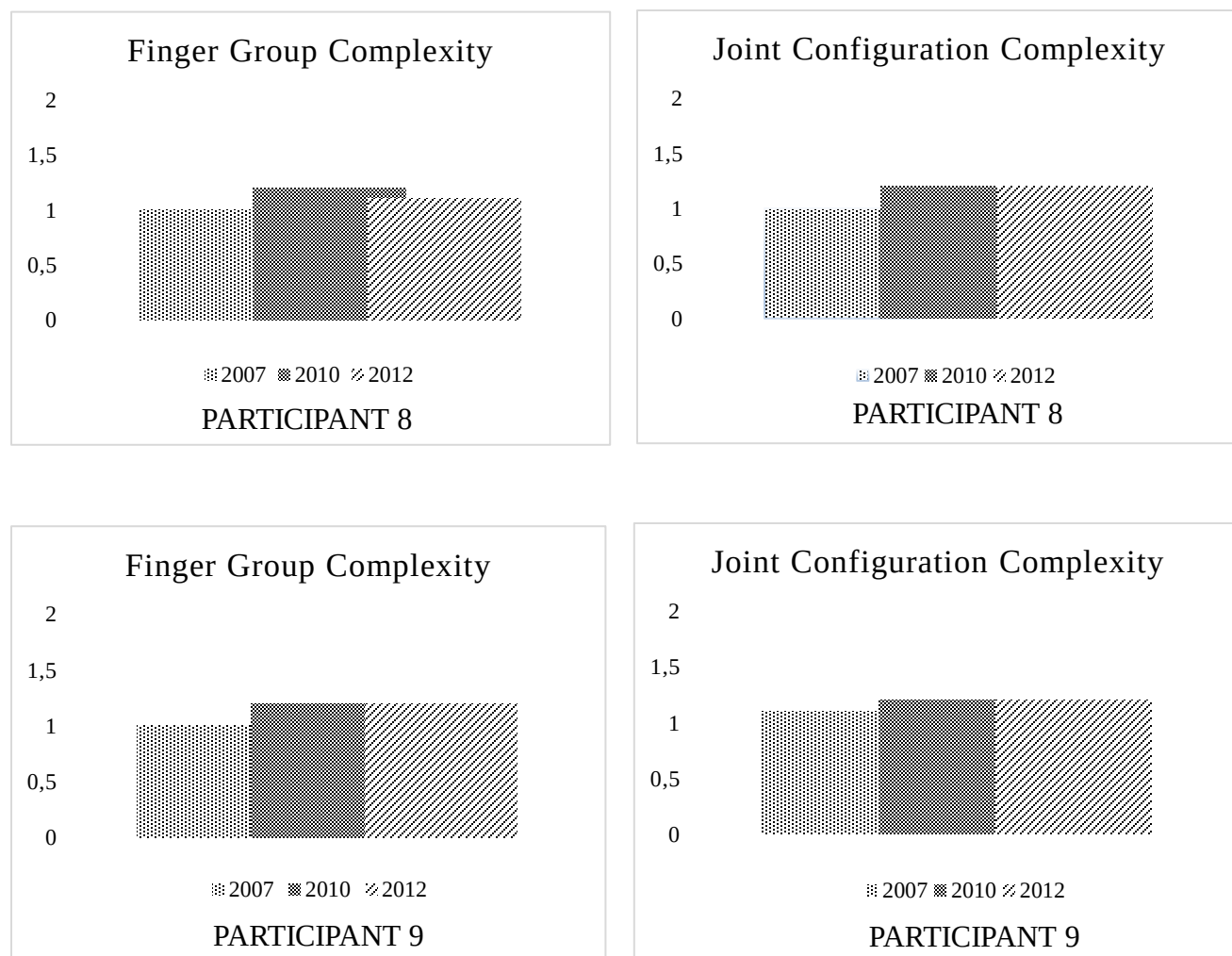


Figure 7. Average finger group and joint configuration complexity produced by two SMSL signers at three testing times.

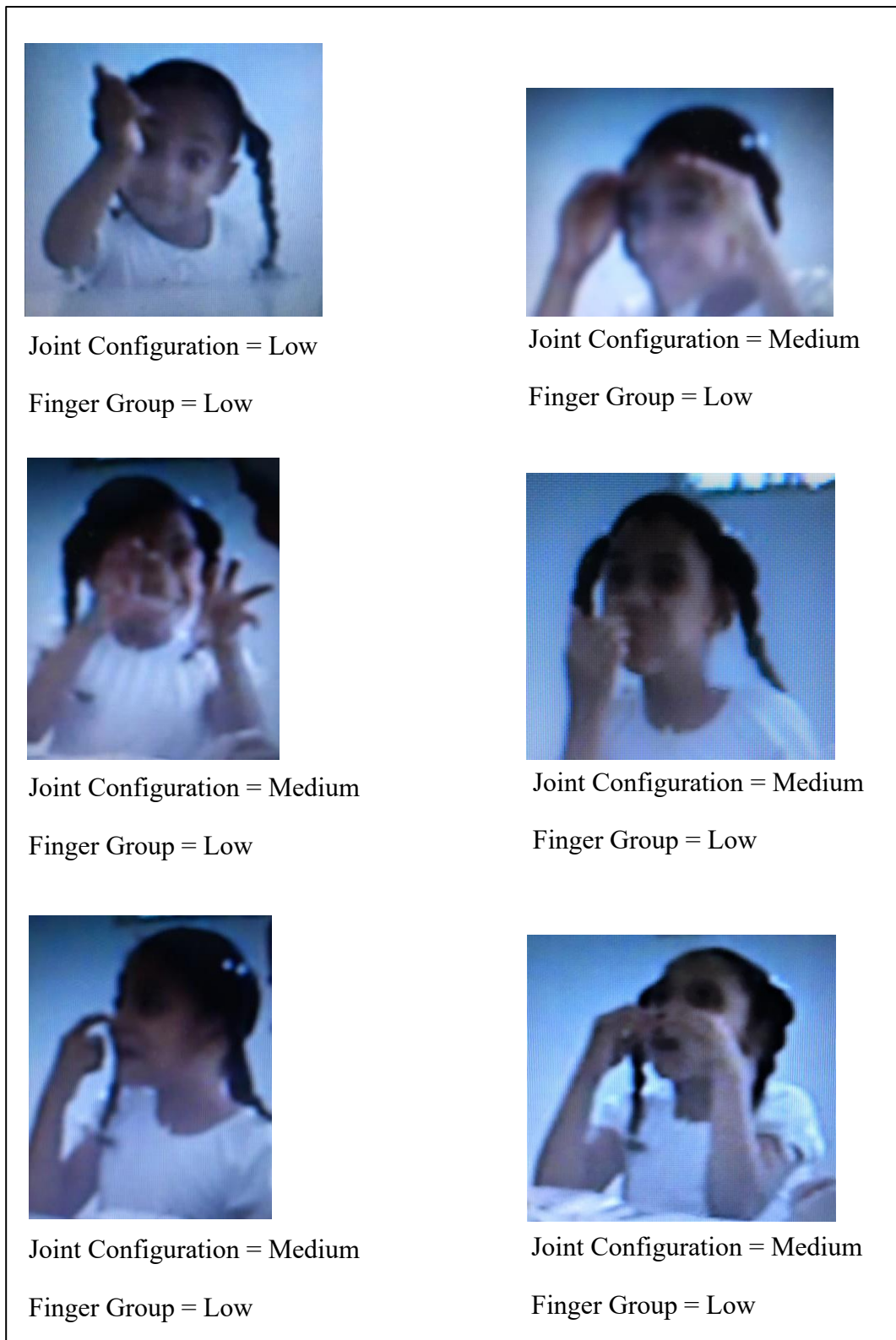


Figure 8. Examples of some of the handshapes produced by two SMSL signers.

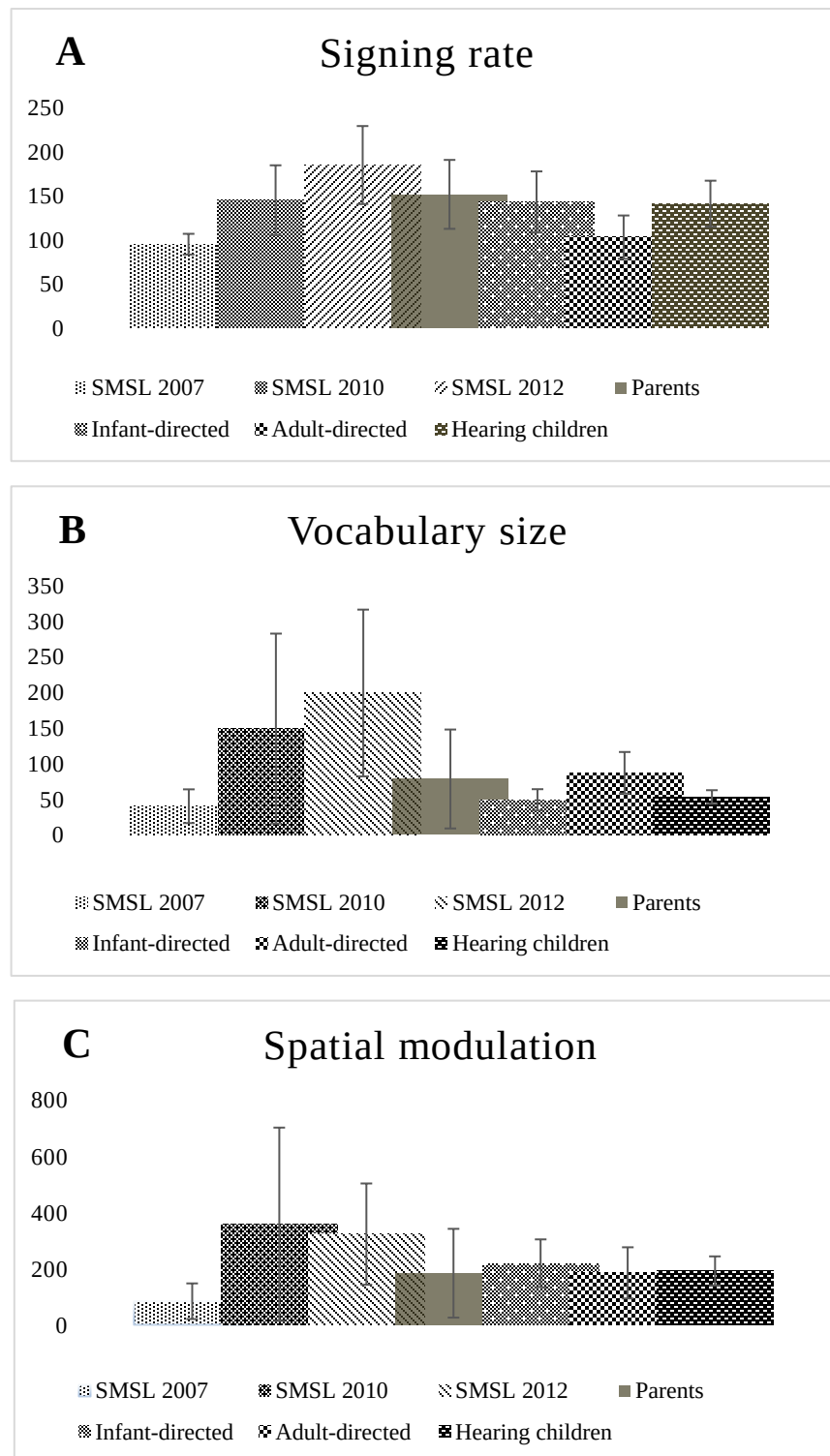


Figure 9. Mean signing rate (Plot A), vocabulary size (Plot B), and spatial modulation (Plot C) produced by SMSL signers in 2007, 2010, and 2012, their hearing parents, hearing adults, and hearing children with standard deviations.

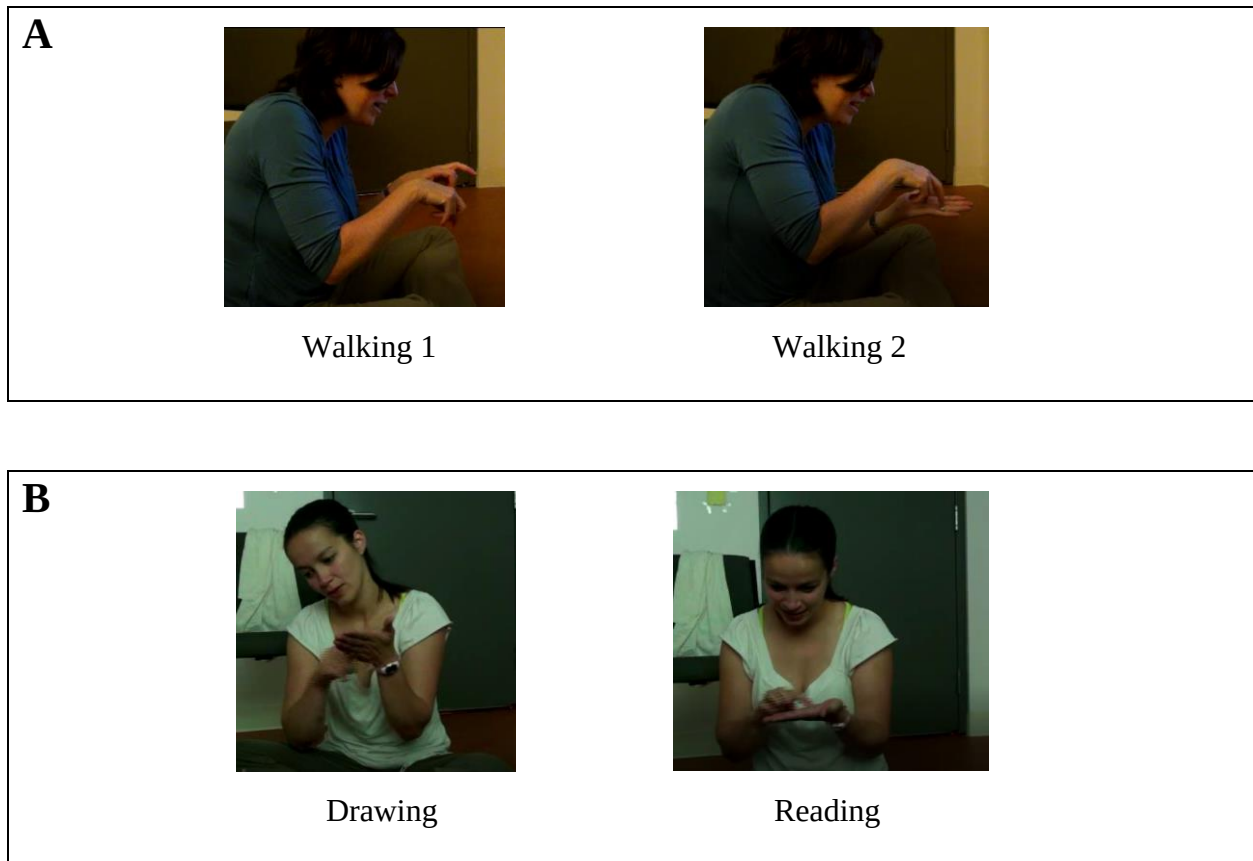


Figure 10. Examples of signing inconsistencies produced by hearing adults, including the use of two different signs to convey the same meaning (Plot A), and the use of the same sign to convey two different meanings (Plot B).



Figure 11. Example of a complex manual representation for the action of “tying one’s shoe” as spontaneously produced by a young hearing child.