EVALUATING THE PHONOLOGY OF NICARAGUAN SIGN LANGUAGE: PREPRIMER AND PRIMER DOLCH WORDS

Julie Delkamiller
University of Nebraska at Omaha

Over the past 30-years linguists have been witnessing the birth and evolution of a language, Idioma de Señas de Nicaragua (ISN), in Nicaragua, and have initiated and documented the syntax and grammar of this new language. Research is only beginning to emerge on the implications of ISN on the education of deaf/hard of hearing children in Nicaragua. The purpose of this comparative exploratory field study was to evaluate preprimer and primer Dolch sight words and sign language frequency between English, American Sign Language (ASL), Spanish and Idioma de Señas de Nicaragua (ISN). The research focused on word and sign frequencies between the languages and used Stokoe's parameters of location, hand shape, and movement to study the phonology of the signs. ISN has been closely evaluated over the first few decades of its existence. This study is meant to serve as a foundation for examining the use of ISN as a means toward achieving literacy for deaf/hard of hearing students in Nicaragua.

The rate of deafness in Nicaragua is much higher than in the United States (Polich, 2005). Unsanitary hospitals in Nicaragua are a leading factor in babies contracting sepsis requiring a powerful dose of the antibiotic gentamicin. Additional risk factors in rural Nicaragua include maternal infection during pregnancy, poor perinatal health care, prematurity, and gentamicin exposure. Heightened blood levels of gentamicin are associated with increased incidences of severe/profound deafness, vision problems and/or balance difficulties and with unrestricted access to the drug, there are higher numbers of individuals with hearing loss in Nicaragua Polich, 2005). Despite the elevated rate of deafness in Nicaragua, Idioma de Señas de Nicaragua (ISN) is only now an evolving sign language that is less than 30-years old. To date, most research has focused on proving that ISN is indeed a language (Senghas & Coppola, 2001).

Phonology of American Sign Language
William Stokoe (1960) described phonology in sign language as a finite set of discrete meaningless, contrastive elements that combine to form words. Since 1960, linguists have been studying signed languages around the world. Studying signed languages has inherent difficulties due to the lack of native signers and the influence of the spoken language on the sign language. Even now, in Nicaragua and Israeli Bedouin communities, linguists are gathering as much data as possible while the sign languages are relatively young and pure (Fox, 2007). Current research shows that signed languages are more similar to spoken languages in how the brain processes the information and in the basic properties of any language (Campbell, MacSweeney, & Waters, 2007). As a result, many schools, universities, and states now recognize American Sign Language as a distinct, world language.

Since Stokoe's pioneering research, additional phonological theories for sign language have been proposed such as, The Hold-Movement Model by Liddell, Visual Phonology by Uyechi, Dependency Phonology by van der Hulst, Prosodic by Brentari, and Hand Tier by Sandler and Lillo-Martin (Brentari, 1998; Sandler, 2012; Valli, Lucas & Mulrooney, 2011). In 1978, Stokoe published a revised edition of his work to include references to the advances in sign language research and psycholinguistics. For this study however, Stokoe's original phonological parameters using the current terminologies of hand shape, location, and movement were utilized to begin the study of the new Nicaraguan Sign Language. While sign language does not have the same long documented history as spoken languages, many similarities exist. Sign languages have been shown to process in the same part of the brain as spoken language and that both the right and left-brain are used (Campbell, et al., 2007). Sign languages have unique phonology, morphology and syntax (Sandler, 2012). Some of the similarities to spoken languages include *tips of the fingers* as compared to *slips of the tongue* meaning that mistakes are

made phonologically (Thompson, Emmorey, & Gollan, 2005). Sign languages are natural and will develop within a community of individuals desiring to communicate. When Leuninger, Hohenberger, & Waleschkowski (2007) studied German Sign Language, it was documented to be the phonological features that accounted for the *slips* and these slips had a tendency to happen mostly with proper names with partial access to phonology. It has been concluded that, *Signs appear to be stored as a set of phonological attributes* (Thompson, Emmorey & Gollan, 2005, p. 859).

While spoken words are linear in nature, signs are organized in bundles. The English words *three* and *there* have the same five letters. However, by rearranging two letters, there are different words with different meanings; it is linear. In ASL, the *phonemes* of hand shape, location, and movement can be expressed at the same time. Because phonological parameters are expressed simultaneously in a sign, one change in one phoneme changes the meaning completely. For example, the hand shape (open 5) and movement (touch) for signs mother and father are the same but the location changes. In ASL, female signs are produced near the chin while male signs are made near the forehead. While these signs are produced with one hand, Fox reports that *...about 60% of the signs of American Sign Language are made with both hands* (Fox, 2007, p. 102)

Sign languages can carry more information in larger chunks than in spoken language and users of ASL can think about the same concepts, beliefs, and doubts as those using spoken languages (Hohenberger, 2008). Yet there are differences in the modalities. The first most notable one is that spoken languages use only the tongue as an articulator whereas sign languages have two articulators: the right hand and the left hand. Such handedness is a phonological feature that is not found in any spoken language. The second most notable difference is the use of facial expressions and body language as a function of grammar (Sandler & Lillo-Martin, 2006). In ASL, different facial features discriminate between a topical sentence and a question for example. These differences carry morphological information simultaneously with the phonological means (Hohenberger, 2008).

Nicaraguan Sign Language
After the Nicaraguan Revolution in 1979, Idioma de Señas de Nicaragua slowly emerged and has been documented since 1986 (Polich, 2005). Linguists have flocked to Nicaragua to study a new language, especially because it was the children who were creating the language (Senghas & Coppola, 2001). As the students gathered, a pidgin language soon developed and was known as Lenguaje de Señas de Nicaragua. When the second generation of students came to school, Idioma de Señas de Nicaragua (ISN) developed as a language that had structure and complexity. The linguistic complexity of a language develops over time as it interacts with and is used within the community (Meir, Sandler, Padden & Aronoff, 2003; Senghas & Coppola, 2001). Beginning with only gestures and home signs, a complete language had evolved before the existence of a Deaf community (Kegl, 2002; Polich, 2005).

The national Nicaraguan Association of the Deaf, Asociación Nacional de Sordos De Nicaragua (ANSNIC), empowers the Deaf to be proactive while at the same time protecting the new language of ISD. Through the association, deaf people are socializing with each other at a much younger age and are able to stay in contact for a longer time. With ISN as a mode of communication, ANSNIC is able to provide educational and employment possibilities, in particular training people to be sign language interpreters.

Language is perhaps the greatest invention of all time but language does not exist in a vacuum. The alphabet of ISN is based on the one-handed alphabet used in the United States, Canada, and Costa Rica. Gloria Campos, a Nicaraguan woman, spent two years (1972 to 1974) working at St. Joseph's School for the Deaf in New York and returned to Costa Rica with the finger spelling alphabet she learned in the United States. At the same time, Gallaudet College established the program Regional de Recursos Para la Sordera (Regional Resource Program on Deafness) at the University of Costa Rica in 1974. Other global influences on ISN are evident as well. There is a strong Swedish influence on ISN as a result of the Swedish Federation of the Deaf providing funds to establish a house for the ANSNIC (Senghas, R.J., 2005). Judy Kegl, a linguist from the University of Southern Maine who has been researching ISN since 1986, wrote the introduction to the ISN dictionary project. The global influences on ISN are evident and ANSNIC is making every effort to preserve the integrity of the original signs and grammar. When visiting with ANSNIC members, there is a collective concern that ASL will usurp ISN and that the government will mandate a sign system that follows spoken Spanish (personal communication, 2008). Even though the alphabet is based on ASL, there are differences unique to the community. Because the ASL sign --*t*-- is actually an offensive gesture in Nicaragua, the ISN --*t*-- has been modified. The --*s*-- is shaken and the --*x*-- moves downward at an angle. In addition, signs for --*ll, ch, ñ*-- have been included to correspond with Spanish (ANSNIC, 1997).

Print Literacy
Much of early sign language development is noun based, but in order to make a link to print literacy, the high frequency sight words must be learned. Dolch words are primarily function words that can be learned quickly through repetition and links to visual elements in order to commit the words to memory (Dolch, 1936; Ehri, 1995). Because one sign may represent many ideas or concepts, there is not a one word to one sign relationship in either ASL or ISN. The English Dolch word *make* can mean to build something, to earn money, to clean your bed, to develop or to create something as shown in Figure 1. The Spanish Dolch word *hacer* has just one sign in ISN as seen in Figure 2. The Fairview Learning Program incorporates these features by adapting the well-established Dolch words and adapting them to also include the varying sign possibilities in ASL (Schimmel, Edwards, & Prickett, 1999). By using the components of Fairview in schools, many deaf/hard of hearing children are becoming bilingual in both ASL and English.

Purpose of Study
The purpose of the study was to evaluate preprimer and primer Dolch sight words and sign language frequency and phonology--location, hand shape, and movement--used to support deaf/hard of hearing students' literacy development in Idioma de Señas de Nicaragua compared to American Sign Language.

Methodology
This study examined the first two, preprimer (40 words) and primer (49 words) of the five Dolch word lists using the Fairview model in English and ASL which will lay the foundation for the creation of a similar teaching methodology in Spanish and Idioma de Señas de Nicaragua (ISN). A descriptive, correlational design was used in this study in order to examine the relations among a number of variables. The preprimer and primer Dolch words were used in order to analyze the phonology of the Nicaraguan Signs. Location, hand shape and movement were compared between an established language, American Sign Language with a relatively new sign language, Idioma de Señas de Nicaragua (ISN).

While Stokoe's original model does not identify all phonologic components, especially for compound signs or signs with multiple movements, it is the original framework for the phonology of signs. Also, non-manual elements such as mouth movements or facial expressions were not included in Stokoe's initial model, but more recent research has confirmed these elements as essential to the sign itself as well as distinguishing a noun from a verb. For this study, Stokoe's initial model was used to establish a foundation upon which to build a literacy development curriculum and research based methodology for teaching the deaf/hard of hearing students in Nicaragua.

Sign Language Data Collection
The translation of the Dolch words was completed over a 12-month period including two ten day research trips to Nicaragua. A commercial package, *Picture Me Reading Spanish Sight Words* was purchased to ensure accuracy (Isaacson, 2003). The creators of the program used two translators: one who was a native English speaker and one who was a native Spanish speaker to ensure inter-interpreter reliability. To verify the translations of Spanish-to-English and English-to-Spanish words used throughout this study was also interpreted using Nicaraguan translators. In addition, one translator acted as the Spanish-to-English, English-to-Spanish, and ISN language interpreter. Furthermore, a deaf adult in the Nicaraguan deaf community, who is widely respected by the Asociación Nacional de Sordos de Nicaragua, translated the Spanish Dolch words into ISN.

Limitations
The researcher holds current national certification in interpreting and transliterating from the United States Registry of Interpreters for the Deaf and is a licensed teacher of the deaf/hard of hearing who has been trained in the Fairview Learning System (Ausbrooks-Rusher, Schimmel, &Edwards, 2012). However, the researcher completed this research relying on the Spanish interpreters and language guides. This exploratory field study was based on the availability of formal Nicaraguan signs that are recognized and used by the deaf community. In addition, the signs could change rapidly, with more signs being added and others diminishing in popular deaf community usage. Another limitation is evaluating the original phonemes of location, hand shape, and movement but not the more recently added phonemes of non-manual markers and palm orientation.

Results
As shown in Table 1, the results of the ASL and ISN sign ratios shows an imbalance of signs to words. There are significantly more signs in ASL for the Dolch words than in ISN, $X^2 = 10.17$, p <.01 for preprimer and $X^2 = 25.38$, p <.01 for primer. This is not surprising because ASL is nearly 200 years old and ISN is in its early stages of development. Yet, this study finds that ISN is a young, vibrant, and organic language with potential for enlarging the vocabulary and expanding the phonemic features of existing signs.

Table 1. Preprimer and Primer American Sign Language Dolch Word and Sign Frequencies Compared to Idioma de Señas de Nicaragua Dolch Word and Sign Frequencies

	American Sign Language (ASL)	Idioma de Señas de Nicaragua (ISN)
Preprimer Dolch		
Words	40	51
Signs	95	51
Primer Dolch		
Words	49	76
Signs	113	51

In this study the linguistic property of phonemes has been analyzed in relation to ASL and ISN using the first two levels of Dolch words. Because ISN is in its infancy, Stokoe's parameters were used because his was the first model to look at sign language phonology. Furthermore, phonological elements do not convey meaning on their own, but when combined with other elements they carry meaning. By studying the smallest parts of the language, it is possible to see how they form words, phrases, and sentences used in signed discourse (Brentari, 1998, Stokoe, 1991).

Location
While there are fewer signs for Dolch words in ISN overall, there was a high correlation between the location phoneme in ASL and the location phoneme in ISN for both preprimer ($r^2 = .97$) and primer ($r^2 = .94$). Following Stokoe's (1960) original work in ASL phonology, there are only 12 locations from which to code the signs. As shown in Table 2, the neutral location holds the most signs, which is that space ahead of the signer's body.

Table 2. Preprimer and Primer American Sign Language Location Compared to Pre-Primer and Primer Idioma de Señas de Nicaragua Location

	Preprimer		Primer
	ASL	ISN	ASL
neutral location	65	43	82
face, or whole head	8	0	2
forehead, brow, or upper face	2	0	1
eyes, nose, or mid face	5	3	2
lips, chin, or lower face	4	3	15
cheek, temple, ear, or side face	0	0	1
Neck	0	0	0
shoulders, chest, trunk	9	10	8
upper arm	0	0	0
elbow, forearm	0	0	1
inside of wrist	0	0	0
back of wrist	0	0	0

Hand shapes
Stokoe did not identify every possible shape a hand could physically form, but instead established different categories that might include more than one hand shape. For the compact, fist hand shape, the sign might actually be an –a--, --s--,--t--, or --10--, but all of those hand shapes would be included in the *A* category. There are 19 categories for hand shapes under Stokoe's system. Individual signs could be further analyzed by individual hand shape or finger placement, but for Stokoe's groundbreaking work the general categories were sufficient. As seen in Table 3, the most frequent hand shapes used in both ASL and ISN are the fist (A), flat hand (B), spread hand (5) and pointing finger (1). There was a moderate correlation between the location phoneme in ASL and the location phoneme in ISN for both preprimer ($r^2 = ..56$) and primer ($r^2 = .68$).

Movement
While studying other languages, Stokoe (1960) realized that there were limits to the kinds of letter combinations that could be used to form words. Stokoe applied that same idea to sign language when he identified 24 movements. The five general categories are vertical, sideways, horizontal, rotary, and interaction. Within each category are sub categories giving more specific movements. For this study, the main movements of individual signs were analyzed and the relationship between ASL and ISN was found to be moderately high. Table 4

compares the movement of ASL and ISN. There was a moderate correlation between the location phoneme in ASL and the location phoneme in ISN for both preprimer ($r^2 = .59$) and primer ($r^2 = .60$).

Table 3. Preprimer and Primer American Sign Language Hand Shape Compared to Pre-Primer and Primer Idioma de Señas de Nicaragua Handshape

Preprimer	Primer		
	ASL	ISN	ASL
fist (as ASL 'a', 's', or 't')	15	11	33
flat hand (as ASL 'b' or '4')	31	18	44
spread hand (as ASL '5')	17	5	12
cupped hand (as ASL 'c', or more open)	6	0	3
claw hand (as ASL 'e', or more clawlike)	1	0	9
okay hand (as ASL 'f'; thumb & index touch or cross)	1	1	1
pointing hand (as ASL 'g' 'd' or '1')	26	22	29
index + middle fingers together (as ASL 'h,' 'n' or 'u')	5	3	10
pinkie (as ASL 'i')	2	0	3
thumb touches middle finger of V (as ASL 'k' or 'p')	0	3	0
angle hand,thumb + index (as ASL 'l')	2	4	8
vehicle classifier hand, thumb + index + middle fingers (as ASL '3')	24	0	1
tapered hand, fingers curved over thumb (as ASL 'o' or 'm')	4	2	20
crossed fingers (as ASL 'r')	0	3	1
spread index + middle fingers (as ASL 'v')	5	3	3
thumb touches pinkie (as ASL 'w')	0	1	3
hook (as ASL 'x')	5	2	6
horns (as ASL 'y', or as index + pinkie)	3	3	9
bent middle finger; may touch thumb (as ASL '8')	4	0	2

Discussion
Language is constantly in a state of flux and continues to evolve within communities, cross culturally and over time. Many tribal languages have become extinct; people no longer use the words *thou*, *whom*, or *shall* in common vernacular and with new technological communication devices, texting abbreviations have infiltrated written work. This may be viewed as either an erosion or destruction of the language, or it may be viewed as part of the necessary journey in a changing world.

The study of ISN is intriguing to linguists as they examine the creation of a language while at the same time document its growth and development. Linguists have been able to study ISN's modest beginnings, and to witness the deep desire for people to communicate and the amazing power of the brain to create order out of very basic raw materials. Much of the research has been spent verifying ISN as a language syntactically such as the use of verbs and classifiers (Kegl, 2002; Senghas, Senghas & Pyers, 2005).

Research has shown a positive correlation between ASL skills and reading skills among deaf/hard of hearing children and adults (Chamberlain & Mayberry, 2008.) Beginning with phonemic awareness in sign language, children are able to understand how a word/sign is produced and formed in a separate manner than its intended meaning. McQuarrie and Abbott (2008) suggested English proficiency was directly correlated to a higher level of ASL and that the better an individual is at ASL Phonemic Awareness, the better that individual was with English skills.

There is limited research on phonemic awareness in American Sign Language specifically. However, Haptonstall-Nykaza & Schick found that d/hh children were more effective at acquiring new vocabulary when a word in print was paired with a sign and lexicalized finger spelling compared to just the printed word and a sign (2008). In one study, teachers of the deaf/hard of hearing described instructional strategies in which they use ASL phonemic awareness because they see it crucial in fostering English development of the students. (Crume, 2012). By emphasizing the sign structure of ASL, students are able to map their knowledge of signs and sign structure onto the structure of print and are then able to be more flexible in their effective communication.

Table 4. Preprimer and Primer American Sign Language Movement Compared to Pre-Primer and Primer Idioma de Señas de Nicaragua Movement

Preprimer	Primer		
	ASL	ISN	ASL
moving upward	5	4	0
moving downward	14	5	7
moving up and down	0	2	1
to the dominant side	3	6	18
to the center or non-dominant side	1	0	1
side to side	3	3	1
toward signer	5	1	9
away from signer	24	11	26
to and fro	5	3	7
supinate (turn palm up)	0	0	3
pronate (turn palm down)	0	0	2
twist wrist back & forth	5	1	1
nod hand, bend wrist	3	2	4
open up	1	0	1
close	2	1	7
wriggle fingers (symbol looks like a cursive *e*)	0	0	1
circle (symbol is a spiral)	6	2	3
approach, move together	5	4	2
contact, touch	7	11	9
link, grasp	0	0	0
Cross	2	1	0
Enter	1	1	2
Separate	1	1	3
exchange positions	0	0	1

The signs for this study were analyzed using Stokoe's parameters for sign language phonology with location having the highest correlation between ASL and ISN. This corresponds with a study by Siedlecki & Bonvillian (1993) that studied sign language acquisition for signing children and found sign locations being more accurately produced when compared to hand shape and movement. Therefore the earliest acquired sign locations are neutral space, trunk, chin, and forehead, which indicate signs in these locations are easier to produce. These locations are important to this study, as location in a sign is crucial to the formation of the other phonological components of a sign.

Boyes Braem's (1998) study identified the --5--, --1--, --b--, and –a-- hand shapes as being acquired first. This corresponds with the results of this study. Because these hand shapes are acquired first, they are also produced more frequently and with fewer errors. The ISN –ch-- hand shape was included in the *H* hand shape category for this study. In this study, any hand shape made during a sign was included in the analysis. Certain hand shapes are used for descriptions of size and shape, which provide the foundation for developing classifiers. When combined with movement and location, these hand shapes begin to carry meaning and move beyond the phonological category. Just as Stokoe's first dictionary of ASL--organized by the hand shapes not by English words--the ISN dictionary is organized by the hand shapes (ANSNIC, 1997).

In the current study the most frequently documented movement was moving away from the signer. While differences in movement frequency exist, the possible movements themselves are significantly related between ASL and ISN. The types of movements a child can produce are largely influenced by gross and fine motor development and the Dolch words are less complex in both the print and the signed forms. In a study of 52 deaf adults using British Sign Language, the major errors happened in the movement category in the subcategories of size and speed (Orfanidou, Adam, McQueen & Morgan, 2009).

There is agreement that ASL is a recognized language based on cultural norms, completeness, and universality of form and function. In the United States, deaf/hard of hearing individuals enjoy the availability of a free prekindergarten through 12th-grade public education, access to trained teachers of the deaf and general human acceptance. Few of these contextual conditions form the realities of the deaf/hard of hearing individuals and

children who are living and growing ISN. By comparison, ISN must be considered a language developing in a country that has neither solidified its deaf communities nor sought to adequately embrace the potential of its deaf individuals.

With significantly fewer Nicaraguan signs for the first two levels of Dolch sight words, there are significantly fewer ways to express concepts in ISN. When studying newer sign languages, the more iconic signs have been seen to develop in the earlier stages. Spatial verbs develop earlier because they are more iconic but using the grammar of space for more complexities in verb agreement gradually emerges over time (Padden, Meir, Aronoff & Sandler, 2010). Therefore, the development of the sign language must be understood as a social system that requires inter-generational interaction within a community of users.

ISN has been closely evaluated over the first few decades of its existence. This study is meant to serve as a foundation for examining the use of ISN as a means toward achieving literacy for deaf/hard of hearing students in Nicaragua. In Nicaragua, medical approaches to deafness will not suffice. Education in its most basic form will be the path to success. However, in order to impact change in education, the history of political and social upheaval, chronic corruption, and natural disasters of Nicaragua must be considered. The people making educational decisions in Nicaragua have been shaped and formed by decades of such institutional instability. Therefore, these individuals have their beliefs based on a history of conflict and not for reforming schools for the future.

Conclusion
This study examined the phonemic elements of individual signs in ISN. Further research will need to examine the additional influences on the development of the signs as the community of users expands, as contact among the users increases, and as ISN is used more for educational purposes. Future research may also look at the iconicity of Nicaraguan signs compared to ASL. Comparing iconicity for the Dolch words, which do not always carry meaning with nouns and verbs in ISN, is one anticipated study.=

While this study examined the first two levels of Dolch words and not general discourse, future research will need to examine the hand shapes and how they are used to develop classifiers as ISN becomes increasingly robust over time. With this study as the foundation, future research will continue to cultivate the budding of new opportunities for the deaf in Nicaragua.

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