Title
Language Development of Children who Use AAC: Early Verb Categories and Inflection and the Emergence of Clause Constructions

Author
Harrusi, Gat Harussi

Publication Date
2017

Peer reviewed|Thesis/dissertation

Language Development of Children who Use AAC: Early Verb Categories and Inflection and the Emergence of Clause Constructions

By

Gat Harussi Savaldi

A dissertation submitted in partial satisfaction of the
Requirements for the degree of
Doctor of Philosophy
in
The Joint Doctoral Program with SFSU
in the
Graduate Division
of the
University of California, Berkeley

Committee in Charge:

Professor Anne Cunningham, Co-chair
Professor Gloria Soto, Co-chair
Professor Eve Sweetser
Professor Eve Clark

Summer 2017

Abstract

Language Development of Children who Use AAC: Early Verb Categories and Inflection and the Emergence of Clause Constructions

by

Gat Savaldi-Harussi

Doctor of Philosophy in the Joint Doctoral Program with SFSU

University of California, Berkeley

Professor Anne Cunningham, Co-Chair

Professor Gloria Soto, Co-Chair

For typically developing children, the process that allows them to master their first language and to acquire adult-like forms by the age of five is well documented through a large body of research (Brown, 1973; Clark, 2016; Miller & Chapman, 1981). However, for children with congenital severe motor and speech disorders (MSDs) who use Augmentative and Alternative Communication (AAC) instead of their natural speech to communicate, the situation is much different. The field of AAC is relatively young and very few empirical studies have been conducted on the grammatical development of such children (Binger & Light, 2008; Sutton, Soto, & Blockberger, 2002). The goal of this dissertation is to raise the question: to what extent does the grammatical development of these children differ from that of typically developing children? To answer this question the dissertation is presented in two distinct but related studies examining the developmental patterns of 1) the production of early verb categories and their inflection and 2) the emergence of clause constructions. These studies were conducted by analyzing a corpus of four children, aged 9 to 13 years, with severe motor and speech disorders (MSDs) who used speech generative devices (SGDs) as they interacted with a familiar adult over the period of nine months. This corpus was collected as part of a larger study exploring the effect of conversation-based intervention on the acquisition of vocabulary and grammatical markers by these children (Soto & Clarke, 2017). Implications of this research suggest that children with severe MSDs and no evidence of cognitive impairment develop mental representations similar to typically developing children. This predicts similarities in the emergence of verbal categories, verbal inflection, and complex clause structures. Discrepancies in development are explained in terms of the characteristics and constraints of aided communication.

Dedication

This dissertation is dedicated to the memory of my great-aunt, Mantzi Honhouze (Ferentz), who I loved dearly. Mantzi suddenly passed away at the age of 90 (3.9.1927- 3.26.2017) five months before she could read these lines and be so proud of me. She is my hero. Although she lost most of her family members in the Holocaust, she and her beloved spouse Oni, and my grandpa and grandma survived the Auschwitz concentration camp, moved to Israel, and continued to live, thrive, and enjoy life. She is the one who taught me what it means to be resilient, the secrets of beauty, and how to enjoy life. I miss her daily and I will continue to be inspired by her.

Table of Contents

List of Figures

List of Tables

Acknowledgements

In the Joint Doctoral Program, I was fortunate to have two incredible advisors, Dr. Gloria Soto and Dr. Anne Cunningham, who believed in me from the very beginning.

I'm grateful to Dr. Gloria Soto for introducing me to the research field of Augmentative and Alternative Communication, which has had a profound impact on the life of children and individuals with complex communication needs, their families, and their community. She gave me many opportunities in the past five years to engage in research, teaching, and publication and to be a part of the International AAC Society.

I'm thankful to Dr. Anne Cunningham for welcoming me to the field of early literacy in typically developing children and to be part of her research group, in which I participated for the last five years. She gave me numerous opportunities to engage in exciting projects, such as writing a book and celebrating its publication, and writing grants and materials for teacher's professional development. She consistently supported me in each milestone of the Ph.D. program.

I'm also grateful for the perspective of my two incredible linguist committee members, Dr. Eve Sweetser and Dr. Eve Clark, for their valuable comments in this research.

Special thanks to Dr. Eve Clark for inviting me to join her acquisition lab at Stanford University and giving me the opportunity to participate in her courses and seminars.

Special thanks to Dr. Eve Sweetser, who encouraged me to continue pursuing my linguistic interests when I first started to explore this field in the Linguistics department at Berkeley.

Many thanks to my colleague Dr. Lyle Lustigman, whom I met in Eve Clark's language acquisition reading group. We had the privilege of working together and collaborating to develop the analysis used in the second study of this dissertation.

Finally, I am thankful to have had the support of my family and friends throughout this work. I'm indebted to my husband, Shachar Harussi, who patiently supported me and took care of our children, Noa, Hila and Ofir, while I was 100% focused on my studies.

Chapter 1. Introduction

Augmentative or Alternative Communication (AAC) methods are designed to either supplement or replace speech or to enhance communicative effectiveness for children with severe congenital motor and speech disorders (MSDs) who cannot acquire the motor control necessary to be able to produce functional, intelligible speech (Beukelman & Mirenda, 2007; Smith, 1996; Smith, 2006). Development of AAC strategies has given these children access to the school curriculum and has great potential to enhance communication needs and provide a method for independent communication (Beukelman & Mirenda, 2013; Murray & Goldbart, 2009). Additionally, the full range of lexical types and grammatical markers that are available in the new speech generative devices (SGDs) is remarkably important in helping children generate and understand different types of clauses and phrases and reduce communication barriers (Smith, 2015).

In my professional role as a speech and language pathologist (SLP), I have a unique perspective in observing the challenges of supporting the communication and language growth of these children. Professionals are required to make decisions about many aspects of the devices, including the message selection, the organization of the symbols (phrases) within the device, the access to the device, and the role of voice output in improving communication. However, before making any of these clinical decisions, there is a need to conduct a thorough evaluation of the child's communicative competence in four interrelated domains: linguistic (expressive and receptive language), operational (level of support in operating the device), social (the ability to comment and greet friends using the device) and strategic (overcoming communication breakdown, selecting the correct vocabulary) (Light, 1989).

Specifically, my interest as an SLP and as a researcher is in understanding the linguistic competence and grammatical knowledge of these children and the interplay between typical and atypical language development. Empirical based knowledge of linguistic competence is essential not just to establish a generalization of the language path of children who use AAC similar to the developmental stages found in typically developing children (Brown, 1973; Miller & Chapman, 1981), but first and foremost to help professionals to design appropriate language intervention based on those predictable developmental stages. As I began the PhD program, I had the rare opportunity to assist a research study that investigated the effects of a conversation-based intervention on vocabulary and grammatical skills in children with MSDs who use AAC (Soto & Clarke, 2017) from its inception until its publication. I spent five years analyzing the children's transcripts and tracking the changes of the different grammatical categories and other variables of interest. In particular, I was interested in understanding how these children acquired verbs and the role of that acquisition in formulating clauses. The acquisition of verbs is, of course, a key milestone in language development in typically developing children (Bloom, 1993; Clark, 1996; Tomasello, 1992).

Research Problem and Hypothesis

Successful verb learning requires understanding of the syntactic structure of a sentence. Longitudinal studies are essential for gaining knowledge about the path of atypical and typical language development to implement efficient language intervention that takes into consideration the characteristics and constraints of aided communication. Much work has been done on the acquisition of verbs by typically developing children, but very little has been done on the acquisition and emergence of verbs and complex clause structures by children with severe MSDs. The limited studies that exist found that the children's speech appeared "telegraphic," in

that they used short sentences of nouns and verbs without any apparent grammatical structure. (Ortloff, 2010; Sutton et al., 2002; Sutton, Trudeau, Morford, Rios, & Poirier, 2010; Trudeau, Sutton, Dagenais, Broeck, & Morford, 2007). However, recent studies suggest that following a systematic and even short language intervention, the linguistic competence of these children improves. They can construct grammatically correct sentences and increase their usage of verb and spontaneous clauses in conversation (Binger, Kent-Walsh, King, Webb, & Buenviaje, 2016; Kent-Walsh, Binger, & Buchanan, 2015; Soto & Clarke, 2017). The goal of this dissertation is to further examine the positive outcomes of the usage of verbs and spontaneous clauses found in Soto & Clarke (2017) for four children, aged 9-13 years, who use SGDs over a period of nine months.

Chapter Two focuses on verbal semantics and observes the developmental patterns of early verb categories and their inflections, following the studies of Clark (1996) and Bloom (1993) of typically developing children. Chapter Three focuses on the form of verbs and the emergence of clause constructions, their complexity, and the effect of adult's prompts during co-constructed interactions and compares these observations to the emergence of clauses in typically developing children as described by Brown (1973).

The underlying assumptions of this dissertation are as follows. First, there is no doubt that non-speaking children who rely on graphic symbols develop lexical, morphological, and syntactic representations in their communication. The issue is in what way, and to what extent, are these mental representations different from those of naturally speaking children (Nelson, 1992). Second, usage-based theory emphasizes the importance of adult-child interaction in language development and the productivity of linguistic categories in children's speech are related to the high frequency of certain grammatical categories in their input (Tomasello, 2009).

As the children in this corpus were provided with extensive language practice and opportunities to use language, we expect that the developmental pattern of the verb categories and the emergence of clause constructions will follow the path found in typically developing children. At some point, any discrepancies can be explained by intrinsic factors related to the disabilities that make AAC a necessity, extrinsic factors, such as the type of communication system and the vocabulary available in the device, and interactional characteristics, such as efforts on the part of the child to accelerate the communication process by omitting morphological markers and function words such as articles, pronouns, prepositions, and verbs (Binger & Light, 2008; Blockberger & Johnston, 2003).

Overview of the Dissertation

In order to present multiple aspects of the language development of children who use SGDs and to present evidence-based research in a concise way that could be disseminated to practitioners in the AAC field, my dissertation is presented in an alternative dissertation format (Duke & Beck, 1999; Brodeur, 2015). The two studies are written as manuscripts for publication and are co-authored. The first study, Chapter 2, is titled "Early Verbal Categories and Inflection in Children who Use Speech Generating Devices" and is co-authored with Dr. Gloria Soto, my advisor, who is the principle investigator of the larger study (Soto & Clarke, 2017). The second study, Chapter 3, is titled "Emergence of Clause Construction with Aided Communication" and is co-authored with Dr. Soto and Dr. Lyle Lustigman, with whom I collaborated in developing the analyses of the clause constructions.

In this introduction, I will first include an overview of the two studies described in Chapters 2 and 3 by describing the research questions and abstracts for both studies, and the research and perspective grounding these studies. Then, I will include two overviews. The first

one is about the AAC field and the characteristic and constrains of graphic symbols modality in related to language acquisition. The second overview is about the cognitive linguistic approach and definitions of the main concepts discussed in Chapters 2 and 3.

Study One Overview - Early Verbal Categories and Inflections

Research questions. Is the developmental pattern of early verb production and inflection for children who use SGDs similar to the developmental pattern for children with typical development in terms of:

a. the types of lexical verb categories produced?
b. the order in which the verb categories are produced?
c. the kinds of predicates in which those verbs are used?
d. the verb inflection used by children with severe MSDs who use SGDs?

Abstract. The usage of early verbal categories, their event type, and the emergence of verbal inflections (*-ing*, *-s*, and *-ed*) were analyzed in the speech of four children aged 9;5 to 13;9 with severe MSDs who use SGDs to communicate. The study was conducted as a secondary analysis of a corpus collected as part of a larger study designed to investigate the effects of a conversation-based intervention on the expressive vocabulary and grammatical skills of these children. The major results of the study are that both Action verbs and Stative verbs were produced by all children from the beginning, and over time their usage increased in multi-word utterances where Action verbs were dominant. The emergence of the inflectional morphemes *-ing*, *-s*, and *-ed* varied across children and distributed selectively with different verb categories and event types. The results are discussed in terms of language development and the interplay with the findings described by Bloom (1993), Bloom, Lifter, and Hafitz (1980), and Clark (1996) of typically developing children, in which Action verbs preceded Stative verbs and inflections were primary acquired based on their correspondence to the verbal categories (Action/Stative). Implications for theory, practice, and further research are also discussed.

Study Two Overview - The Emergence of Clause Constructions

Research questions. How did the frequency and complexity of clause constructions change over the 9-month period?

What types of clause constructions were produced in terms of:

i. their linguistic constituents (subject, verb, and object) and phrase-internal elements (verb and noun inflections, articles, and prepositions)?
ii. the types of grammatical errors?
iii. the number of ungrammatical clauses?

How did the intensity of the adult's prompting affect linguistic behavior?

How many clauses were co-constructed with an adult?

How many turns did each co-constructed clause require?

Abstract. The purpose of this study was to detect general patterns in the structural changes of clause constructions produced by four children aged 9;5 to 13;9 with severe MSDs who use SGDs during clearly delineated sequences of adult-child interaction defined here as Clause Construction Communication Cycles (CCCC) over the period of nine months. This study was conducted as a secondary analysis of a pre-analyzed corpus (Soto & Clarke, 2017). The developmental patterns of generating clause constructions were analyzed in terms of their *types*, *linguistic complexity*, and *intensity of the adults' prompts* (number of turns). The major results of the study are that from the very beginning, all children produced the basic structure of a clause, including subject, verb, and object, and over time the grammatical complexity increased by

adding phrase internal elements such as inflections, articles, and prepositions (e.g., *I want car*, [Subject-Verb-Object] vs. *I am going to the beach with my family*, [Subject + (be)Verb(ing) + (preposition) (article) Object + (preposition) (possessive) Object]). Use of specific grammatical elements followed the developmental stages observed of typically developing children (Brown, 1973). For all children, the personal pronoun *I* (first-person singular) emerged before *she/he* (third person singular) and *we/they* (plural). Children who had the highest number of co-constructed clauses also had the highest number of well-formed clauses. Finally, the intensity of adults' prompts (number of turns) increased as the clause structure became more complex and the child needed more support. Implications for theory, practice, and further research are discussed.

Research and Perspective Grounding the Studies

As mentioned above, the scientific field of AAC is young and the innovative methods developed for this dissertation were created based on the literature written about communication by typically developing children. This study adopts a psycholinguistic approach and incorporates generative grammar, cognitive development, and the perspective that linguistic verbal modality is superior to graphic symbols modalities as explained below. I would like to mention here that there are many theories concerning language production via graphic symbol modality as well as many theories of language acquisition by typically developing children. The interplay between these two different modalities of communication is very complex. I will address this interaction in the overview of the characteristics and constraints of graphic symbols modality and in the concluding chapter (Chapter 4).

AAC researchers have tried to understand the impact on language acquisition of using graphic symbols to communicate. One point of contention is the effect of production on the process of acquisition. One view holds that production (here via graphic symbols) reflects the output of the language acquisition process. Thus, the output could be explained by the interaction of three components: the input (spoken language), language acquisition, and the communication device (Smith, 2006). Another view holds that the use of graphic symbols for constructing messages differs greatly from the use of spoken language, not because of age or disability, but due to the graphic symbols modality (Smith, 2006; Soto, 1997). This view emerged from studies that relied on elicited tasks to stimulate language production through graphic symbols (typically using PCS or Blissymbols) with typical and atypical preschool children, adolescents, and adults (Soto, 1997). These researchers found that even typical individuals displayed significant morpho-syntactic differences when comparing the structure of their graphic messages and their spoken messages.

From this, three main hypotheses are conjectured to explain how children construct messages with graphic symbols: (1) the compensation hypothesis; (2) the modality specific hypothesis; and (3) the hypothesis that spoken modality is superior to graphic symbols modality (Trudeau et al., 2007). These are all described below.

Compensation hypothesis. The compensation hypothesis suggests that atypical structure of graphic symbol messages reflects the compensation strategies used by graphic symbol users and their partners, in order to facilitate any cognitive, physical, and linguistic barriers during the interaction via aided communication (Beukelman & Mirenda, 2013; Soto, 1999).

Modality-specific hypothesis. The modality-specific hypothesis is the idea that the graphic symbol modality itself directly influences the structure of the constructed utterances and doesn't reflect a spoken utterance model. This predicts that the production of graphic symbol

utterances will differ from what one might expect based on spoken word order (Soto, 1999; Sutton et al., 2002; Trudeau et al., 2007).

Linguistic verbal modality is superior to graphic symbols modalities hypothesis. This hypothesis assumes that producing messages with graphic symbols is based on a mental representation that is first constructed in a spoken structure and then transposed into graphic symbols. This predicts that the basic structure of the utterance produced via graphic symbols modality will follow the structure of the spoken language grammar and be modified based on the specific AAC system (Trudeau et al., 2007). As a result, the utterance produced via graphic symbols is a result of a translation task rather than expressing the exact linguistic constituents of the oral language (Smith, 1996). Under this hypothesis, the functional match between the spoken and the graphic representation needs to be learned by the child (Trudeau et al., 2007).

Theories and Factors of Verb Acquisition. Two distinct approaches, nativist theory (generative linguistics) and learnability theory (e.g., cognitive psychology, usage based theory), have attempted to understand how children acquire language over such a short span of time and what the source of that linguistic knowledge is**.**

Nativist theory. Under a nativist theory, one assumes that Universal Grammar, the human knowledge of grammar, is innate. This innate knowledge allows the child to acquire any language despite the "poverty of the stimulus," which refers to the limited exposure to the input of the ambient language (Berwick, Pietroski, Yankama, & Chomsky, 2011).

Learnability theories. Learnability or empiricist theories are data-driven and evidence-based. These theories attribute major importance to the linguistic input or child-directed speech (Valian, 2009). In these theories, one assumes that children acquire language by constructing abstract categories and schemas of concrete items by analyzing their distribution, frequency, and information from the input.

AAC: Characteristics and Constraints of Graphic Symbols Modality

Augmentative and Alternative Communication (AAC).

AAC as a field of research is young and evidence-based practices and literature began in the mid-1970s (Murray & Goldbart, 2009). The year 1950 marks the starting point from which speech therapists and teachers began to use AAC methods to provide alternative methods of communication to facilitate the communication of individuals with significant motor or speech disorders who had difficulties developing intelligible speech or communication skill (Hourcade, Pilotte, West, & Parette, 2004; Von Tetzchner & Grove, 2003). The American Speech-Language Hearing Association (ASHA) defines AAC as "an area of clinical practice that attempts to compensate, either temporarily or permanently, for the impairment and disability patterns of individuals with severe expressive communication disorders" (http://www.asha.org). The goal of AAC is to support the full communication of the individual by incorporating any existing modality of communication such as speech, vocalizations, gestures, manual signs, and aided communication.

Aided vs. unaided AAC. AAC can be defined as a multimodal process involving *aided* and *unaided* symbols. *Unaided AAC* requires no additional parts of equipment, and the messages are expressed by using only the body as the mode of communication (Lloyd, 1997). Gestures, manual signs, traditional orthography, and other types of traditional symbols are all considered unaided AAC (Sutton et al., 2002). *Aided AAC* "involves use of some external device or equipment, which may range from very simple handmade materials, such as a picture board or

wallet, to highly complex electronic devices that produce computer-synthesized speech" (Lloyd, 1997 p.1).

Symbols representation and organization. Aided graphic symbols can be presented as three different systems that differ in the level of their technology range from *no technology* to *low-technology* to *high-technology*. *No technology* boards were the first to be developed (Figure 1.1). They typically include albums or books of printed or drawn symbols without voice output capability. *Low-technology* devices consist of an array of static symbols on a pre-set grid (fixed display) with voice output capability by pre-recording and then retrieving auditory labels for each symbol (Figure 1.2). These devices usually contain from under ten to several dozen symbols (Lloyd & Loncke, 1999). *High-technology* devices include special software that can store hundreds or thousands of symbols, displayed on a dynamic screen and can provide voice output in either human voice (pre-recorded voice) or a synthetic speech (Figure 1.3) (Lloyd & Loncke, 1999). These high-tech computers with voice output capability are known as Voice Output Communication Aid (VOCA) devices or Speech-Generating Devices (SGDs) (Beukelman & Mirenda, 2007; Sutton et al., 2002). The number and types of graphic symbols, along with the type of device, vary according to the child's language and cognitive ability. The technology that supports independent communication for individuals with severe speech impairment have emerged since 1981, the year that represents the beginning of the computer age and the development of the personal computer. In the last few years, AAC applications have been placed on personal devices, such as cell phones, tablets, etc. (Flores et al., 2012).

Figure 1.1 Non-Tech
Note. From AAC-RERC

Figure 1.2 Low-Tech
Note. From Center in Excellent of Disabilities, West Virginia University Website.

Figure 1.3 High-Tech
Note. From Daynavox Website

Populations who Use AAC

AAC can support three different groups of children based on their linguistic needs of the AAC system: expressive, supportive and alternative language groups. The three groups differ in various dimensions related to: (1) the gap between their expressive speech and spoken language comprehension, (2) the role of spoken language in the intervention, (3) how long the child is expected to depend on AAC, and (4) the range of situations in which the AAC system is needed (Martinsen & Von Tetzchner, 1996).

The expressive language group. This dissertation focuses on children with congenitally severe MSDs belonging to the *expressive* group. The expressive group includes individuals who have discrepancy between their understanding of other's speech and their ability to express themselves through natural speech. In other words, their expressive language skills lag behind their receptive language skills. (Von Tetzchner & Martinsen, 2000).

The supportive language group. This group involves two sub-groups: (1) children who will use AAC temporarily as a support for language comprehension because their language development is very delayed, but are otherwise expected to begin to speak (visual support); and

(2) children who will use AAC as a means to improve the intelligibility of their speech. They are similar to the expressive group except that the AAC is not their main mode of communication.

The alternative language group. This group includes children who need to use AAC as a permanent means of receptive and expressive communication.

In short, there is not a typical population that relies on AAC. Good candidates to benefit from AAC are individuals who cannot rely on their natural speech to meet their daily communication needs. Congenital causes such as cerebral palsy, intellectual disability, autism, and developmental apraxia of speech are all common causes of severe communication disorders for which AAC can have a crucial role in supporting communication growth (Beukelman & Mirenda, 2007 p.4).

Modalities of Communication and Graphic Symbol Modality

A variety of behaviors and modalities are available to express language. Typically developing children communicate with each other to convey messages and they often select the optimal or preferred form based on the contexts. This process is defined as multimodality of communication (Loncke, Campbell, England, & Haley, 2006). There are two main modalities of communication: verbal and non-verbal. Verbal communication includes natural speech that explicitly represents oral language and non-verbal communications includes any gestures or communication function expressed by facial expression, eye-gaze, physical proximity, etc. While nonverbal communication primary relies on the visual modality and the verbal communication relies on the auditory modality, they are both complementary functions for communication (Loncke et al., 2006). In typical modalities of communication, individuals use natural speech and they can choose to use both types of modalities (visual, auditory) either in parallel or one at a time. For typically developing children, the core mode of communication is speech and in order to clarify their message or emphasize specific needs, they use other modalities (Loncke et al., 2006). Finally, Loncke et al. (2006) summarizes for typical developing children the three factors that impact their decision for selecting their preferred modality in communication (auditory or visual): (1) the theme of the communication, (2) maintaining efficient communication, and (3) the level of mastery of each of the communication forms.

Atypical modalities of communication. In contrast to typically developing children**,** children who use AAC are often restricted in selecting their preferred mode of communication due to their disabilities and thus, their major mode of communication is likely to be through graphic symbols, which can be displayed in different modes: pictures/symbols without voice output, or within devices that produce vocalizations. However, when using graphic symbols, they hold two basic assumptions: (1) AAC forms such as signs, gestures, graphic symbols, and speech generating devices can be used as an alternative form to replace the natural speech; (2) the message will be clearer to the communication partner when other modes of communication are added (Loncke et al., 2006).

Graphic Symbols and Receptive/Expressive Language

Most children who use graphic symbols belong to the expressive group. As defined above, these children comprehend the spoken language of their community but have difficulties in expressing themselves. The output of their communication partner is transmitted to the child orally and the message that the child wants to convey is transmitted via graphic symbols (Smith, 2006). The child's comprehension develops via the auditory channel and his or her speech, production develops via aided communication. This asymmetry between input and output creates challenges for language acquisition and for researchers in understanding this complex modality relationship.

A common tool used to explain language acquisition via this complex relationship between input and output modalities is the notion that the goal of aided communication devices is to recode the message conveyed via oral language into graphic symbols. The output of the device is expected to be a mirror for the formal structural properties of the message. The task of translation is to "connect" these two modalities and to do so the child needs to develop complex metalinguistic skills. The implications of this notion in terms of intervention are to develop the child's metalinguistic skills in order to improve his ability to translate the spoken language (input) into symbols (output) in the order of spoken language (Smith, 2006; Sutton et al., 2002; Trudeau et al., 2007).

Graphic symbols: language development and learning. The community of typically developing children is surrounded by individuals who use their natural speech and thereby provide them with enough input to be able to naturally develop their spoken language (Brekke & Tetzchner, 2003). Their language acquisition is naturally acquired due to biological competence along with social interaction (Brekke & Tetzchner, 2003; Chomsky, 2005). However, children who use graphic symbols to express themselves often lack a community who uses aided communication and can provide them with enough modeling to enhance their language production via AAC. Instead, they must learn to develop their language and express themselves by explicit intervention and instruction provided by professionals, who do not use graphic symbols for their own communication. Typical language development is acquired mostly by maturation along with experience, whereas learning and developing aided communication is strongly related to one's own experience rather than natural maturation. Likewise, the major concern in the AAC field is how to optimize the aided communications interactions and explicit instructions to a level that allows the child to learn AAC skills in order to become an independent communicator and nonetheless to ensure that these skills will not be forgotten. Up to today, there is no clear framework on how to optimize AAC learning to fully support the expression of oral language (Smith, 2006; Tetzchner & Grove, 2003; Von Tetzchner & Grove, 2003).

Graphic symbols and morphosyntax acquisition. Morphology is the field in linguistics that studies the structure of the words based and the specific rules that speakers use to change word structure to express new meanings. For example, the word *car* refers to one car but adding to it the morpheme *-s* that marks plural will change the meaning of the word *car* to more than one car: *cars*. Similarly, adding the morpheme for past tense *-ed* to the word *walk*, which describes a current action, will turn the meaning to a past action: *walked*. Syntax refers to the rules for putting words into sentences. For example, if a child acquired English syntax, then he would know that *I like this cake* is a better form than *like I this cake*, even though listeners might be able to comprehend both (Beukelman & Mirenda, 2007). This knowledge of both the order of the words within a sentence and the structure of the words themselves is a crucial component in expressing and understanding any language (Blockberger & Johnston, 2003; Sutton et al., 2002).

For typically developing children, language is learned through interaction in which they take an active role in observing and analyzing the language of the native speakers they interact and converse with. They have many opportunities to practice and produce language and to receive feedback and self-correct themselves. In contrast, one of the main barriers for children with severe MSDs is their limited opportunities to interaction with others and practice producing language via their aided communication (Blockberger & Johnston, 2003).

Comprehension and the acquisition of morphology and syntax are enhanced by the use of the graphic symbols modality. For children who use AAC, acquiring language and grammar

becomes a challenge (Blockberger & Johnston, 2003; Sutton et al., 2002). Research shows that their constructed messages via aided communication are often described as "telegraphic" by omitting grammatical morphemes (using short sentences including nouns or verbs without following grammatical standards) both in aided and sign language output (Blockberger & Johnston, 2003). Moreover, researchers have found unusual syntactic patterns that occur in the messages of children who use AAC. Message construction in graphic symbols exhibits word order irregularity. For example, while typical English word order is subject-verb-object (SVO), users of graphic symbols tend to order clauses in SOV (*boy store drive*) or VSO (*climb girl tree*) or OVS (*bread buy boy*). When forming compound sentences graphic symbol users tend to change word order in multiple positions: *girl tree help nest climb boy* (instead of the more typical *the girl helps the boy climb a tree to catch a nest*) (Soto, 1997). Following, a systematic review of 31 articles that include data of 155 individuals with severe speech and physical impairments, Bedrosian (1997) found that a large proportion of these individuals had difficulties with mastering grammar.

Sutton et al. (2002) explain initial barriers that may limit language production of children with little or no functional speech:

1. They have fewer opportunities for engaging in pre-symbolic forms of communication, such as vocalizations, babbling, and gestures than typical children.
2. They have fewer opportunities in their access to an existing AAC system because they depend on the help of others. As a result, language output is likely to be reduced even within the constraints of the AAC system.
3. They use graphic symbols rather than spoken language and thus, someone else programs their device and chooses the graphic symbols selection. The range of accessible modes over time and users' motor limitations influences the process of development.

Moreover Sutton et al. (2002) discuss three additional issues that might explain the limited grammatical development and performance of children who use AAC

1. The access to select specific symbol using aided AAC takes a longer learning process compared to natural speech production. For example, if the child wants to add a morpheme (e.g., past tense when using a dynamic display system with several levels), he may require a multistep process involving selection of a symbol for the specific morpheme that is visually very similar to the other symbols in the same pop-up window. Faced with this situation, the child may choose another way of marking the past time concept that seems clearer or less difficult (e.g., using a symbol for "yesterday") (Sutton et al., 2002)
2. The representation of the linguistic elements of spoken language via graphic symbols is challenging. For example, the Picture Communication Symbols (PCS) for *sit* (a line drawing of a portrayed person sitting on a chair viewed in profile) includes both an agent and a thing sat upon and therefore does not represent the action of sitting alone. Similarly, the pictures for *throw* and *push* depict the agent, the one who receives the action and the action itself. Grammatical category boundaries of symbols may be unclear because of this ambiguity, which may, in turn, influence sentence construction. Moreover, the visual graphic representations in AAC displays are constrained by the physical space available.

Graphic symbols and semantic acquisition. Semantics refers to the understanding of words and how they relate to one another (Beukelman & Mirenda, 2007). Typically developing

children use both visual and auditory channels to express meaning. To learn the structure and meaning of the words, children analyze the stream of the linguistic constituents in the speech they hear. They also use the visual channel to gather spatial information (Smith, 2006). Typically developing children can express meaning either by expressing spontaneous messages via gestures or by retrieving words from their mental lexicon (Loncke et al., 2006).

However, the situation is different for children who use AAC. Their output lexicon is restricted to what is available in the AAC system. The number of elements is often limited and depends on the communication level of the AAC users. It is important to note that AAC users constantly depend on the adult to have access to the lexicon. For example, the communication board of a beginning AAC user includes only five elements as it is easier to use than a communication board with 64 elements. It is generally agreed that increasing the participation of children who use AAC in natural contexts such as interactive storybook reading, can facilitate their language acquisition process and greatly expand their vocabulary (Barton, Sevcik, & Romski, 2006).

Cognitive Linguistic Approaches in Child Language

First, I will define the linguistic concepts of verb, clause, and verb categories based on Generative Grammar (Chomsky, 1957). Then, I will include an overview of the cognitive linguistic approaches in child language, which all agree that cognitive factors are the most important components in explaining the psychological processes involved in language acquisition. Cognitive linguistic approaches try to answer questions such as how children acquire their linguistic knowledge, how this knowledge is organized and represented in their mind, and how this knowledge is related to other cognitive domains (Bloom, Lahey, Hood, Lifter, & Fiess, 1980; Brown, 1973; Clark, 2016; Dromi, 1987; Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Mandler, 1992; Miller & Chapman, 1981; Pinker, 1994; Tomasello, 2000, 2009; Tomasello & Akhtar, 1995).

Definition of Verb/Predicate and Clause

From a linguistic point of view, nouns and verbs are universal categories that reflect two fundamental communicative functions of language: reference (nouns) and predication (verbs). These categories aim to represent events that occur in the world and the participants in those situations (Van Valin & LaPolla, 1997). Likewise, verbs and other predicate elements describe the situation, while nouns phrases depict the participants. According to Generative Grammar, nouns and verbs categories differ not just according to their semantic aspect but mainly by their syntactic role, which relies on the contrasts between the predicating elements and non-predicating elements, or between the arguments of the predicate and the non-arguments of the predicates (Van Valin & LaPolla, 1997).

Predicating elements. The structure of a clause must contain a predicate, which is often a verb. In English the predicating element is usually a verb, whereas non-verbal predicates require the copula *be* or other kind of copular verb (Van Valin & LaPolla, 1997). For example, predicates can be simple verbs, like *eat*, or a copula followed by a noun phrase or adjective (e.g., *be a mother*, *be tall*), or even a more complex phrase (e.g., *want to eat*, *believe that Gat will win the lottery*, *tell me that the weather will be nice today*). A clause structure can contain a number of noun phrases (NPs) and prepositional phrases (PPs), whereas some of them are semantic arguments of the predicate and some are not. Linguists distinguish between the elements of the predicate and those which are not by making a distinction between the *core* of the clause and the *periphery*. In short, the *core* of a clause consists of the *predicate* (nucleus, verb) and its *arguments* (NPs, PPs), whereas the *periphery* includes elements, which are not arguments of the

predicate. For example, the simple sentence *Gat wrote her thesis at Starbucks* is a clause, in which *Gat wrote her thesis* is the core with *wrote* being the nucleus, *Gat* and *her thesis* being the core arguments, and *at Starbucks* in the periphery as shown in Figure 1.4 (adapted from Van Valin & LaPolla, 1997 p. 26).

CLAUSE	
CORE =Predicate + its Arguments *Predicate (NUCLEUS, VERB)*	*PERIPHERY = Non-Arguments*
Gat WROTE her thesis	*at Starbucks*

Figure 1.4 Layered Structure of the Clause

Components of the Layered Structure of the Clause

The semantic representation of a verb is represented by the core of the clause and it is worth noting that the distinction between nucleus, core, and periphery is universal (Van Valin & LaPolla; Van Valin & LaPolla, 1997) . Therefore, in order to study the development pattern of stative and action verbs, verb categories, this dissertation focuses on an analysis of predicates headed by verbs (nucleus), the basic unit of a clause, in the utterances constructed by children,

Verb classes definition. Every verb has a basic Aktionsart ("form of action" in German) type, which is how they are represented in the lexicon. The lexical aspect of a clause or Aktionsart of a verb depicts the internal temporal (semantic) properties of verb phrases. In other words, it tells us the way in which the verbs are structured in relation to time. Is the event completed or not? Is it ongoing or recurring? Does it happen all in one moment, or does it extend in time. For example, the distinction in the lexical aspect between *eat* and *sit* refers to whether or not these verbs have natural endpoints and thus will be classified as *telic* (from Ancient Greek telos, end); or do not have a natural endpoint or conclusion and will be classified as "atelic." Given that *eat an apple* has an endpoint at which the eating is finished and completed, while *sit* does not have an endpoint because it does not make any sense to say, *finished sitting*, unless more details are added. The addition of prepositions (e.g., *to Mary*) or adverbials (e.g., *yesterday*) can result in a different Aktionsart interpretation for the verb in context of the entire clause. In short, a given verb can be used with more than one Aktionsart interpretation (Dowty, 1979a). Based on the distinctions in Aktionsart, Vendler (1957) proposed that verbs can be classified by their temporal properties into four categories: *activity*, *accomplishment*, *achievement* and *state* (Dowty, 1979a). Van Valin and LaPolla (1997) explain that the term 'state of affairs' refers to phenomena in the world that can be classified to four basic types of states of affairs according to the role of its participants as follows:

1. Situation: "non-dynamic states of affairs which may involve the location of a participant (*a book being on the table*), the state or condition of a participant (*Maria being tired*), or an internal experience of a participant (*Fred liking Alice*)"
2. Event: states of affairs that happen instantly (*balloons popping)*.
3. Process: states of affairs which involve change and take place over time (*ice melting*).
4. Action: dynamic states of affairs in which the participants are active (*Chris is singing*; *the sun is shining*; *the ground is shaking)*. As shown in Table 1.1 each of the Aktionsart types corresponds to one of the basic state of affairs types: situations are expressed by state verbs, events by achievement verbs, processes by accomplishment verbs, and actions by activity verbs.

Table 1.1 *Aktionsart Types in Relations to the Basic State-of-Affairs Types*
(adopted from Van Valin & LaPolla, 1997 p.92)

State of affairs type	Aktionsart type
Situation	State verbs
Event	Achievement verbs
Process	Accomplishment verbs
Action	Activity verbs

Moreover, Table 1.2 shows whether the verbs, in terms of their basic Aktionsart type, have an inherent terminal point or not, in three features: +/-[static]; +/- [punctual]; +/- [telic]

Table 1.2 *Verbs in Terms of their Basic Aktionsart Types*
(adopted from Van Valin & LaPolla, 1997, p. 93)

Aktionsart type	+/- [static]	+/- [telic]	+/- [punctual]
State	+	-	-
Activity	-	-	-
Accomplishment	-	+	-
Achievement	-	+	+

Cognitive linguistic approach. The acquisition of verbs is considered to be a significant milestone in child language, according to the cognitive linguistic approach to language development (Tomasello, 1992). If verbs reflect conceptual development, it is important to link it to the child's overall cognitive development. In 1954, Piaget defined the sensory-motor period as a period that happens before grammar emerges (Bloom, 1993). In this period, children learn about the permanence of objects through their actions on objects and their observations of actions on objects. For example, the child learns that objects exist by acting in ways that make them disappear and return. Consequently, the literature defines three cognitive stages during the first three years that impact the language acquisition as follows. In the first year, children are able to talk about actions and feelings that are linked to objects that are perceivable in the environment or internal conditions. In their second year, children begin using verbs that refer to objects that are not physically present. Next, children acquire the ability to mentally act on objects instead of acting on them directly (Bloom, 1993). The transition from infancy to childhood occurs when the child develops the ability to recall prior experiences in relation to present events and to expect new events that are informed by his beliefs, desires, feelings and experiences. In fact, language enables the child to express these thoughts, and as we stated above, verbs appear later than nouns in lexical acquisition (Golinkoff, Hirsh-Pasek, Mervis, Frawley, & Parillo, 1995).

Children's meaning representations of world events. Mandler's (1992) theory depicts the origin of children's meaning representations and the role of these representations in language acquisition. Infants acquire verbs for motion events. Therefore, they must be capable of mapping their knowledge of spatial relations onto image schema and then onto language. This process has three levels. In the first, the perceptual analysis level, infants interpret the world through perceptual analysis (comparing two events) that leads them to discover whether the events are the same kind or different events. In the second, the non-verbal (image schema) phase, categorization is attained. This phase mediates between the perceptual analysis of the first level

and the linguistic meaning of the third level. In the third level, the linguistic meaning level, infants acquire verbs for motion events (Mandler, 1992)

Semantic and Syntactic Bootstrapping. As noted above, children first observe the events and then they rely on their image schema to acquire the meaning. However, the verbal meaning cannot come only through observation of the world's events. The form of language itself acts like a zoom lens that gives perspective on the main event (Gleitman, 1990; M. Maguire, K. Hirsh-Pasek, & Golinkoff, 2006; Maguire, Hirsh-Pasek, & Golinkoff, 2006). This process is known as syntactic bootstrapping and occurs when the child focuses on the syntactic frames in which the verb is used. Syntactic bootstrapping allows the children to observe the verb's main event and link the event components to semantic components. The frames tell the listener whether to focus on one actor or another, one affected entity or another, the cause or the effect (Pinker, 1994). Thus, in order to consider a sentence well-formed, the argument structure needs to be specified to the number and types of arguments required by the verb. The preferential-looking paradigm is a common method in psycholinguistics to explore the comprehension of toddler and infants by tracking their gaze after a linguistic stimulus is provided to them. Evidence shows that by age 2;0 to 2;6, infants are sensitive to the meanings of different verb frames (Golinkoff et al., 1987). For example, Golinkoff et al. (1987) showed that when children hear a sentence frame of a transitive verb such as *Oh see Big Bird glorping Cookie Monster*, they were more likely to look at a picture that depicts Big Bird making Cookie Monster do something (a causal event) more than a non-causal event in which Big Bird and Cookie Monster were performing a novel action together. The same results occurred when the infants heard a sentence with an intransitive frame such as *Oh, see Big Bird is glorping with Cookie Monster.* They looked at the non-casual event when they heard this sentence.

Usage Based Theory. Usage based theory (Tomasello, 2009) emphasizes two major cognitive skills in language acquisition: joint attention and pattern detection. Three principles underline development according to this view: 1) Entrenchment: in order for an action to become habitual, the child needs to perform the action successfully a sufficient number of times; 2) Preemption: in order to successfully produce a correct form, the child needs to engage in a process of correction approximation and modify his output according to the adult's mature linguistic representation; and 3)The role of frequency in the input: high frequency of a certain grammatical category will lead to earlier productivity of this category in the child's speech.

In sum, the cognitive linguistic approach for language development assumes that children play an active part in acquiring language by engaging in activities, observing, and making inferences based on their cognitive level.

Chapter 2. First Study: Early Verbal Categories and Inflections in Children who Use SGDs.

Introduction

The use of verbs is considered a key milestone in language development. Verbs play a crucial role in language development as they afford and boost the construction of more complex grammatical structures and the expression of more complex meaning (Bloom, 1993; Bloom, Lifter, & Hafitz, 1980; Clark, 1996; Golinkoff et al., 1995; Tomasello, 1992). According to Clark (1996), verbs are connectors that, in English, link the participants with events, and structure the grammatical relations through a combination of inflections (e.g., person, number, animacy) and word order. Verbs indicate the semantic role of each noun phrase (e.g., agent, location, instrument). For example, in an utterance like *the dog seized the bone*, the verb *seized* links the agent (*dog*) to the theme (*bone*); while in the utterance *the boy put the parcels on the table,* the verb *put* links the agent (*boy*), the theme (*parcels*) and the location (*table*) (Clark, 2016). The acquisition of verbs depends on the prior acquisition of grammatical forms such as nouns. Nouns serve as the buildings blocks or syntactic arguments of the verb; thus, they are typically acquired before verbs (Waxman & Lidz, 2006). Nouns and verbs are categories that reflect two fundamental communicative functions of language: reference (nouns) and predication (verbs).

The core of a clause (e.g., *John ate the sandwich*) includes the verb/predicate (*ate*) and its arguments (*the sandwich*, *John*). Vendler (1967) classified verbs according to their temporal properties into four main lexical categories: Activity, Accomplishment, Achievement, and State (Dowty, 1979a). State verbs describe continuous and unchanging events as in: 1) the location of a participant (a book being on the table), 2) the state of a participant (Mary being tired); or 3) an internal experience of a participant (John likes Mary). Activity verbs describe Actions in which the participants are active for a continuous period without specific limitation, as in *John is singing*. Achievement verbs describe Actions that occur punctually as in *he kicked the ball* and Accomplishment verbs indicate completion of a process as in *John built a house*.

Acquisition of Verbal Categories and their Inflections in Typically Developing Children.

Bloom (1993) documented the production of verbs in four typically developing children from the age of 2 to the age of 3 (Mean Length of Utterance (MLU) ≈ 2.5) during natural conversations. She categorized each verb according to whether a movement was implied in the utterance (i.e., Action versus State events). All children produced sentences with Action verbs before sentences with Stative verbs and both Stative and Action verbs in non-locative sentences appeared before Stative and Action verbs in locative sentences. The order of these developmental stages can be summarized: (1st) Action: *open the button* (2nd) Stative: *I hear children!* (3rd) Locative: *this go there*.

Using diary data, Clark (1996) documented the production of verbs by a child from the age of 1;7[1] to 3;0 and used Vendler's categories to classify them. Since young children typically produce early verbs without inflections or arguments, and with unreliable word order, Clark had to rely on the whole predicate and its context to classify the verbs as follows: (1) Activities: events where the child was engaged in or watching some ongoing Action (e.g., *running*,

[1] Age will sometimes be denoted as a numerical value in the following format: Year; Month, e.g., 1;7 would refer to a child being one year and seven months old.

swimming, or *splashing*); (2) Accomplishments: events where the agent produces some change of state through an Action or series of Actions (e.g., the child saw someone tear a piece of newspaper or the child himself knocked down a pile of blocks and the blocks were scattered); (3) Achievements*:* events in which the child engaged in some activity, often with effort, to achieve some goal (e.g., the child climbed up the ladder of a slide and announced his arrival at the top); (4) States*:* events in which the child talked about someone being in some state (e.g., asleep, tired). Clark (1996) found that the earliest and largest verbal category used by the child was Activity verbs while State and Achievement verbs were the smallest categories (Clark, 1996). Moreover, she found that the emergence of verbal inflections (*-ing*, *-ed* and *-s*) is based on their correspondence to the verbal categories: Activity, Accomplishment, Achievement, and State. Children first begin to add inflection to verbs whose inherent semantics matches with the meaning of that inflection. For example, up to age 2;0, 90% of Damon's *-ing* uses, which is typically used to mark the duration of an Action, were used on Activity verbs, whereas 60% of his *-ed* uses first appeared on Accomplishment verbs. Finally, 100% of the simple present *-s*, which is typically used for habitual or generic Actions, appeared on State verbs. In the next year, he extended his use of the simple present *-s* to both Activity and Accomplishment verbs, which comprise the Action verbal category.

Developmental studies in AAC. Longitudinal studies are essential for gaining knowledge about the patterns of language acquisition both in atypical and typical development. Despite the importance of verb acquisition in language development in typically developing children, there has been little work describing the patterns of verb acquisition in children with congenital severe motor and speech disorders who use speech generating devices (SGDs). Previous studies found that these children often use single-meaning graphic symbols (predominantly nouns) and multi-word messages characterized by unusual syntactic patterns and omission of grammatical morphemes (Blockberger & Johnston, 2003; Soto, 1997; Sutton et al., 2002).

Evidence shows that through explicit instruction and systematic language exposure children with motor speech disorders who use SGDs can improve their grammar and usage of verbs (Binger & Light, 2008; Binger, Maguire-Marshall, & Kent-Walsh, 2011; Blockberger & Johnston, 2003; Soto, 1997, 1999). In a recent study, Binger, Kent-Walsh, King, Webb & Buenviaje (2016) found that following a short semantic–syntactic structure intervention, four 5-year-old children with normal receptive language who use augmentative and alternative communication (AAC) generated grammatically correct constructions using Action verbs in semantic–syntactic relations of agent–Action (*Mickey jumps*), Action–object (*Kiss Minnie*), agent–Action–object *(Goofy kiss Minnie)* and attribute–agent–Action (*Sad Goofy falls*). Similarly, Kent-Walsh, Murza, Malani & Binger (2015) successfully taught three participants aged 4 to 6 to use Action verbs in declarative *to be* constructions (e.g., *Mickey is jumping*) and inverted yes/no questions (*Is Mickey jumping?*).

Taken together, these findings indicate that children with MSDs who use AAC can develop mental representations of lexicon, morphology, and syntax and with appropriate instruction can "translate" those mental representations and their related constructions onto the graphic symbols modality in their communication devices. It remains to be seen if the developmental pattern of early verb production and inflection for children who use SGDs is similar to the developmental pattern for children with typical development. This question forms the basis of this study, which describes: (a) the types of lexical verb categories produced; (b) the order in which the verb categories are produced; (c) the kinds of predicates in which those verbs

are used; and (d) the verb inflection used by children with severe motor speech disorders who use SGDs.

Method

Participants

The participants for this study included four children, ages 9–13 years, with severe motor and speech disorders who used high-tech SGDs with access to thousands of words and grammatical markers. The children were competent users of their SGDs as indicated by their performance on the AAC profile (Kovach, 2009). According to their test performance on receptive language, they had normal or near normal receptive single word vocabularies, yet they performed very poorly on morphological judgment tasks (see Table 2.1 for participant and device characteristics). It is important to note that before the language intervention, all the children constructed one-to-two-word level utterances, using mostly nouns with no evidence of using grammatical markers or inflection.

Table 2.1 *Participants' Demographic Characteristics*

Participant	Age	Speech disorder	Mobility	SGD[a]	SGD Access	Languages spoken at home	Receptive vocabulary age equivalent (percentile)	Morphological judgment age equivalent (percentile)	Expressive language[b]	Speech intelligibility rating
Carmen	9;5	Dysarthria secondary to Pfeiffer syndrome	Wheelchair user	Dynavox DV 4 with Gateway Modified 45, 60	Finger pointing	English, Spanish	8:6[c] (37)	6;6[c] (9)	MLU 1-2 mostly nouns and adjectives	0% (non-verbal)
Mateo	13;7	Dysarthria secondary to Cerebral palsy	Wheelchair user	Vantage Light with Unity 84	Joystick	English, Spanish	8;11[d] (5)	< 8[e] (n.a)	MLU 1-2 mostly nouns and adjectives	20% (minimally verbal)
Julian	13;9	Dysarthria secondary to Cerebral palsy	Wheelchair user	Dynavox Maestro 5 with Gateway Modified 45	Finger pointing	English, Spanish	9;9[d] (12)	< 8[e] (n.a)	MLU 1-2 mostly nouns and adjectives	7% (minimally verbal)
Kareem	13;3	Dysarthria secondary to Cerebal palsy	Wheelchair user	Vantage Light with Unity 60	Finger pointing	English, Arabic	9;6[d] (7)	< 8[e] (n.a)	MLU 1-2 mostly nouns and adjectives	0% (non-verbal)

[a]Gateway ™ and Unity ™ are two language-based vocabulary organization systems that include: (i) core vocabulary words (i.e., most frequently used words), allowing for the creation of spontaneous and novel messages and (ii) grammatical markers, allowing for grammaticalization of the utterance.
[b]From educational records.
[c]Test of Auditory Comprehension of Language-3 (Carrow-Woolfolk & Allen, 1999).
[d]Peabody Picture Vocabulary Test-4 (Dunn & Dunn, 2012).
[e]Test of Language Development-I:4 (Newcomer & Hammill, 2008).

Research Design

This study involved a secondary analysis of language transcripts collected as part of a larger study designed to investigate the effects of a conversation-based intervention on the expressive vocabulary and grammatical skills of children with motor speech disorders who used SGDs (Soto & Clarke, in press). As a part of that study, the participants met with a familiar adult to have a conversation, once before the intervention started, every sixth intervention session, and three times after intervention had terminated over the span of nine months. Neither the children nor the adults were given any instructions as to how or what to converse about and were only

asked to engage in a conversation as they normally would. For each child, the total number of conversations and their total length are as follows: Carmen (N=8, 200.4 min), Kareem (N=6, 183.16 min), Mateo (N=7, 209.8), Julia (N=8, 215min). In sum, the database includes 29 conversations, totaling 808.36 minutes (13.5 hours).

Data Coding and Analysis

These observations were videotaped and transcribed using the conventions of the Systematic Analysis of Language Transcripts (SALT) (Miller, Andriacchi, Nockerts, Westerveld, & Gillon, 2012). Only intelligible verbalizations and device-generated utterances were transcribed. The transcripts were analyzed for the frequency of types (different verbs) and tokens (total number of verbs) of verbs and predicates according to the coding system described below.

Verbal categories: Stative verbs and Action verbs. Following Bloom's (1993) work on the acquisition of Stative verbs and Action verbs in typically developing children, we coded two major verbs categories Stative verbs (*State verbs*) and Action verbs (*Activity verbs*, *Accomplishment verbs,* and *Achievement verbs*) (Dowty, 1979a). For each child, we identified all his/her lexical verb productions in the SALT transcripts. Each predicate from single word verb to multi-word phrase was then manually coded as Stative or Action verb according to the linguistic tests used by Dowty (1979) and Lakoff (1965). If a verb can be used in the simple present form and has a present tense interpretation, then it is a Stative verb (Dowty, 1979b). Stative verbs cannot be used in present progressive. Only Action verbs occur in the progressive and can occur as imperative. Copular verbs (am, is, are, was, were) were classified as Stative verbs (Bloom, 1993). In complex phrases when a predicate included two verbs (e.g., *I want to eat*, *I'm going to swim*), we analyzed the predicate category according to whether the head verb, (e.g., *want*, *going*), behaved like a Stative or Action predicate category and did not analyze the verbs *eat* or *swim*.

Inflection coding. We also coded the temporal verb inflections: *-ing*, *-ed*, and *-s* (simple present tense). It is important to note that the language organization systems in the communication devices required post-morphing for the encoding of temporal verb inflections. For instance, participants had to first select a verb in its present tense (e.g., *go*), and then select the morpheme (e.g., *-ed*) to modify it. In this way, the SGD provides a regular form to encode an irregular verb (e.g., *go* + *-ed* = *went*). Therefore, we counted all verbs with *-ed* morphemes as past regardless of whether they were regular or irregular. For the copula (*be*), we coded and counted all the different inflections (*am*, *are*, *is*, *was* and *were*) as a different Stative lexical verb type as they appeared as different forms on the participants' SGDs.

Reliability

Several steps were taken to ensure that the transcripts and results were accurate. Both SALT codes and manual analysis were used to calculate the types and total number of verbs, and the types and total number of inflectional morphemes. Two separate, independent observers transcribed 25% of randomly selected conversations. Transcription discrepancies were resolved through a viewing of discrepant utterances and reaching consensus on the form (Kovacs & Hill, 2015). Intertranscriber consensus was achieved for all discrepancies. The lead author used the language tests described above to manually code verb and predicate categories into Stative or Action. Instances of ambiguity were discussed with an expert in child language, Eve Clark.

Results

Overview

Analysis of all the verbs represented in the children's corpus yielded a list of 525 conventional lexical verbs (tokens) and 89 different verbs (types) produced by the four children during the nine-month period. Carmen produced 178 verbs, Mateo 116, Kareem 110, and Julia 122. The total number of lexical verbs (tokens) produced in relation to the total number of words (tokens) was similar across children and formed 15% to 18% of their lexicon as follows: for Carmen, 15% of her words production were verbs, for Mateo 18%, for Kareem 18%, and for Julia 16%.

Types of lexical verb categories produced. The production of lexical verbs categories (Stative and Action) by tokens and types for each participant across all sessions are summarized in Tables 2.2 to 2.5. For all children, the percentages of the total number of Action verb types (different words) were higher than the total number of Stative verbs types (Carmen 71% vs. 29%, Mateo 59% vs. 41%, Kareem 52% vs. 48% Julia 63% vs. 37%). The data also indicate that the frequencies of Stative and Action verbs (both tokens and types) increased for all participants.

Table 2.2 *Carmen's Production of Lexical Verbs Categories Over Time*

		Tokens			Types		
Conversation	MLU[a]	Total	Stative	Action	Total	Stative	Action
1	2.56	5	1	4	4	1	3
2	3.27	26	18	8	9	3	6
3	3.18	34	8	26	15	4	11
4	3.91	30	9	21	14	4	9
5	4.36	16	7	9	9	4	5
6	3.9	29	13	16	10	6	4
7	5.75	19	4	15	13	3	1
8	3.67	19	10	9	13	6	7
Total		178	70	108	45	13	32
Percentage		100%	39%	61%	100%	29%	71%

[a]Mean Length Utterance.

Table 2.3 *Mateo's Production of Lexical Verb Categories Over Time*

		Tokens			Types		
Conversation	MLU	Total	Stative	Action	Total	Stative	Action
1	1.14	7	3	4	5	2	3
2	1.7	4	0	4	3	0	3
3	1.21	22	17	5	5	4	1
4	1.49	16	9	7	7	3	4
5	1.49	21	15	6	8	5	3
6	1.56	16	5	11	7	3	4
7	1.53	30	14	16	9	5	4
Total		116	63	53	27	11	16
Percentage		100%	54%	46%	100%	41%	59%

The production of different lexical verb categories (types) over time across children is shown in Figure 2.1. Despite variability in the number of lexical verbs produced in each

observation, all children increased their production of verb types over time. The apparent anomaly in the case of Julia's last three observations corresponds to the end of intervention and a drop-in production of multi-word predicates (see Table 2.Table 2.4 *Kareem's Production of Lexical Verb Categories Over Time*

		Tokens			Types		
Conversation	MLU	Total	Stative	Action	Total	Stative	Action
1	1.62	2	0	2	2	0	2
2	1.28	8	6	2	5	3	2
3	1.8	29	8	21	11	6	5
4	2.41	33	14	19	5	2	3
5	1.87	10	10	0	4	4	0
6	2.0	28	19	9	6	5	1
Total		110	57	53	21	8	13
Percentage		100%	52%	48%	100%	38%	62%

Table 2.5 *Julia's Production of Lexical Verb Categories Over Time*

		Tokens			Types		
Conversation	MLU	Total	Stative	Action	Total	Stative	Action
1	1.59	4	3	1	4	3	1
2	3.83	25	6	19	5	3	12
3	2	13	2	11	9	2	7
4	4.43	22	6	16	14	5	9
5	2.39	24	5	19	13	3	10
6	2.43	17	8	9	4	2	2
7	1.61	5	0	5	2	0	2
8	2.67	12	5	7	6	4	2
Total		122	35	87	38	12	26
Percentage		100%	30%	70%	100%	32%	68%

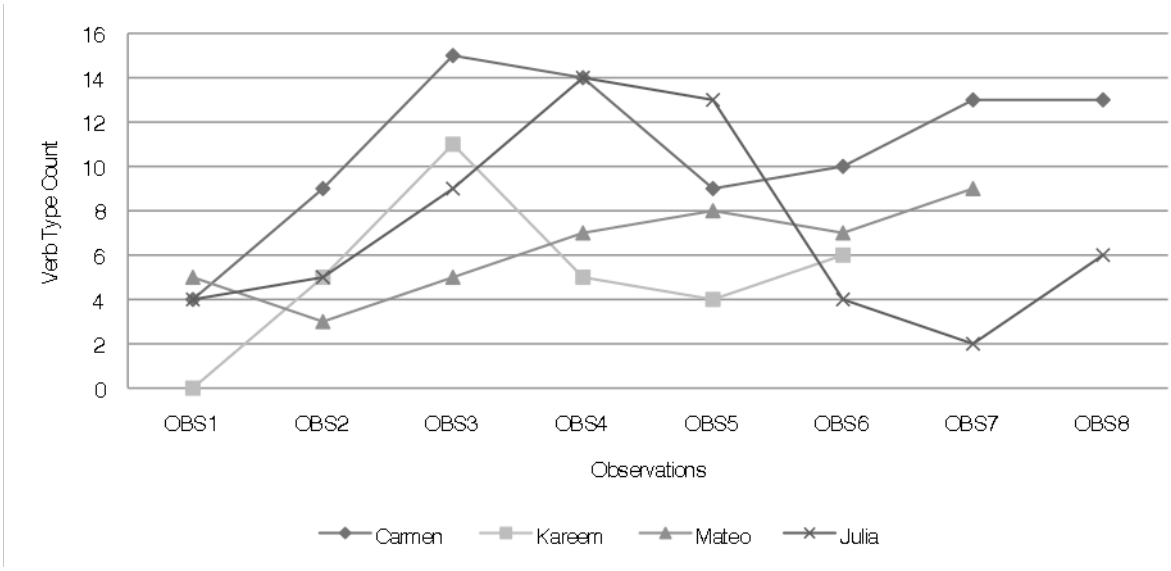

Figure 2.1 Production of Verb Types across Children over Time.
The types of verbs used in each observation increased for all children over time.

The percentages of the most frequent Action and Stative verb types were calculated for each participant and were compared to the production of these verbs in the corpus of the other children as shown in Table 2.6. The verb *go* was the most frequently used Action verb across all children (Carmen=16%; Kareem=13%; Mateo=14%; Julia=12). All children used the Action verbs *eat* and *play*. For Julia, these verbs were the most frequent (10%, 8% respectively) after *go* (12%). As for Stative verbs, there was not a specific verb that was most frequently used across all participants, but all children produced *want* and *like*. For example, Carmen most frequently produced the Stative verb *feel* (12%), whereas neither Kareem nor Mateo produced this verb. The copula *be*, in the form of third person, *is*, was the dominant copula inflection across all children whereas the other forms (*are, am, was, were* and the imperative *be*) were varied and did not appear in the corpus of all children. A list of the lexical Stative and Action verbs (token and type) for each child can be found in Appendix A.

Table 2.6 *The Most Frequent Action and Stative Verb Types in The Children's Corpus*

	Action			Stative					
Participants	*go*	*eat*	*play*	*be*	*is*	*want*	*like*	*see*	*feel*
Carmen	16%	2%	4%	11%	55%	5%	2%	2%	11%
Mateo	14%	5%	4%	28%	59%	9%	8%	-	-
Kareem	13%	5%	7%	15%	35%	27%	7%	1%	-
Julia	12%	10%	8%	8%	40%	1%	2%	6%	6.5%

Note. The percentages of each lexical verb type were calculated in relation to the total number of verbs produced by each child as shown in the Appendix A. The percentages of the inflected copula form *is*, was calculated in relation of the total number of the of copula *be* (*is, am, are, was, were*) for each child.

Production order of Stative vs. Action verbs. Three children (Carmen, Mateo and Julia) only produced Stative verbs in Observation 1 (Carmen: *feel*, Mateo: *love*, copula *is*; Julia: *forget*), while Kareem used an Action verb (help) in Observation 1 and started to use Stative verbs in Observation 2 (*am*, *want*). In short, three children produced both Action verbs and Stative verbs from the first observation, while one child produced only Action verbs in Observation 1 and both types in Observation 2.

The kinds of predicates in which those verbs were used. Tables 2.7 to 2.10 lists counts of: 1) complex phrases - predicates in multi-word utterances that include two verbs (e.g., *I want to eat*, *I go swim*); 2) total predicates in multi-word utterances including predicates that were pre-stored and stored in the communication device as one message named pre-stored phrases; 3) Stative predicates in multi-word utterances; 4) Action predicates in multi-word utterances; and 5) pre-stored predicates in multi-word phrases. These counts are described in greater detail below and are followed by the tables.

Complex phrases. The number of complex phrases counted in each observation is listed in the first column. Three children began to use complex phrases in Observation 2 (Carmen Kareem and Julia) and one child begun to use complex phrases in Observation 3 (Mateo).

Action vs. Stative production order in multi-word combinations. In contrast to our findings reported above where the production of Action and Stative verb in single word utterances occurred at Observation 1 and 2 for all children, the emergence of predicates in multi-word combination varied across children and occurred in various stages. Carmen used both Stative and Action predicates in multi-word combinations in Observation 1, while Mateo first used Action predicates in multi-word combination in Observation 3 and only in Observation 4

did he use both Stative and Action predicates in multi-words combination. Kareem's production shows the reverse pattern: he first used Stative predicates in multi-word combinations (e.g. *I want bed sleep,* Observation 2) and only in Observation 3 did he use both Action and Stative predicate in multi-word combinations. Julia displayed a similar pattern: she first used Stative predicates in multi-word combinations (Observation 1) and then used both categories in Observation 2.

Action vs. Stative predicate counts in multi-word combinations. Action predicates in were more frequent than Stative predicates in multi-word combinations for three children (Julia, Mateo, and Carmen), while the reverse was true for Kareem.

Pre-stored predicates in multiword combinations. Pre-stored predicates are phrases that were pre-recorded in the device and the child can express them by selecting one button. The number of pre-stored predicates in multi-word combinations in each observation is listed in the final column along with its cumulative number in relation to the total number of predicates in multi-word combinations. For Carmen, 10% of her predicates in multi-word combinations were pre-stored, for Kareem 9%, for Julia 44%. Mateo did not use pre-stored predicates. In sum, among the four children, Julia used this strategy the most (44%) while the other children did not use it or only used it 10% of the time in conversation. It is important to note that all of Julia's pre-stored predicates in multi-word phrases were generated by her with the support of her communicator partner and were programmed in her device for the purpose of using them in a conversation. Therefore, we included them all in the analysis.

Table 2.7 *Carmen's Production of Predicates in Multi-Word Utterances Over Time*

	Predicate counts				
Observation	All	Stative	Action	Pre-stored	Complex phrases
1	4	1	3	0	0
2	22	18	4	8	4
3	25	8	17	5	4
4	25	10	15	0	7
5	16	5	11	2	4
6	23	12	11	0	11
7	18	4	14	0	3
8	15	10	5	0	8
Total	148	68	80	15	41
Percentage	100%	46%	54%	10%	28%

Table 2.8 *Mateo's Production of Predicates in Multi-Word Utterances Over Time*

	Predicate counts				
Observation	All	Stative	Action	Pre-stored	Complex phrases
1	0	0	0	0	0
2	0	0	0	0	0
3	7	0	7	0	1
4	11	2	9	0	0
5	12	1	11	0	1
6	8	3	5	0	1
7	14	2	12	0	3
Total	52	7	44	0	6
Percentage	100%	13%	87%	0%	12%

Table 2.9 *Kareem's Production of Predicates in Multi-Word Utterances Over Time*

	Predicate counts				
Observation	All	Stative	Action	Pre-stored	Complex phrases
1	0	0	0	0	0
2	7	7	0	3	2
3	16	11	5	4	2
4	23	14	9	0	5
5	10	10	0	0	0
6	19	17	2	0	7
Total	75	59	16	7	16
Percentage	100%	79%	21%	9%	21%

Table 2.10 *Julia's Production of Predicates in Multi-Word Utterances Over Time*

	Predicate counts				
Observation	All	Stative	Action	Pre-stored	Complex phrases
1	2	2	0	2	0
2	18	5	13	16	3
3	12	9	3	6	0
4	20	5	15	12	2
5	16	2	14	8	2
6	13	8	5	0	1
7	4	0	4	0	0
8	14	8	6	0	0
Total	99	39	60	44	9
Percentage	100%	39%	61%	44%	9%

Verb inflections (*-ing*, *-ed*, and *-s*). The production, frequency, and emergence of verbal inflection (*-ing*, *-ed*, and *-s*) for each child are detailed in Tables A1-A4 (see Appendix A). Present progressive *-ing* was produced by all children but emerged in different observations across children. Mateo first produced *-ing* in Observation 1, Kareem and Julia followed in Observation 4, while Carmen did not produce *-ing* until Observation 8. Past tense *-ed* was produced by three children and also emerged at different stages of observations across children. This time, Julia was earliest, producing *-ed* in Observation 1, followed by Carmen in Observation 2 and Mateo in Observation 5. Simple present *-s* was produced by three children and emerged late for all three children. Kareem and Julia were first to produce *-s* in Observation 5, while Carmen did so in Observation 6. Together, the children produced 88 verb inflection tokens and 29 verb inflection types which are actually inflections grouped into types based on the verb it is paired with. The majority of the verb inflection types occurred with *-ed* (65%), followed by *-ing* (20%) and *-s* (14%).

Correspondence of verb inflection and verb category (Action vs. Stative). The verbs (tokens) that were inflected in the children's corpus (N=88) were grouped based on their inflection and event category. 84% of the verb types inflected with *-ed* were Action verbs and 16% of them were Stative verbs (Table 2.11). Within the *-ed* Action verbs, 56% of them were Activity verbs and 44% were Accomplishment verbs. 83% of the verbs inflected with *-ing* were Action and 17% were Stative (Table 2.12). Within the *-ing* Action verbs, 80% of the verbs were

Activity verbs and 20% were Accomplishment verbs. 50% of the verbs inflected with *-s* were Stative verbs and 50% were Action verbs (Table 2.13)

Table 2.11 *Frequency and Event Category of Verbs Inflected with* -ed

Event category	Sub-event category	Verb types and frequency	Total frequency	Percentage of total
Stative		feel (8), see (7), forget (1)	16	29%
Action			40	71%
	Accomplishment	go (10), draw (4), make (2), buy (1), glue (1), open (1), wear (1)	20	36%
	Activity	eat (8), ride (3), watch (2), play (2), dance (1), help (1), walk (1), swim (1), talk (1)	20	36%

Table 2.12 *Frequency and Event Category of Verbs Inflected with* -ing

Event category	Sub-event category	Verb types and frequency	Total frequency	Percentage of total
Stative	State	love (1)	1	6%
Action	All Action		16	94%
	Accomplishment	go (12)	12	71%
	Activity	carry (1), cook (1), roll (1), swim (1)	4	24%

Table 2.13 *Frequency and Event Category of Verbs Inflected with* -s

Event category	Sub-event category	Verb types and frequency	Total frequency	Percentage of total
Stative	*State*	have (4), want (2)	6	40%
Action	All Action		9	60%
	Accomplishment	go (7)	7	47%
	Activity	tell (2)	2	13%

Discussion

The research presented here provides some understanding into how children who use Augmentative and Alternative Communication (AAC) instead of natural speech acquire early verb categories and inflection in comparison to typically developing children. Specifically, this study observed how children aged 9;5 to 13;9 with severe motor and speech disorders who use speech-generating devices (SGDs) produce verbs and verbal inflection.

Typically developing children first acquire Action verbs and then Stative verbs and these event categories are the major influence on verbal inflection acquisition (Bloom, Lifter, et al., 1980; Clark, 1996). That being said, typically developing children first use the inflectional marker with its aspectual meaning: *-ing* for activity verbs that mark process, *-ed* for accomplishments that mark change of state and *-s* for verbs that mark habitual aspect and later they extend the use of these inflections to the other verbs categories. In contrast, adult speakers use tense and aspect morphemes contrastively within the same verb stem (e.g., *swims*, *swimming*, *swam*) (Bloom et al., 1980).

In early observations, the children in this study presented similar linguistic expertise via their communication devices as the typically developed children did in the beginning of Bloom's (1993) study. In Observation 1, they produced mostly nouns with no evidence of inflection. But

over a period of nine months, in which a conversation intervention was used, these children began producing verbs and verbal inflection in single- and multi-word utterances, at times even producing complex (multiple) verb constructions, as detailed in the results.

How frequently and in what order these children begin using various verb types and event categories can be compared to the frequency and verbal development order of typically developing children from the age 1;6 to age 3, a period during which typically developing children begin to use verbs and inflectional morphemes (Bloom et al., 1980; Bloom, 1993; and Clark, 1996).

Comparison of lexical verb category types. The children in this study matched their typically developing peers (Clark, 1996; and Bloom, 1993) by also producing more Action verbs than Stative verbs. The verb *go* was the most frequently used Action verb across all children (Carmen=16%, Kareem=13%, Mateo=14%, Julia=12%) and was also one of the most frequent verbs used by typically developing children when they produced their earliest lexical verbs at age 1;3-2;0 (Bloom, 1993; Clark, 1996). The most frequently used Stative verbs by children in this study were *want* and *like,* two of the most frequently used verbs by young children when they began using verb inflection and had an MLU of 1.5-3 (Bloom et al., 1980). Other Stative verbs used by typically developing children include *need*, *think*, and *feel*.

Comparison of verb category order of production. While the children in this study matched their typically developing peers in verb type choice, they differed in that they did not consistently produce Action verbs before Stative verbs as typically developing children did (Bloom, 1980; Bloom et. al, 1993). In this study, all children produced both Action and Stative verbs in single word utterances from the very beginning (Observations 1 and 2). Although the emergence of Action and State verbs in multi-word utterances varied across children and emerged in different observations, Action verbs in multi-word utterances did not precede Stative verbs in multi-word utterances for three children.

Comparison of predicate type frequency.

Complex phrases. Typically developing children produce complex phrases (two verbs in one utterance) only after they begin producing Action and Stative verbs on their own (Bloom, 1993). However, the children in this study began using complex phrases very early (Carmen, Kareem, and Julia in Observation 2 and Mateo in Observation 3). Early usage of complex phrases supports the idea that the children in this study had already developed the mental representation of Stative and Action verbs and rapidly moved to use them in complex phrases.

Pre-stored phrases. One of the characteristics of aided communication is the use of pre-stored phrases to facilitate the speed of communication. Although these types of messages do not represent directly the process of generating a message based on its linguistic components, we included them in the analysis as we believe that they represent the children's lexicon to some extent. It is important to note that most of the pre-stored utterances were constructed by the children in previous sessions.

Comparison of verbal inflection. Overall our findings suggest that children who use AAC acquire verbal inflection similarly to their typically developing peers. Typically developing children acquire aspectual inflection before tense inflection. This predicts a pattern, in which *-ed* and *-ing* are first used to distinguish Accomplishment and Activity verbs, respectively, before distinguishing tense (Bloom et al., 1980; and Clark, 1996). Indeed, children who use AAC also used *-ing* overwhelmingly (80%) with Activity verbs that were durative (ongoing Actions). However, while *-ed* did occur primarily on Action verbs (84%), within the Action verbs, most –*ed* occurrences were found on Activity verbs (56%) not Accomplishment verbs (44%). This

could be explained by the age of the children and their mental representation of both Aspect and Tense concerning the *-ed* inflection. The low frequency of *-s* in the children's corpus (14%) along with its late emergence could be explained by its complexity in acquisition. Typically developing children first produce *-ing*, then *-ed,* and lastly *-s* (Brown, 1973). As the children in this study had challenges in morphological judgment tasks, they may need further language instruction and practice to reach this third inflectional stage.

In short, this study reveals characteristic aspects of the developmental pattern of Stative and Action verbs and verbal inflection in children with significant speech and physical impairments who use SGDs. The findings concerning verbal inflection are consistent with the patterns observed in typically developing children, where children use the verb meaning and their inherent aspects in the production of early inflection and that the inflection *-s* is less salient in acquisition than the inflections *-ing* and *-ed* which are being acquired earlier. However, the findings contrast with Bloom's (1993) findings, where in all cases, Action verbs preceded Stative verbs. We found that school-aged children who use AAC and begin to construct verbs are able to use both types of verbs categories in early conversation. Perhaps these results contradict Bloom's findings due to a relationship between the children's age ranges, world experience, and cognitive level. The participants in this study are older than Bloom's with no record of intellectual impairment, although initially in the study they communicated mostly with nouns using one-word utterances.

Chapter 3. Second Study: The Emergence of Clause Constructions in Children who Use SGDs

Introduction

How and when do children shift from uttering single verbs to constructing clauses? Very little research has been done on the linguistic practices of children with severe MSDs as they begin formulating well-formed clauses. Universal Grammar (UG) studies the properties of generative grammar (Chomsky, 1969) and its underlying assumption is that the formal structures of language are independent of its semantic or pragmatic usage (Chomsky, 1969; Goldberg, 2003). Based on UG, children are equipped with innate structure of a language acquisition device that allows them to acquire grammar and adult like structures within a short period of time. This approach focuses on the adult structures and defines a clause as any sentence that has at least a subject and a verb (Chomsky, 1969). However, this psycholinguistic approach is interested in understanding the changes in the complexity of the clauses produced by children since they first produced the basic unit of the clause, a verb, until they construct adult-like clauses. It is based on the notion that in development, form and function interact with each other (Berman & Slobin,1994). Berman & Slobin (1994) explain that the term *form* includes various types of linguistic devices ranging from grammatical morphemes and bound inflections to interclausal connectives and syntactic constructions, which differ in their complexity level in acquisition. *Function* includes a range of functions that take part during the construction, such as turn taking and question-answer pairs. This study adopted Berman & Slobin's (1994) definition of the minimal unit of a clause as a starting point to track the changes in the clause constructions of children with severe MSDs who use SGDs and defined *clause construction* as "any unit that contains a unified predicate…a predicate that expresses a single situation (activity, event, or state)" (p.660).

Much more research has been done on the linguistic practices of typically developing children. Before we present the results of a study analyzing the linguistic development of children with MSDs, let's review what is known about typical language development.

Typically developing children can express more information as they learn more complex linguistic structures (Clark, 2016). To explain the development of the children's structures, Brown (1973) proposed the term "law of cumulative complexity" (p.185): "A construction *x*+*y* may be regarded as more complex than either *x* or *y* because it involves everything involved in either construction alone plus something more" (p.407). For example, children begin to use verbs and over time they add more complexity in each utterance, such as moving from *more block* to *I need another block* to *they have got all the blocks* (Clark, 2016). Likewise, children go from single-word utterances to word combinations, to verb-islands (each verb appears in only one or a very small number of constructions), before they start to construct more adult-like constructions (Clark, 2016).

Learning grammar occurs once verbs are productive in children's speech. Thus, to be able to construct a clause, children need to start using verbs, which typically are produced at the age of two years old. Then, children move from one stage to another by learning the conventional constructions of their language. First, they need to learn how to construct inflections (e.g., *-ing*, *-ed*, *-s*) and how to order arguments in a clause (e.g., English requires subject-verb-object (SVO) word order).

Linguists use the notion of thematic roles such as *agen*t and *patient* to describe the relationship between the semantics of a verb and the syntactic structure of the verb

arguments(Fillmore, 1968). The first multi-word utterances that children produce follow both the adult's word order (SVO) and the adult's thematic patterns, which puts the *patient* after the verb and the *agent* before it (Thothathiri & Snedeker, 2011). In short, when children first produce the SVO structure, it includes the basic semantic relations of agent-patient (e.g., in *I eat sandwich*, *I* is the agent and *sandwich* is the patient). Later, children add greater precision to clauses by specifying more complex semantic roles like *locative* and *instrument* (e.g., *I eat sandwich in the kitchen*, and *I eat sandwich with fork*) (Bloom, 1980). Syntactic complexity is developed over time by modifying nouns with adjectives and quantifiers (e.g., *more block*, *red block*) and modifying verbs with adverbs (e.g., *run faster*) (Clark, 2016).

Despite individual differences, there are shared trajectories of acquisition in terms of stages in the first five years of life, and one of the most stable measures of a child's language development is their mean length of utterance (MLU) measured in terms of number of morphemes (Brown, 1973; Miller & Chapman, 1981). Dromi (1987) posits three main grammatical stages in child language: the early grammar, late grammar, and discourse skills. However, before children move to the early grammar they go through the one-word stage and the two-word stage. The one-stage appears by the age of 12 months and includes words for objects (*ball)*, living entities (e.g., *mommy*, *doggy*), and actions (e.g., *go*). Then, from the age of 18 months to 24 months, children start to combine words and start to learn the morphosyntactic conventions of their language as their vocabulary continues to increase and they are able to produce multi-word utterances and complex structures (e.g., *I want more cookie and milk*) (Dromi, 1987, 1999; Levey & Polirstok, 2010).

The verb is a crucial component in learning grammar and in expressing complex meaning (Tomasello, 1992). As children start to use verbs they start with the core of the clause, the basic unit of a clause (Berman & Slobin, 1994). Inflectional morphology and grammatical morphemes are acquired after children begin to combine two or more words and have established a vocabulary of at least 50 words (Brown, 1973). Brown (1973) found a consistent order for some 14 grammatical morphemes. For example: the verb inflection *-ing*, emerges first, followed by the prepositions *in* and *on*, then the nominal plural inflection *-s*, then the verbal past inflection *-ed*, then the nominal possessive inflection *-s*, then the uncontractibile copula forms *was* and *are*, then articles *a*, *the* and so on. As children move from one stage to another, their number of utterances increases and the length, grammatical morphemes, and the complexity of the utterances increase resulting in higher MLU scores (Brown, 1973; Miller & Chapman, 1981). However, the MLU measure should be used carefully with children who use Augmentative and Alternative Communication (AAC) due to the unique characteristics of aided communication (Kovacs & Hill, (in press); Nelson, 1992). This is further discussed in the Methods section.

Children with severe congenital MSDs who have little or no intelligible speech are not only faced with learning the linguistic structures described above, but must also learn how to use the specific communicate device and its graphic symbols that represent the oral language (Beukelman & Mirenda, 2013; Lloyd & Loncke, 1999). AAC includes a wide range of communication forms from unaided (gestures, facial expression) to aided communication such as speech generating devices (SGDs) that replace their natural speech. This asymmetry between the input, receptive language that is acquired through the aural modality and output, expressive language that is expressed via graphic symbols, along with intrinsic (e.g., motor, cognitive skills) and extrinsic factors (e.g., level of practice, type of device) impact the children's grammatical performance. This performance differs from the linguistic behavior observed of typically developing children in that utterances are "telegraphic" and often lack grammatical morphemes

both in aided and manual sign output. Children who use AAC are reported to experience a wide range of vocabulary and grammatical difficulties beyond what would be expected from their individual cognitive differences and language competence (Binger & Light, 2008; Blockberger & Johnston, 2003; Light & McNaughton, 2014; Smith, 2006; Smith, 2015; Sutton et al., 2002). However, a new technology that allows access to the full range of grammatical markers together with advanced intervention strategies help these children to generate and understand different types of clauses and phrases and reduce communication barriers (Smith, 2015).

Recent studies on the morpho-syntactic acquisition of children who use AAC show that systematic language intervention, and even short training, improves the performance of their grammatical skills (Binger et al., 2016; Kent-Walsh et al., 2015; Soto & Clarke, 2017). Binger et al. (2016) found that four 5-year-old children who use AAC with normal receptive language generated grammatically correct constructions of the following types: (i) agent–action (*Mickey jumps*), (ii) action–object (*Kiss Minnie*), (iii) agent–action–object *(Goofy kiss Minnie),* and (iv) attribute–agent–action (*Sad Goofy falls*) after a short training. Similarly, Kent-Walsh et al. (2015) found that children aged 4 to 6 generated declaratives with *to be* (*Mickey is jumping*) and inverted yes/no questions (*Is Mickey jumping?*). Moreover, Soto & Clarke (2017) found that a systematic conversation-based intervention improved the expressive vocabulary and grammatical skills of eight children aged 8 to 13 years with severe MSDs who use AAC. The grammatical acceptability of the children's spontaneous clauses improved, including their usage of pronouns, verbs, and bound-morphemes while before the language intervention they communicated mostly with one-word noun utterances.

These findings suggest that children with severe MSDs can acquire the mental representation of clause structures and can translate this representation onto the graphic symbols in their speech generating devices when provided with adequate assistance. That said, similar to the sequences observed in conversation between adults and young typically developing children in which the adult scaffolds the child language by enhancing language forms (Scollon, 1976), one characteristics of AAC is co-constructed production, where utterances are constructed across multiple turns and with the support of the adult's prompts and elicitation behaviors (Savaldi-Harussi & Soto, 2016; Soto, Hartmann, & Wilkins, 2006; Soto, Solomon-Rice, & Caputo, 2009).

Taken all this together, one of the remaining questions in the AAC field is to what extent the mental representation of morphosyntactic structure and the kinds of variation in grammatical categories of children who use AAC differ from children with typical linguistic development. Up to date, there is no well-organized evidence on the changes in the clause structure from one stage to another across participants, apart from a few longitudinal single case studies that describe general aspects of language development and vocabulary growth (Brekke & Von Tetzchner, 2003; Soto & Seligan-Wine, 2003).

The goal of this research is to further examine Soto & Clarke's (2017) study in order to report empirical data of the structural changes of clause constructions produced by four children with MSDs who use SGDs. This corpus includes for each child six to eight conversational interactions with a familiar adult before, during, and after they participated in conversation-based interventions. We tracked the structural changes in the children's utterances from when they first started to use the basic unit of a clause (i.e., a predicate or verb) until they constructed a multi-word clause to answer the following questions:

1. How did the frequency and complexity of clause constructions change over the 9-month period?
    a. What types of clause constructions were produced in terms of:

i. their linguistic constituents (subject, verb, and object) and phrase-internal elements (verb and noun inflections, articles, and prepositions)?
ii. the types of grammatical errors
iii. the number of ungrammatical clauses.

2. How did the intensity of the adult's prompting affect linguistic behavior?
    a. How many clauses were co-constructed with the adult?
    b. How many turns did each co-constructed clause require?

Method

Participants

The corpora of four children (two girls, two boys) aged 9-13 with severe MSDs were selected for this secondary analysis. All children used a high-tech SGD with software that allowed access to grammatical markers and thousands of words. Before the language intervention, all children communicated with one-to-two-word level utterances (mostly nouns) with no evidence of grammatical markers or inflection in unstructured interaction. Table 3.1 describes the children and the characteristics of their devices. They all shared the following characteristics. First, all children demonstrated functional communicative competence at level 3 on the Augmentative Alternative Communication Profile ((Kovach, 2009; Light, 1989). This level indicates that the child selects targeted symbols with few prompts (operational), is beginning to engage in dialogue and combines words to create simple phrases (linguistic), is using the AAC for social interaction to comment and greet friends (social), is familiar with the vocabulary in the device and may use telegraphic messages but understands the importance of selecting the correct vocabulary and be understood by the communication partner (strategic). Second, all children formulated their messages in the SGD via direct selection. Third, all children used English as their dominant language, their hearing and vision were within the normal limits, and according to their educational and clinical records they did not have a diagnosis of any intellectual impairments. Finally, according to a battery of tests documented in Table 3.1, their receptive language measurements were of at least six years of age and above: they had normal or near normal receptive single word vocabularies, but performed very poorly on morphological judgment tasks.

Research Design

The corpus analyzed in this study was collected as part of a larger study designed to investigate the effects of a conversation-based intervention on the expressive vocabulary and grammatical skills of children with MSDs who use SGDs (Soto & Clarke, in press). This study took place over nine months, in which time each participant met with a familiar adult to have six to eight normal conversations. The pairs met once before the first conversation intervention, then every sixth intervention session, and finally three times after the intervention had completed.

Table 3.1 *Participants' Demographic Characteristics*

Name	Age	Speech Disorder	Speech Generating Device[a]	SGD Access	Languages Spoken at Home	Receptive Vocabulary Age Equivalent (Percentile)	Morphological Judgment Age Equivalent (Percentile)	Expressive language (from educational records)	Speech intelligibility rating
Carmen	9:5	Dysarthria secondary to Pfeiffer Syndrome	Dynavox DV 4 with Gateway Modified 45, 60	Finger Pointing	English Spanish	8:6[b] (37)	6:6[b] (9)	MLU 1-2 mostly nouns and adjectives	0% (non-verbal)
Mateo	13:7	Dysarthria secondary to Cerebral Palsy	Vantage Light with Unity 84	Joystick	English Spanish	8:11[c] (5)	< 8[d] (n.a)	MLU 1-2 mostly nouns and adjectives	20% (minimally verbal)
Julia	13:9	Dysarthria secondary to Cerebral Palsy	Dynavox Maestro 5 with Gateway Modified 45	Finger Pointing	English Spanish	9:9[c] (12)	< 8 [d] (n.a)	MLU 1-2 mostly nouns and adjectives	7% (minimally verbal)
Kareem	13:3	Dysarthria secondary to Cerebral Palsy	Vantage Light Unity 60	Finger Pointing	English Arabic	9:6[c] (7)	< 8[d] (n.a)	MLU 1-2 mostly nouns and adjectives	0% (non-verbal)

[a] Gateway ™ and Unity ™ are two language-based vocabulary organization systems, that include: (i) core vocabulary words (i.e., most frequently used words), allowing for the creation of spontaneous, and novel messages, and (ii) grammatical markers, allowing for grammaticalization of the utterance).
[b] Test of Auditory Comprehension of Language-3 (Carrow-Woolfolk & Allen, 1999)
[c] Peabody Picture Vocabulary Test-4 (Dunn & Dunn, 2012)
[d] Test of Language Development-I:4 (Newcomer & Hammill, 2008)

Neither the children nor the adults were given any instructions on how to conduct the conversation or on what to talk about. The conversations were videotaped and transcribed using the conventions of the Systematic Analysis of Language Transcripts (SALT; (Miller et al., 2012). Only intelligible verbalizations, i.e., glossed conventional manual signs and device-generated utterances, authored by the child were transcribed and analyzed. The total number of conversations and their total length are as follows: Carmen (N=8, 200.4 min.), Kareem (N=6, 183.16 min.), Mateo (N=7, 209.8 min.), Julia (N=8, 215 min.). In sum, the database includes 29 conversations, totaling 808.36 minutes (13.5 hours).

Data Coding and Analysis

The following analysis used exploratory and descriptive methods of analyzing the corpus. For the purposes of this study, the transcripts were analyzed both manually and with SALT software for: 1) the types of clause constructions produced by the children; 2) the linguistic complexity of the clauses; 3) the intensity of the adults' prompts (number of turns) during a co-constructed clause; and 4) the linguistic types of the adult's prompts that opened the co-constructed clause. The analysis process and coding system are described below.

Clause construction types produced by the children. When coding child-authored constructions, we differentiated between *presorted clauses, co-constructed clauses,* and *constructed clauses*. Pre-stored clauses are messages that were constructed by the children in previous sessions for expressing personal narrative (e.g., *Tio John, Mom, and I went to see San Francisco*) or generic social messages (e.g., *how are you*, *my favorite team is*). These clauses are

produced by selecting one button (symbol) in the device to express the message. These messages are often used to accelerate the speed of communication and for pragmatic purposes, such as participating in predictable settings. Co-constructed clauses are messages that were constructed during a conversation, in which the message was constructed across multiple turns with the support of the adult (Savaldi-Harussi & Soto, 2016). Finally, constructed clauses are messages that were generated during one turn without any support from a conversation partner. Both the co-constructed clauses and the constructed clauses require the child to select all the constituents of the clause by selecting the buttons that represent the specific constituent. For the purposes of this study, we grouped the constructed clauses and co-constructed clauses into one group called *clause constructions*. Pre-stored messages and repetitions were excluded from the analysis as our questions involved tracking how children use different types of constructions in terms of their morpho-syntactic constituents over time.

Identifying the structures to be targeted. In each interaction, we identified the structures to be targeted in the following way. First, we identified the basic unit of a clause based on Berman and Slobin's (1994) definition as any unified predicate. For example, the verb *sleep* would be considered a clause as well as the utterances *I run* (activity) and *is happy* (state). Next, we assessed whether the identified basic unit of a clause was part of a larger turn-taking sequence. The adults in this study played a major role in supporting the children in shifting from formulating single words to constructing clauses and increasing their complexity. We defined turn-taking sequences of two or more consecutive turns as Clause Construction Communication Cycles (CCCC). Each CCCC aimed to co-construct a grammatically well-formed clause. During each CCCC, the adult typically recasts and prompts the child within a sequence of turns. Box 1 describes an example of a CCCC producing the clause *I like cartoon.*

Box 1. *Example of Clause Construction Communication Cycle (CCCC)*

Child	*Adult*
	A: Who? Who's going to the park? What about the park? You need to add more
C: I like.	
	A: I like. I'd like to go to the park for your birthday? You're okay. Good.
C: Cartoon.	
	A: Are you moving on with your topic? Yeah? So, can you say that whole thing?
C: I like cartoon.	

Coding clause structure. Once all the constructed and co-constructed clauses were identified, we coded the structure of each clause according to its linguistic constituents (subject, verb, object) and additional phrase-internal elements, such as verbal or nominal inflections, articles, and prepositions. For example, the co-constructed clause *I like cartoon* (Kareem, Observation 3) was coded as S+V+O as it included a subject, verb and object. The clause *My dad and mom were happy (*Kareem, Observation 6) was coded as (poss) Sbj [N+and+N] + (inf)COP + CMPCOP as it included a possessive, a subject consisting of two nouns and a connective, an inflected copula, and a copula complement. Moreover, we noted the grammatical acceptability of

each clause. When errors occurred, we identified the target meaning and the types of grammatical errors. Glosses and abbreviations are defined in Table B1.

Coding linguistic complexity. Next, we determined a complexity score for each construction as a metric of linguistic complexity found in typically developing children. Each linguistic component of the clause received one or two points depending on its added complexity as found in typical language development and in linguistic structure in general. For example, adding a subject or a modal verb each added a single point to the phrasal complexity, but use of a preposition, article, or inter-clausal connective each added two points as these are more arbitrary language-specific elements that express more complex relations and are typically acquired later (Bloom, Lahey, et al., 1980; Brown, 1973; Clark, 2016; Diessel, 2004). Moreover, based on Brown's (1973) description of the emergence of 14 grammatical morphemes over five stages of development (from 12 months to 47+ months), we allocated two points to specific grammatical morphemes that emerged in Stage 5, such as the use of articles. The mean length utterance in morphemes (MLUm) of the total number of clause constructions produced by each child was calculated using SALT software and based on Brown's stages for expressive language development Brown (1973) we matched the equivalent developmental stage.

Table 3.2 *Quantifying Complexity*

Point allocation	Structure type	Example
+1	verbal argument (subject, object, complement)	nouns
+1	verb (regular, copula, modal)	*come*, *am, want to*
+1	inflection (nominal, verbal)	plural -*s*, present-*s*, past -*ed*, progressive -*ing*
+1	modifiers (adjective, quantifier, possessive, another noun, etc.)	*big car, one car, my car, cat's*
+1	negation	*no*, *not*
+2	article	a, an, the
+2	preposition	*in*, *on, around, with*
+2	inter-clausal connective	*and, when, because*

Quantifying adult's prompts in CCCCs. The intensity of the adults' prompts was examined in two ways. First by examining the overall percentages of the clauses in the corpus that were constructed during one sequence of turns vs. the percentages of the clauses that were constructed during two or more turns. Second by counting the number of turns within clearly delineated sequences of a CCCC. For example, the intensity of the adult's prompts in the CCCC of the clause *I like cartoon* (shown in Table 3.2) was three turn sequences. We predict a correlation between complexity of the final phrase and number of turns in the CCCC.

Reliability

Several steps were taken to ensure that the transcripts and results were accurate. Two independent observers transcribed 25% of randomly selected conversations. Transcription discrepancies were resolved through viewing of discrepant utterances and reaching consensus on form (Kovacs & Hill, 2015). Inter-transcriber consensus was achieved for all discrepancies and a single transcript was analyzed by SALT. The identification of the target clauses, the count of number of turns, and the analysis of the clause structure were analyzed by the lead author and the

second author. SALT software was used to analyze the grammatical categories produced in each utterance.

Results

Overview

Table 3.3 summarizes the total number of clauses produced by each child over the period of nine months including the total number of pre-stored clauses and clause constructions (constructed and co-constructed clause), the MLUm and its equivalent developmental stage based on Brown's stages (1973). Table 3.3 shows that the children's corpus yielded a total of 300 pre-stored clauses and clause constructions. Most were produced by Carmen (129 clauses), followed by Julia (88), Mateo (45) and Kareem (38). As stated above, we analyzed just the clauses that were constructed during the interaction (clause construction) and the pre-stored clauses were excluded for the analysis, reducing clause counts by 12 for Carmen (9%), 45 for Julia (51%), 1 for Mateo (2%), and 5 for Kareem (13%). Carmen produced the highest number of clause constructions (clauses that were constructed during the interaction) (N=117). Mateo and Julia produced a similar number of clause constructions (N=43, N=44), and Kareem produced the least (N=33). Carmen and Kareem had an average MLUm of 4.99 and 4.85, placing them in Brown's Stage 5+, Mateo and Julia had an average MLUm of 3.36 and 3.3, Brown's Stage 4. The children's stages, 4 and 5, are at least three developmental stages higher than the stage calculated in their first observation before the language intervention. It is also higher than the stages calculated for each of the observations. The reason for the higher MLUm is that it reflects only the level of the identified clause constructions and it does not include utterances that are not a clause, or utterances produced during CCCC to form the target clause which reduce the average MLUm score for all utterances in each observation.

Table 3.3 *Frequency, MLUm, and Developmental Level of Clause Constructions*

Speaker	All clauses	Pre-stored clauses	Clause constructions	MLUm	Brown's stage
Carmen	129	12 (9%)	117	4.99	5+
Mateo	45	1 (2%)	44	3.36	4
Kareem	38	5 (13%)	33	4.85	5+
Julia	88	45 (51%)	43	3.3	4
Total	300	63	237		

Table 3.4 *The Number of Clause Constructions Produced over Time Across Children*

Observation	Carmen	Kareem	Mateo	Julia
OBS1	4	0	7	1
OBS2	8	1	4	4
OBS3	14	7	6	5
OBS4	17	9	5	7
OBS5	13	5	6	8
OBS6	23	11	8	5
OBS7	15	-	8	5
OBS8	23	-	-	8
Total	117	33	44	43

Changes in frequency and complexity of clause constructions. Table 3.4 lists the number of clause constructions produced in each observation across children and shows that the number of clause constructions increased over time for three children: Carmen, Kareem and Julia. In Mateo's data, the number of clauses in Observation 1 is higher (N=7) and only increased by one in Observations 5 and 8.

It is important to note that the number of clauses includes all types of clauses, even the simplest clauses with just the verb (*play*). Figure 3.1 illustrates how the grammatical complexity increased over time for all children, where the highest complexity score from each observation is plotted. A list of all clause constructions, their structures, complexity cores, and adult interaction levels can be found in Appendix B, Tables B2, B3, B4, and B5.

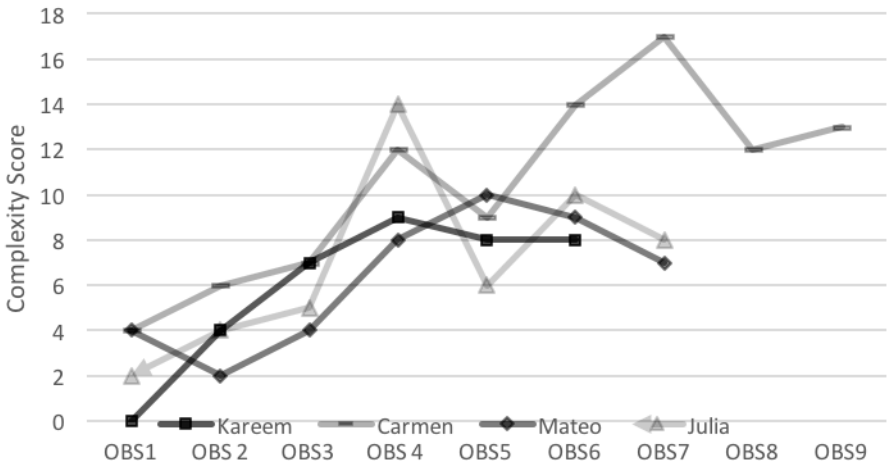

Figure 3.1 Most complex clause construction in each observation.
This figure shows an increase over time.

Type of clause constructions. In the first observations (1 and 2), all the children produced very simple clause constructions including a subject, verb, and object (SVO), and

gradually increased the complexity of the clause (as shown in Figure 3.1) by adding internal phrases elements such as adjectives, pronouns, connectives, negation and quantifiers. Tables B6, B7, B8, and B9 show the emergence of the different grammatical categories over time for each child (for extended discussion about the emergence of verb inflection see Savaldi-Harussi & Soto, 2017). The developmental pattern of personal pronouns was similar across children and followed the developmental pattern observed of typically developing children as described in Brown's stages (1973) where the pronoun *I* emerged before the usage of *you, she, we they*. The next paragraphs describe for each child: 1) examples of the basic structure, SVO clause, produced at the beginning and one of the complex structure that emerged later as well as and their complexity 2) The emergence of personal pronouns.

Carmen. In Observation 1, she produced the structure: Sbj + V + Obj*, I go with Tia Coco house* which received a complexity score of 6 using only one internal phrase preposition (*with*) and in observation 7 she produced the structure Sbj + (prep) + V + Obj/Adv + (inf)V + (poss)Obj + (poss) Adv [N+N] + (prep) Adv [N+N+no, *I to go Freemont to see dad sister grandma party birthday on March Sunday 10,* which received a complexity score of 17. The first-person singular *I* emerged in Observation 1 while the personal pronouns *you* and *she* emerged in Observation 2 and 4 respectively.

Kareem. In Observation 2, Kareem produced the basic structure Sbj + (mod) V + Obj, *I want bed sleep*, which received a complexity score of 4. In Observation 4, he produced the structure Sbj + (inf) (inf) V + (prep) (art) Obj + (prep) (Poss) Obj, *I am go/ing to the beach with my family*, which received a complexity score of 13. The pronoun *I* was first produced in Observation 2 and the pronouns *he* and *they* emerged in Observation 3

Mateo. In Observation 1, Mateo constructed the structure Sbj + V + Obj [N+N], *I me read comic book*, which received a complexity score of 4 and in Observation 5, he constructed the structure Sbj + (mod) (inf)V + (prep) (art) Obj, *I want to go to the movie/s,* which received a complexity score of 10. The personal pronoun *I* was first produced in Observation 1 and the personal pronoun *we* only emerged in Observation 5.

Julia. In Observation 2, Julia constructed the simple structure Sbj + V + Obj, *I like car,* which received a complexity score of 3, and in Observation 4, she generated the construction (inf) V + (prep) (poss) Obj + Adv, *went with my mom post office,* which received a complexity score of 7.

Grammaticality and co-construction. All clause constructions were coded for grammaticality and the number of turns it took to construct the clause. We would predict that that the percentage of grammatical clauses will positively correlate with the percentage of co-construction. In other words, constructions supported by a conversation partner are more likely to be grammatical. Table 3.5 details the percentages of grammatical and ungrammatical clauses and the percentage of clauses that were constructed in one turn versus those that were co-constructed clauses in multiple turns. The intensity of adult's prompts in the children's corpus is the percentage of the co-constructed clauses, clauses that were prompted during CCCC. Carmen had the lowest percentages of grammatical correct clauses (46%) and the lowest percentage of co-constructed clauses (28%). Compare her statistics with Mateo's, whose clause constructions were 93% grammatically correct and 77% co-constructed. This is illustrated in Figure 3.2.

Table 3.5 *Grammaticality and Co-construction*

Names	Clause constructions produced	Percent grammatical	Percent ungrammatical	Percent constructed in one turn	Intensity of adult's prompts
Carmen	117	46% (54)	54% (63)	72% (84)	28% (33)
Kareem	33	79% (26)	21% (7)	0%	100% (33)
Mateo	44	93 % (41)	7% (3)	22% (10)	77% (33)
Julia	43	65% (28)	35% (15)	48% (21)	51% (23)

Kareem and Mateo, who had the highest number of co-constructed clauses (100%, 77%) and the highest percentages of grammatically correct clauses (79% and 93%), displayed a positive correlation between co-construction and complexity of the clause as well. This is illustrated in Figures 3.3 and 3.4, respectively.

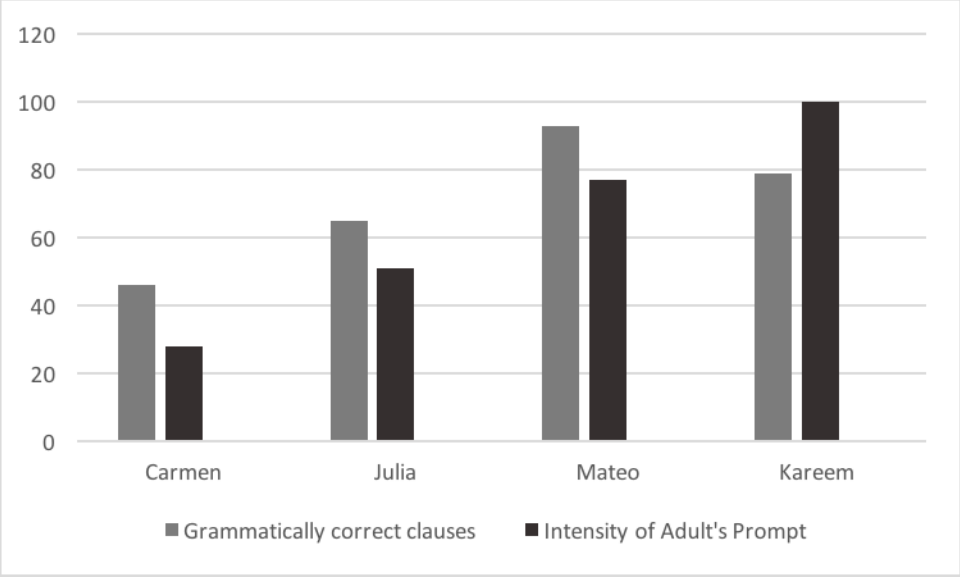

Figure 3.2 Intensity of adult's prompts and grammatically across children.
As the intensity of the adult's prompts increases, the number of grammatically correct clauses also increases.

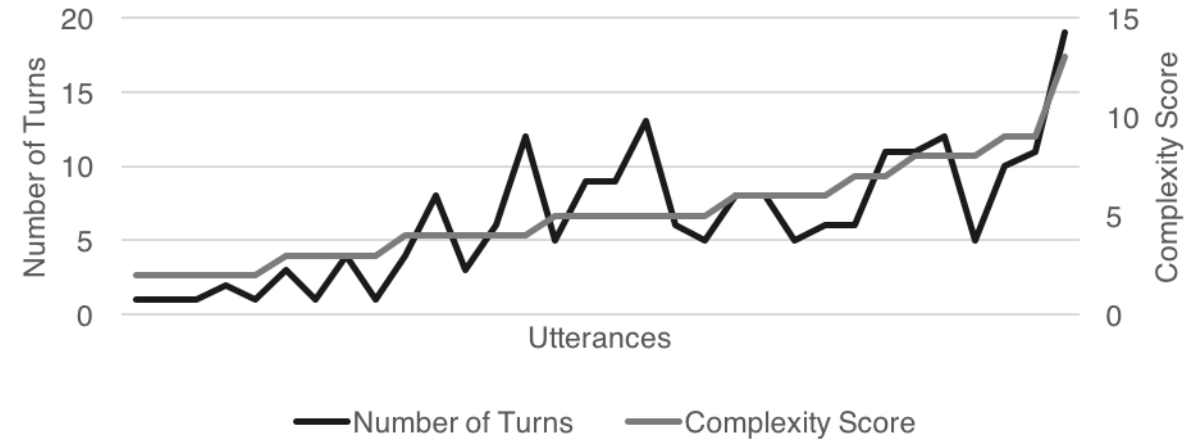

Figure 3.3 Kareem's Interaction of Complexity and Co-construction.
As the linguistic complexity of the co-constructed clause increases, the number of turns in the co-constructed interaction also increases.

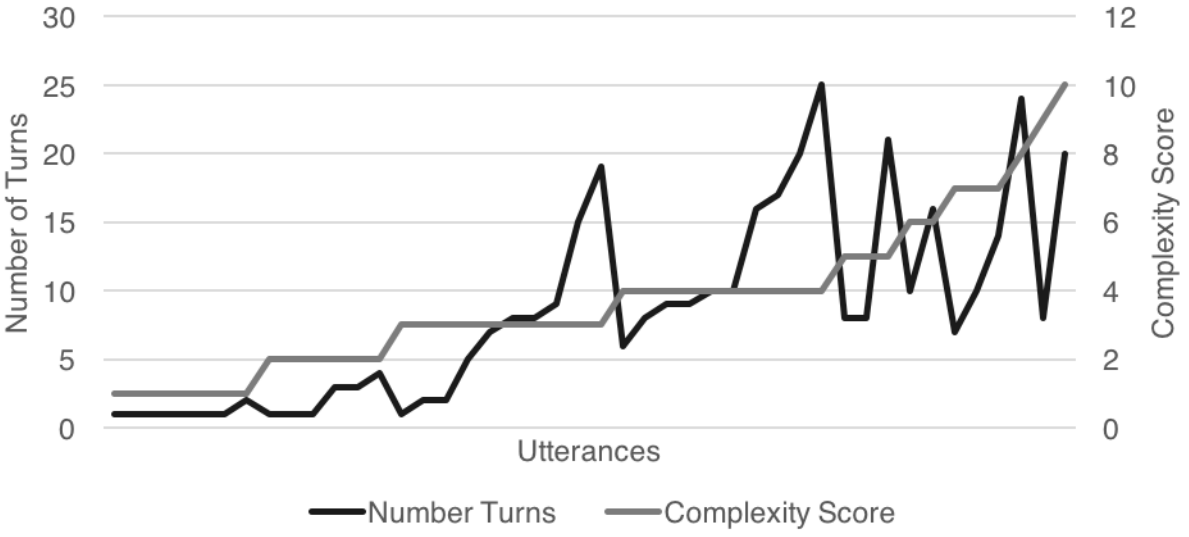

Figure 3.4 Mateo's Interaction of Complexity and Co-construction.
As the linguistic complexity of the co-constructed clause increases, the number of turns in the co-constructed interaction also increases.

Table 3.6 describes the types of grammatical errors across children. All children produced errors in their use of inflection and articles. Carmen, Kareem, and Julia produced grammatical errors in their use of prepositions and word order.

Table 3.6 *Types of Grammatical Errors across Children*

Names	Errors	Inflection	Articles	Word Order	Preposition	Connective	Mishit
Carmen	115	26%	16%	12%	21%		
Kareem	11	20%	35%	27%	18%		
Mateo	3	33%	33%				33%
Julia	18	17%	39%	6%	27%	11%	

Discussion

The purpose of this study was to explore the developmental patterns in the structural changes of clause constructions produced by children with severe MSDs who use SGDs. The findings indicate that the number of clause constructions increased over time, and the complexity of the clause structure notably increased from the very first observation starting with the simple structure of a clause, SVO (observation one and two) and then continued to develop by adding internal phrase elements such as adjectives, pronouns, connective, negation and quantifiers, and increasing the number elements in the utterances. The developmental pattern of personal pronouns was similar across children and followed the developmental pattern found in typically developing children as described in Brown's stages (1973), where the pronoun *I* emerged before the usage of *you, she, we they*.

These generals patterns of increasing the number of clauses, adding complexity over time and producing specific structures in specific order (pronouns) follow the path described in typically developing children (Brown, 1973; Clark, 2016) and support the hypothesis concerning the usage of graphic symbol utterance and their relation to the spoken language. The hypothesis is that the utterances are first constructed in a mental representation and then transposed onto graphic symbols. The core structure of the utterance is based on the spoken language grammar, and then modified to fit the graphic symbol modality and the specific AAC system available (Trudeau et al., 2007).

All children had errors in their use of inflection and articles. These types of errors could imply that these types of structures are more complex, however on the other hand it could be shedding light on the peculiarities of communicating with AAC, indicating that these errors are a result of the graphic symbol modality, in which the message could be conveyed clearly to the addressee without these elements. By choosing not to add these elements it saves operational time of locating these element in the device and enhances the speed of communication.

For many non-speaking children, the desire to communicate quickly and efficiently gives preference to strategies that deliver short messages without grammatical markers or to use pre-programmed phrases (Nelson, 1992). In this study, although we excluded the pre-stored messages from the analysis of clause construction, we tracked their usage and we found that this strategy of using pre-stored messages varied across participants and only one child, Julia used it dominantly in her corpus. While the clause constructions can inform us about the morpho-syntactic knowledge of the children, the presorted clauses can inform us about the pragmatic competence to use those types of constructions in a conversation. It is important to note that children who use AAC sometimes use the same phrase that they used in previous turns for various reasons. First, it could be an operational issue, if child did not properly clear the device. Second, the child could repeat a phrase for pragmatic reasons, for example if the child wants to reply quickly and chooses the pre-constructed message.

The intensity of adult prompting in the children's corpus was measured by the metric of the number of turns and the percentage of the co-constructed clauses that were constructed in two or more turn sequences. Interestingly, we found that the children who had high percentages of co-constructed clauses also had high percentages of grammatically correct clauses. This could mean that the support of the adult helped them to generate grammatically correct clauses. Moreover, when we looked at the number of turns in each Clause Construction Communication Cycle (CCCC), we found that the number of turns increased as the complexity of clause increased. We did not analyze the time during each CCCC, but the number of turns can inform us that constructing grammatically correct complex construction takes time. For example, the clause that Kareem's constructed *(I am goi/ng to the beach with my family,* which has the complex structure Sbj + (inf) (inf) V + (prep) (art) Obj + (prep) (Poss) Obj) received a complexity score of 13 and was constructed across 19 turn sequences. These findings raise the question of the conflict between conveying efficient message in short time or complex structure in long time.

Lastly, we would like to discuss the issue of measuring grammatical complexity of clauses produced by children who use AAC. We believe that the MLUm of clause constructions may better inform the linguistic competence of children who use AAC than the MLUm of the whole utterances in the transcript. Taking into consideration the characteristic of aided communication, in order to assess the changes in the syntactic complexity of the utterances of the children who use AAC it is important to take language samples that include the target clauses during the CCCC to assess the child's syntactic competency and to reduce operational (mishit, repetitions), pragmatic, and modality influences on the MLU. The considerations of which utterances to include in the language sample to assess the expressive language, was well discussed by Klee and Fitzgerald (1984) concerning assessing the expressive language in typically developing children. They suggested using the mean syntactic length (MSL) which excludes single-morpheme responses from the language sample instead of using the general MLUm, that was found not to be reliable in the later developmental stages. Kavatch & Hill (in press) adapted the MSL method (Klee & Fitzgerald, 1985) to assess the expressive language of children who use AAC. The reliability of the general MLU measurements (Brown 1973) is beyond the discussion of this paper, however to better assess the syntactic complexity of the clauses in children who use AAC we recommend including a measure of complexity as we developed for this study. This measure helped to solve instances in which children who use AAC tend to list words, repeat the same words in the clause and as a result increase the MLU. It is important to first identify the core structure of the clause and then to assign its complexity score as in the following example. The clause *Prince Prince is handsome* matches the structure Sbj+COP+COPCMP and received 3 points even though the length of the clause is 4 units.

Chapter 4. Conclusion

"Both the typical communicator and the Augmentative and Alternative Communication user are essentially human minds processing and exchanging information…. there is no reason to believe that these processes follow different channels." (Loncke, 2014, p.6)

The central question of this dissertation is in what way, and to what extent, the mental representation of verb categories, inflection, and clause constructions of children with severe MSDs who use AAC differ from those of typically developing children. Or in other words do the language profiles of children with a severely impaired ability to articulate speech and express oral language follow typical or deviant language acquisition when using alternative communication?

The previous chapters in this dissertation aimed to answer this question by understanding the characteristics and constraints of the graphic symbols modality and developing ways of analyzing atypical speech based on common methods used in the field of developmental psycholinguistics for typically developing children. The goal of the two studies presented in this dissertation was to detect developmental patterns in the corpus of children who use AAC and to examine the interaction between these patterns and those found in typically developing children.

Summaries and Connections

Both Chapter 2, "Early Verbal Categories and Inflections in Children who Use SGDs" and Chapter 3, "The Emergence of Clause Constructions in Children who Use SGDs" used d a secondary linguistic analysis to analyze the same corpus. The corpus represents the production of four children with severe MSDs aged 9 to13 years old who use SGDs during conversational interactions with a familiar adult over the period of nine months, and it includes 29 conversations, totaling 808.36 minutes (13.5 hours). The corpus was collected as part of a larger study (Soto & Clarke, 2017), in which the children participated in a conversation-based language intervention aimed to improve their vocabulary and grammatical skills. The conversations were not structured and the child and the adult conversed as they would normally and without any instructions on how to structure the conversation. Therefore, these observations are considered as close to natural settings as possible. The children chose to converse about any preferred topic.

The patterns detected in these studies reflect not just the children's language development in their usage of verbs and clause constructions over the nine-month period as noted in the original study (Soto & Clarke 2017), but provide a thorough developmental psycholinguistic perspective on the stages of the of verb, inflection, and clause production of these children as described in the following paragraphs. Possible implications for clinical intervention and future direction in the AAC field are also discussed.

The Role of Verbs in Language Acquisition of Children who Use AAC

The study in Chapter 2 was conducted first, as the verb is the basic unit of the clause and plays a crucial role in language development (Berman & Slobin, 1994). The usage of verbs facilitates the construction of more complex grammatical structures and the expression of more complex meaning (Bloom, 1993; Bloom, Lifter, et al., 1980; Clark, 2016; Clark, 1996; Golinkoff et al., 1995; Tomasello, 1992). Similar to the role of verbs in typically developing children, the findings of the two studies suggest that once the usage of verbs increases in the children's corpus over time, the number of clause constructions increases and the complexity of the clause constructions also increases by adding more complex inter-phrasal elements into the clause structure (see Chapter 3). The take-home conclusion is that acquisition of the verbal category

bootstraps the acquisition of complex constructions in children who use SGDs. Therefore, any language interventions to enhance grammar should focus on the usage of verbs.

Complexity for Learning

Language includes components with various degrees of complexity and thus various degrees of ease of learning. Acquisition of more complex (harder to learn) structures correspond with the overall cognitive development of the child and incremental development stages (Clark, 2016). There are two sources of complexity in language: conceptual complexity and formal complexity. Conceptual complexity relates to the meaning of words (free morphemes) and inflections (bound morphemes) and the idea being expressed. Formal complexity relates to how that meaning is presented in the structure of the language and its salience in the speech stream (Clark, 2016). We predict and indeed observed that children will learn simpler conceptual distinctions before more complex ones (see Chapter 2 for verbs and inflection and Chapter 3 for clause structure).

Developmental Patterns of Verbal Categories of Children Who Use AAC

In Chapter 2, we examined two major verb categories in the children's corpus: Stative and Action verbs. Action verbs include activity, accomplishment, and achievement verbs, while Stative verbs include state verbs. The difference between Action and Stative is in their relation to time (aspect). Typically developing children first produce early verb categories without inflection (Clark (1996). They also acquire the verb categories in a specific order based on the complexity of their meaning. For example, children aged 2 to 3 first produce action verbs such as open the button and later produce state verbs such as *I hear children* (Bloom, 1993). The explanation for this could be that action verbs (e.g., *run, swim*) are more salient than stative verbs and their mental representations emerge first (Mandler, 1992). Stative verbs are known in cognitive theory as mental verbs. Mental state verbs (e.g., *think, know*) mark the ability of human cognition to think and communicate about the knowledge, beliefs, and goals of oneself and others (e.g., *She know all this*). Their acquisition is used as a benchmark of human cognition and are typically acquired in the child's 3rd year (Levey, 2014; Shatz, Wellman, & Silber, 1983).

Shatz et al. (1983) assessed children's ability to communicate about mental states in naturally occurring speech. They found that mental state verbs have their own developmental pattern, in which the earliest productions involve idiomatic forms learned as a whole, such as *know what?* or *I don't know*, which are not intended to make specific reference to the listener's or speaker's knowledge state. Shatz et al. (1983) concluded that the earliest uses of mental verbs are for conversational functions rather than for mental reference and that the frequency and variety of mental verbs increased over time. For example, by the age of 2;4, children typically use the stative verbs *know* and *forget*, by the age of 2;6, they typically use the verb *figure*, by the age of 2;7 *hope*, and by the age of 2;8 *think*, *guess*, *believe*, and *mean*.

The findings in Chapter 2 indicate that children who use AAC produced Stative and Action verbs from the beginning, yet over time they displayed increases in the types and frequency of these verbs. The sudden emergence of both categories informs us that school-aged children who use AAC have already developed the mental representations of Stative and Action verbs even if they aren't actively producing them. Moreover, while typically developing children only produce complex phrases (two verbs in one utterance) after they produce Action and Stative verbs on their own (Bloom, 1993), the children in this study began using complex phrases very early. Early usage of complex phrases supports the idea that the children in this study had already developed the mental representation of Stative and Action verbs and rapidly moved to use them in complex phrases.

Similar to typically developing children, the more frequent verb category used by children with severe MSDs was Action verbs, while Stative verbs were relatively less frequent (Clark, 1996; and Bloom, 1993). Interestingly, children who use AAC also showed similarities to typically developing children with regards to the types of verbs produced (Clark, 1996; and Bloom, 1993). For all children, the verb *go* was the most frequent Action verb, and all children used the verbs *play* and *eat*. As for Stative verbs, all children produced the verbs *want* and *like* but there was not a specific stative verb that was most frequently used across all participants. Children who use AAC often use Stative verbs as pre-stored phrases for social interaction such as "I don't know", "I want_____" and "I like____" to express needs and wants and as a strategy for alleviating communication breakdowns. These pre-stored messages may at the beginning be learned idiomatically, similar to the acquisition of Stative verbs by typically developing children (see above) and only later will they be used for expressing the knowledge, beliefs, and goals of others. Further research is needed to explore the developmental pattern of Stative verbs of children who use AAC. It is important to note that children with severe MSDs depend on the organization of the vocabulary available to them, which is usually being programmed by an adult. The basic assumption in the AAC field is that the organization of the vocabulary in the device should follow the core vocabulary, the most frequent words used in typically developing children, and indeed the verbs *go, want, like, play* are included in the list of the top frequent words. This may explain the frequency of these verb in the children's corpus apart from the psycholinguistic perspective (Banajee, Dicarlo, & Buras, 2003; Van Tatenhove, 2005).

Developmental Patterns of Verbal Inflection in Children who Use AAC

The use of verbal inflection overall was quite limited in the children's corpus. Out of 525 conventional lexical verbs (tokens) produced in the children corpus, only 17% (N=88) were inflected. However, it is important to note that before the language intervention they did not use grammatical markers at all. One of the major findings concerning the emergence of verbal inflection in children with severe MSDs is that they follow the patterns found of their typically developing peers. Lexical verbs can be categorized by how the event they denote is placed in time and accordingly they are classified into four verb categories: activity, accomplishment, achievement, and state (Vendler, 1967). Verbal inflections can mark both aspect and time. Typically developing children acquire aspectual inflection before tense inflection and thus they begin to add inflection (*-ing*, *-ed* and *-s*) to the verb category whose inherent semantics matches with the meaning of that inflection (present progressive, past, present simple, respectively). Later they expand the use of these inflections with other verbal categories to mark tense. This predicts a pattern, in which *-ed* and *-ing* are first used to distinguish accomplishment and activity verbs, and only later to distinguish past and present tense. For example, *-ed* is first used with accomplishment verbs that denote a change of state, also known as result verbs (e.g., *I went home)*, *-ing* is used with activity verbs that denote ongoing process (e.g., *He is running)* and *-s* is used with verbs that denote habitual, generic action (e.g., *He knows the answer*) (Bloom et al., 1980; and Clark, 1996). In this study children who use AAC also used *-ing* overwhelmingly (80%) with activity verbs that were durative (ongoing actions). However, most *-ed* occurrences were found on activity verbs (56%) not accomplishment verbs (44%). This could be explained by the age of the children and their mental representation of both Aspect and Tense concerning the *-ed* inflection. Lastly, the low frequency of the inflection *-s*, which denotes present simple and habitual events in the children corpus (14%) supports its complexity in acquisition. Typically developing children first produce *-ing*, then *-ed*, and lastly *-s* (Brown, 1973).

Developmental Patterns of the Structural Changes of Clause Constructions in Children Who Use AAC

In order to express ideas and not just talk about the here and now, children need to learn how to use complex linguistic structure. Similar to the patterns found in typically developing children (Brown, 1973; Clark, 2016), the major findings of Chapter 3 are that children with severe MSDs who use SGDs increased their number of clause constructions over time and the complexity of the clause structure significantly increased over time as well. In the very first observations, children produced simple clause structures consisting of a subject, verb, and object, but over time began adding internal phrase elements such as adjectives, pronouns, connective, negation, and quantifiers, and increasing the number of elements in the utterance. The developmental pattern of personal pronouns was similar across children and followed the developmental pattern found in typically developing children as described in Brown's stages (1973) where the pronoun *I* emerged before the usage of *you*, *she*, *we,* and *they*.

The adults in this study played a major role in supporting the children in shifting from formulating single words to constructing clauses and increasing their complexity. We labeled this type of interaction a Clause Construction Communication Cycle (CCCC). This interaction includes two or more consecutive turns aimed to construct a target clause. The findings indicate that the intensity of adult's prompt, which was measured by the number of exchange turns in the CCCC, correlated with the resulting complexity and grammatical acceptability of the clause.

Taking into consideration the characteristics of AAC, the clauses that were constructed during CCCCs were classified as co-constructed clauses to differentiate them from the clauses that were constructed during one turn or those that were pre-stored in the devices. Children use pre-stored clauses by selecting one button (symbol) on the device to express the whole message. Although pre-stored clauses were not included in the analysis of clause structure, they play a key role in accelerating the speed of communication, which is a crucial component in conversation. This study showed that children who use AAC may take up to 20 exchange turns to generate a grammatically correct clause depending on the complexity of the clause. This is very inefficient. Loncke (2014, p. viii) states that "the use of AAC does not always permit [one] to keep conversation within the comfort zone. I believe this is one of the major challenges that we still face in AAC." This study shows that the communication partner for one child, Carmen, focused more on the flow rather than form of the conversation, as most of her clauses (78%) were constructed over one turn, and 54% of her clauses were considered ungrammatical. Most of her errors were in using inflection (26%), preposition order (21%), articles order (16%), and other word order (12%). Sutton et al. (2002) explains that one of the reasons that children who use AAC omit inflections is because of the graphic symbol interface. The process of adding an inflectional morpheme takes time—the child must go through follow multi-step stages to select a morpheme. Further research must be done to investigate the effect of the preferences of the communication partner, as these studies showed that some communication partners supported the child in generating grammatically correct clauses during a conversation, while others focused less on grammar and more on flow.

Lastly, the study of the clause construction reveals another challenge in measuring the complexity of expressive language of children who use AAC. In order to measure the changes in the complexity of the clause structure, it is recommended to compare the target clauses during the CCCC to assess the child's linguistic competency and to reduce operational (mis-hit, repetitions), pragmatic, and modality influences on the MLU.

In sum, the findings from this study suggest that children with severe MSDs who use SGDs are able to construct grammatically correct clause constructions that include various types of linguistic elements such as articles, prepositions, verbs, and modals. Clauses that are co-constructed over two or more turns are more likely to be grammatically correct, and as the clause structure becomes more complex, the child uses more support (number of turns) from their communication partner during the interaction. The developmental path of the complexity of the clause during the period of nine months follows an order observed of typically developing children, where children first produce the basic form of a clause SVO and then add inflection and grammatical morpheme to the construction. These findings strongly support the notion that children who use AAC primarily rely on their mental representations of the oral language in the process of generating messages via speech generating devices. The mental representation and the acquisition of the different grammatical constructions follow similar patterns as found in typically developing children. However, children who use AAC face the additional challenge of learning how to operate the AAC system and how to use it effectively within conversation. The AAC system holds its own limitations, as described above.

Language acquisition theories and aided communication. There are three main hypotheses in the AAC field that attempt to explain the morphosyntactic production of children who use aided communication in form of graphic symbols: the compensation hypothesis (Binger & Light, 2008), the modality-specific hypothesis (Sutton et al., 2002; Trudeau et al., 2007), and the linguistic verbal modality is superior to graphic symbols modalities hypothesis (Smith, 2006; Smith, 2015; Trudeau et al., 2007). The modality-specific hypothesis explains that children who use the graphic symbol modality tend to omit verbal inflection even when these grammatical markers are available in the device because of the inefficient communication process that involves taking multi-step stages to select the target morpheme; and therefore, slow down the rate of the communication. Needless to say, in many cases the message could be understood to the communication partner without spending time on this process. The linguistic verbal modality is superior hypothesis states that children who use AAC translate their mental representation of the spoken language into the graphic symbol modality. The findings in this dissertation strongly support the linguistic modality is superior hypothesis as the children in these studies follow similar patterns of acquisition as typically developing children in generating well-formed clauses starting with the SVO structure and adding complexity to the clause structure over time. However, the types of errors that occurred in formulating the different clause structures support the modality-specific hypothesis and compensation hypothesis as most of the children's errors occurred in using inflections and functional words such as prepositions and articles. Lastly, the intensity of adults' prompts during the co-constructed interactions also supports the compensation hypothesis, because the adult and the child are using unique co-constructed interaction techniques to overcome any cognitive, physical, and linguistic barriers.

Clinical Implications

Organization of the vocabulary in the communication system. Action verbs vs. State verbs. Professionals are required to design and implement AAC interventions that optimize the language and communication skills via the AAC tools, which range from small boards to speech-generating devices. Decisions about message selection and the organization of the symbols (messages) within the device should take into consideration the Action and Stative verb categories as this organization might facilitate the acquisition of verbs and their inflections.

Instructional grammar activities on verb inflections: aspect before tense. Children who use AAC must acquire metalinguistic skills when they begin to use verbal inflection because they need to understand the meaning of the suggested morphemes in the device and intentionally select the target inflection after selecting the target word.

Verb instruction and inflection sequences. One of the main questions for clinicians is what verb should be targeted first and in what sequence during language intervention. The findings of this dissertation suggest that with school-age children who use SGDs with no evidence of cognitive impairment, both Stative and Action verbs should be targeted, as these children have already developed the mental representation of these categories similarly to typically developing children even though they may not be producing them for various reasons, such as low representation of verbs in the device, low expectations of the environment to use verbs, and the overwhelming focus on nouns. However, with young children who use AAC, Action verbs should be the focus of the intervention, as these verbs are more salient and typically developing children produce Action verbs before Stative verbs.

Action verbs is the major verb category in the mental lexicon and includes various types of verbs who can be classified into three subcategories: Activity (action, ongoing process), Accomplishment (process, change of state) and Achievement (event, something that happened instantly) which differ in term of their relation to time. Targeting these four types of verb categories (stative, activity, accomplishment and achievement) with the verbal inflections (*-ing, -ed, -s*) that matches the meaning of the verb category may facilitate the acquisition of the verbal inflections when taking into consideration how verbal inflections are acquired by typically developing children: *-ing* emerges first, then *-ed*, and lastly *-s*. It is important to say that the achievement verb category is very small and includes a few verbs that denote punctual events such as finish, arrive. Taking all these together, grammar instructions aiming to teach the *-ing* inflection should target activity verbs such as *run, walk , swim, dance* that are ongoing actions without an endpoint. Then, grammar instruction aiming to teach the *-ed* inflection should target accomplishment verbs, events in which the agent produces some change of state in something through an action such as *go* or *glue*. Lastly, grammar instruction aiming to teach the simple present form *-s* should include stative verbs such as *know*, *love*, and *want*.

Consideration for grammar instruction. This knowledge is essential for implementing efficient language interventions that consider the various characteristics and constraints of graphic symbols. First, one must understand that AAC typically incorporates non-linguistic (e.g., graphic symbols) and linguistic communication modes, that should be considered during language intervention. Second, one must also understand the importance of the communication partner in terms how much they support the child's language development and that they understand that the process of selecting a message through graphic symbols requires both time and competence. Third, we need to develop essential instructional approaches that promote the acquisition of grammar focusing on providing access to grammatical marks in the communication devices and explicit instructions. Lastly, and most importantly, we need to provide natural and constructed communication opportunities for language participation for children who use graphic symbols in order to help them develop their language skills.

Limitations

These findings must be interpreted according to the limitations of the study. These studies have two major limitations. First, the use of verbs and verb inflections, and the number of clause constructions in this data is small and far from the criterion that Brown used to establish acquisition, i.e., 90% occurrences in obligatory context (Bloom et al., 1980). However, as verbal

categories and inflection were only just emerging in the children's production, a comparison of the major patterns found in this data with those found in typically developing children informs us about the differences between typical and atypical language development. Second, one of the characteristics of aided communication is the co-constructed interaction where the message is constructed across multiple turns with the assistance of the communication partner (Savaldi-Harussi & Soto, 2016) In the first study, we did not analyze the level of support of the adult, nor did we describe the types of elicitation behaviors. In the second study, we used a new method of identifying target clauses and assigning a complexity score. This method needs to be further examined for reliability with a larger number of participants. Future research should also examine the types of adult prompts and elicitation behaviors during the CCCC to better understand what types of prompts enhance the production of specific grammatical forms and how the adult's prompts change as the children clause complexity increases.

Future Research

More observational studies and analyses of language transcripts of children who use SGDs are needed to generalize these findings. One avenue of research is to explore the syntactic construction of predicates in multi-word utterances to study the emergence of adult-like clauses in children who use SGDs. Further research is also needed to explore the types of elicitation behaviors by the communication partner and the level of support in each construction. Concerning the emergence of verbal inflection, much research is needed to explore whether instructional grammar activities on verbal inflection that target the verb types whose inherent aspect matches the meaning of the inflection that is being thought will facilitate their acquisition.

Finally, morpho-syntax is an additional critical component in language development and use, and thus it is important to continue examining whether future technology in AAC will facilitate the production of grammatical markers and accelerate the speed of communication.

References

Banajee, M., Dicarlo, C., & Buras, S. S. (2003). Core vocabulary determination for toddlers. *Augment Altern Commun, 19*(2), 67-73.

Bedrosian, L. (1997). Language acquisition in young AAC system users: issues and directions for future research. *AAC Augmentative and Alternative Communication, 13*.

Berman, R., & Slobin, D. (1994). *Relating events in narrative: A crosslinguistic developmental study*. New Jersey: Lawrence Erlbaum Associates.

Berwick, R. C., Pietroski, P., Yankama, B., & Chomsky, N. (2011). Poverty of the stimulus revisited. *Cognitive Science, 35*(7), 1207-1242.

Beukelman, D., & Mirenda, P. (2007). *Augmentative alternative communication supporting children & adults with complex communication needs* (Vol. 3). London: Paul H. Brookes.

Beukelman, D., & Mirenda, P. (2013). *Augmentative alternative communication supporting children & adults with complex communication needs* (Vol. 4th Ed.). London: Paul H. Brookes.

Binger, C., & Light, J. (2008). The morphology and syntax of individuals who use AAC: research review and implications for effective practice. *Augment Altern Commun, 24*(2), 123-138. doi: 10.1080/07434610701830587

Binger, C., Kent-Walsh, J., King, M., Webb, E., & Buenviaje, E. (2016). Early Sentence Productions of 5-Year-Old Children Who Use Augmentative and Alternative Communication. *Communication Disorders Quarterly*, 1525740116655804.

Binger, C., Maguire-Marshall, M., & Kent-Walsh, J. (2011). Using aided AAC models, recasts, and contrastive targets to teach grammatical morphemes to children who use AAC. *Journal of Speech, Language, and Hearing Research, 54*(1), 160-176.

Blockberger, S., & Johnston, J. R. (2003). Grammatical morphology acquisition by children with complex communication needs. *Augment Altern Commun, 19*(4), 207-221. doi: 10.1080/07434610310001598233

Bloom, L. (1993). *Language development from two to three*: Cambridge University Press.

Bloom, L., Lahey, M., Hood, L., Lifter, K., & Fiess, K. (1980). Complex sentences: Acquisition of syntactic connectives and the semantic relations they encode. *Journal of child language, 7*(02), 235-261.

Bloom, L., Lifter, K., & Hafitz, J. (1980). Semantics of verbs and the development of verb inflection in child language. *Language*, 386-412.

Brekke, & Tetzchner, V. (2003). Co-construction in graphic language development. In S. Von Tetzchner & Grove (Eds.), *Augmentative and alternative communication developmental issues* (pp. 176-211). London: Whurr.

Brekke, K. M., & Von Tetzchner, S. (2003). Co-construction in graphic language development In S. Von Tetzchner & N. Grove (Eds.), *Augmentative and Alternative Communication Developmental Issues* (pp. 176-211). London: Whurr.

Brodeur, K. A. (2015). Middle school literacy practices, teachers who construct them, and students who experience reading difficulties and disabilities (Doctoral dissertation, University of Minnesota).

Brown, R. (1973). *A first language: The early stages*: Harvard U. Press.

Chomsky, N. (1957). *Syntactic stractures (Juana Linguarum no.4)*. Gravenhage: Mouton.

Chomsky, N. (1969). *Aspects of the theory of syntax*. Cambridge, Mass: M.I.T. Press.

Chomsky, N. (2005). Three factors in language design. *Linguistic inquiry, 36*(1), 1-22.

Clark, E. V. (1996). Early verbs, event-types, and inflections. *Children's language, 9*, 61-73.

Clark, E. V. (2016). *First language acquisiiton* (3rd ed.). Cambridge: Cambridge University Press.

Diessel, H. (2004). *The acquisition of complex sentences* (Vol. 105): Cambridge University Press.

Dowty, D. (1979a). The semantics of aspectual classes of verbs in english *Word meaning and Montague grammar: The semantics of verbs and times in generative semantics and in Montague's PTQ* (Vol. 7, pp. 37-132): Springer.

Dowty, D. (1979b). *Word meaning and Montague grammar: The semantics of verbs and times in generative semantics and in Montague's PTQ* (Vol. 7): Springer.

Dromi, E. (1987). *Early lexical development* Cambridge: Cmbridge University Press.

Dromi, E. (1999). Early Lexical development. In B. Martyn (Ed.), *The development of language* (pp. 99-131). NY, US: Psychology Press.

Fillmore, C. (1968). The case for case. In E. Bach & T. Harms (Eds.), *Universals in linguistic theory* (pp. 1-88). New York: Holt, Rinehart and Winston.

Flores, M., Musgrove, K., Renner, S., Hinton, V., Strozier, S., Franklin, S., & Hil, D. (2012). A comparison of communication using the Apple iPad and a picture-based system. *Augment Altern Commun, 28*(2), 74-84. doi: 10.3109/07434618.2011.644579

Gleitman, L. (1990). The structural sources of verb meanings. *Language acquisition, 1*(1), 3-55.

Goldberg, A. E. (2003). Constructions: a new theoretical approach to language. *Trends in cognitive sciences, 7*(5), 219-224.

Golinkoff, R. M., Hirsh-Pasek, K., Mervis, C., Frawley, W., & Parillo, M. (1995). Lexical principles can be extended to the acquisition of verbs. In M. Tomassello & W. Merriman (Eds.), *Beyond names for things: Young children's acquisition of verbs* (pp. 185-217): Psychology Press.

Golinkoff, R. M., Hirsh-Pasek, K., Cauley, K. M., & Gordon, L. (1987). The eyes have it: Lexical and syntactic comprehension in a new paradigm. *Journal of child language, 14*(01), 23-45.

Hourcade, J., Pilotte, T. E., West, E., & Parette, P. (2004). A history of augmentative and alternative communication for individuals with severe and profound disabilities. *Focus on Autism and Other Developmental Disabilities, 19*(4), 235-244.

Kent-Walsh, J., Binger, C., & Buchanan, C. (2015). Teaching children who use augmentative and alternative communication to ask inverted yes/no questions using aided modeling. *American Journal of Speech-Language Pathology, 24*(2), 222-236.

Kovach, M. T. (2009). *Augmentative & alternative communication profile: A continuum of learning*: LinguiSystems.

Kovacs, T., & Hill, K. ((in press)). Language samples from children who use speech generating devices: Making sense of small samples and utterance length. . *American Journal of Speech Language Pathology.*

Levey, S. (2014). Preschool-age children's language development In S. Levey (Ed.), *Introduction to language development* (pp. 153-210). San Diego: Plural Publishing.

Levey, S., & Polirstok, S. (2010). *Language development: understanding language diversity in the classroom*: SAGE.

Light, J. (1989). Toward a definition of communicative competence for individuals using augmentative and alternative communication systems. *Augment Altern Commun, 5*(2), 137-144.

Light, J., & McNaughton, D. (2014). Communicative competence for individuals who require augmentative and alternative communication: A new definition for a new era of communication? : Taylor & Francis.

Lloyd, L., & Loncke, F. (1999). Research issues and graphic symbol use. In F. Loncke, J. Campbell, H. Arvidson & L. Lloyd (Eds.), *Augmentative and alternative comminication new directions in research and practice* (pp. 201-203). London: Whurr.

Loncke, Campbell, England, & Haley. (2006). Multimodality: a basis for augmentative and alternative communication psycholinguistic, cognitive, and clinical/educational aspects. *Disabil Rehabil, 28*(3), 169-174.

Maguire, M., Hirsh-Pasek, K., & Golinkoff, R. (2006). 14 A Unified Theory of Word Learning: Putting Verb Acquisition in Context. *Action meets word: How children learn verbs*, 364.

Mandler, J. M. (1992). How to build a baby: II. Conceptual primitives. *Psychological review, 99*(4), 587.

Martinsen, H., & Von Tetzchner, S. (1996). Situaing augmentative and alternative language intervention. In S. Von Tetzchner & M. H. Jensen (Eds.), *Augmentative and alternative communication european perspective* (Vol. 1996, pp. 37-48). London: Whurr.

Miller, J. F., Andriacchi, K., Nockerts, A., Westerveld, M., & Gillon, G. (2012). Introduction to LSA using SALT *Assessing Language Production using SALT Software. A Clinician's Guide to Language Sample Analysis. New Zealand version*. Middelton: SALT Software.

Miller, J. F., & Chapman, R. S. (1981). The relation between age and mean length of utterance in morphemes. *Journal of Speech, Language, and Hearing Research, 24*(2), 154-161.

Murray, J., & Goldbart, J. (2009). Cognitive and language acquisition in typical and aided language learning: a review of recent evidence from an aided communication perspective. *Child Language Teaching and Therapy, 25*(1), 31-58.

Nelson, M. W. (1992). Performance Is the Prize:Language competence and performance among AAC users. *AAC Augmentative and Alternative Communication, 8*, 3-18.

Ortloff, M. (2010). Language Development in physically and motor impaired children without speech: A case study of a child using a speech-generating device. (L. Jeschull, Trans.) (Unpublished doctoral dissertation). University of Cologne, Germany.

Pinker, S. (1994). How could a child use verb syntax to learn verb semantics? *Lingua, 92*, 377-410.

Savaldi-Harussi, G., & Soto, G. (2016). Using SALT: Considerations for the Analysis of Language Transcripts of Children Who Use SGDs. *Perspectives of the ASHA Special Interest Groups, 1*(12), 110-124.

Shatz, M., Wellman, H., & Silber, S. (1983). The acquisition of mental verbs: A systematic investigation of the first reference to mental state. *Cognition, 14*(3), 301-321.

Smith, M. (1996). The medium or the message: A study of speaking children using communication boards. In S. v. Tetzchner & M. H. Jensen (Eds.), *Augmentative and alternative communication: European perspectives* (pp. pp. 119–136). London: Whurr.

Smith, M. (2006). Speech, language and aided communication: connections and questions in a developmental context. *Disabil Rehabil, 28*(3), 151-157. doi: 10.1080/09638280500077747

Smith, M. (2015). Language Development of Individuals Who Require Aided Communication: Reflections on State of the Science and Future Research Directions. *Augment Altern Commun, 31*(3), 215-233.

Soto, G. (1997). Multi-unit utterances and syntax in graphic communication. In E. Bjorck-Åkesson & P. Lindsay (Eds.), *Communication... naturally. Theoretical and Methodological Issues in Research in Augmentative and Alternative Communication: Proceedings of the Fourth ISAAC Research Symposium* (pp. 26-32). Toronto, Canada: Malardalen University Press.

Soto, G. (1999). Understanding the impact of graphic sign use on the message structure. In F. T. Loncke, J. Clibbens, H. H. Arvidson & L. Lloyd (Eds.), *Augmentative and alternative communication. New direction in research and practice* (pp. 40-48). London: Whurr

Soto, G., & Clarke, M. T. (2017). Effects of a conversation-based intervention on the linguistic skills of children with motor speech disorders who use augmentative and alternative communication. *Journal of Speech, Language, and Hearing Research*, 1-19.

Soto, G., Hartmann, E., & Wilkins, D. P. (2006). Exploring the elements of narrative that emerge in the interactions between an 8-year-old child who uses an AAC device and her teacher. *Augment Altern Commun, 22*(4), 231-241.

Soto, G., & Seligan-Wine, J. (2003). Child-driven development of alternative communication: a case study. In S. Von Tetzchner & N. Grove (Eds.), *Augmentative and Alternative Communication developmental issues* (pp. 211-229). London: Whurr.

Soto, G., Solomon-Rice, P., & Caputo, M. (2009). Enhancing the personal narrative skills of elementary school-aged students who use AAC: The effectiveness of personal narrative intervention. *J Commun Disord, 42*(1), 43-57.

Sutton, A., Soto, G., & Blockberger, S. (2002). Gramatical Isuues in graphic symbol communication. *Augmentative and Alternative Communication, 18*, 192-204.

Sutton, A., Trudeau, N., Morford, J., Rios, M., & Poirier, M.-A. (2010). Preschool-aged children have difficulty constructing and interpreting simple utterances composed of graphic symbols*. *Journal of child language, 37*(1), 1.

Tetzchner, V., & Grove (Eds.). (2003). *The development of alternative language forms*: Whurr

Thothathiri, M., & Snedeker, J. (2011). The Role of Thematic Roles in Sentence Processing: Evidence from Structural Priming in Young Children.

Tomasello, M. (1992). *First verbs: A case study of early grammatical development*: Cambridge University Press.

Tomasello, M. (2000). First steps toward a usage-based theory of language acquisition. *Cognitive Linguistics, 11*(1/2), 61-82.

Tomasello, M. (2009). The usage-based theory of language acquisition *The Cambridge handbook of child language* (pp. 69-87): Cambridge Univ. Press.

Tomasello, M., & Akhtar, N. (1995). Two-year-olds use pragmatic cues to differentiate reference to objects and actions. *Cognitive Development, 10*(2), 201-224.

Trudeau, Sutton, Dagenais, Broeck, d., & Morford. (2007). Construction of Graphic Symbol Utterances by Children, Teenagers, and Adults: The Effect of Structure and Task Demands. *Journal of Speech, Language, and Hearing Research, 50*, 1314–1329.

Valian, V. (2009). Innateness and learnability. In E. L. Bavin (Ed.), *The Cambridge handbook of child language* (pp. 15-34). Cambrige: Cambridge University Press.

Van Tatenhove, G. M. (2005). Normal language development, generative language & AAC. *Retrieved February, 1*, 2009.

Van Valin, R., & LaPolla, R. (1997). Syntax: form, meaning, and function. *Cambridge University Press. Cambridge*.

Von Tetzchner, S., & Grove, N. (2003). The development of altenative language forms. In S. Von Tetzchner & N. Grove (Eds.), *Augmentative and alternative commnuication developmental issues* (pp. 1-27). London: Whurr.

Von Tetzchner, S., & Martinsen, H. (2000). *Introduction to Augmentative and Alternative Communication: Sign Teaching and the Use of Communication Aids for Children, Adolescents and Adults with Developmental Disorders*. London: Whurr.

Waxman, S. R., & Lidz, J. L. (2006). Early World Learning. *Handbook of child psychology*.

Appendix A. Study One Tables

Table A1. *List of Carmen's Lexical Verbs by Tokens and Verb Categories (Stative & Action)*

Event category	Lexical verbs	Tokens (178 total)	Percentage
Stative verb (10 types)	BE (are, is, was, be)	(2, 11, 4, 3) = 20	11%
	have	7	4%
	hear	1	.6%
	know	2	1%
	like	3	1.7%
	feel (felt)	19 (1) = 20	11%
	miss	2	1%
	need	2	1%
	see	4	2.2%
	want (wants)	7 (2) = 9	5%
Action verb (32 types)	buy (bought)	0 (1) = 1	.6%
	come	7	4%
	cry	2	1%
	dance	1	.6%
	decorate	2	1%
	do	6	3.4%
	dress	2	1%
	drink	1	.6%
	eat	3	1.7%
	feed	2	1%
	look	1	.6%
	fight	2	1%
	give	4	2.2%
	go (went)	28 (1) = 29	16%
	jump	6	3.3%
	make	3	1.7%
	open	2	1%
	paint	2	1%
	play	8	4.5%
	read	1	.6%
	sign	1	.6%
	sleep	4	2.2%
	stop	4	2.2%
	talk	2	1%
	tell	3	1.7%
	wait	1	.6%
	walk	1	.6%
	work	3	1.7%
	write	1	.6%
	pretend	1	.6%
	remember	1	.6%
	share	1	.6%

Table A2. *List of Mateo's Lexical Verbs by Tokens and Verb Categories (Stative & Action)*

Event category	Lexical verbs	Tokens (116 total)	Percentage
Stative verb (7 types)	BE (am, are, is, was, were)	0 (3, 4, 19, 5, 1) = 32	27.5%
	feel (felt)	0 (2) = 2	1.7%
	have	4	3.4%
	like	9	7.8%
	love (loving)	0 (1) = 1	0.9%
	need	5	4.3%
	want	10	8.6%
Action verb (16 types)	clear	1	0.9%
	cook (cooking)	1 (1) = 2	1.7%
	dance (danced)	2 (1) = 3	2.6%
	drink	3	2.6%
	eat	6	5.1%
	go (going, went)	14 (1, 1) = 16	13.8%
	listen	2	1.7%
	play	5	4.3%
	read	2	1.7%
	ride	5	4.3%
	roll (rolling)	1	0.9%
	stop	1	0.9%
	swim (swimming)	0 (1) = 1	0.9%
	watch (watched)	1 (3) = 4	3.4%
	win	1	0.9%

Table A3. *List of Kareem's Lexical Verbs by Tokens and Verb Categories (Stative & Action)*

Event category	Lexical verbs	Tokens (110 total)	Percentage
Stative verb (5 types)	BE (am, is, are, were)	0 (5, 6, 5, 1) = 17	15.5%
	have (has)	0 (4) = 4	3.6%
	like	7	6.4%
	see	1	0.9%
	want	28	25.5%
Action verb (12 types)	do	0 (1) = 1	0.9%
	eat	5	4.5%
	go (goes, going)	4 (2, 8) = 14	12.7%
	live	5	4.5%
	look	10	9.1%
	play	8	7.3%
	read	3	2.7%
	run	1	0.9%
	sleep	1	0.9%
	stop	1	0.9%
	watch	2	1.8%
	help	0	0%
	take	2	2.8%

Table A4. *List of Julia's Lexical Verbs by Tokens and Verb Categories (Stative & Action*

Event category	Lexical verbs	Tokens (122 total)	Percentage
Stative verb (9 types)	BE (am, are, was, is)	0 (1, 1, 4, 4) = 10	8.2%
	feel	8	6.6%
	forget (forgot)	0 (1) = 1	0.8%
	have (has)	0 (1) = 1	0.8%
	know	2	1.6%
	like	3	2.5%
	love	2	1.6%
	saw	7	5.7%
	want	1	0.8%
Action verb (23 types)	eat (ate)	2 (10) = 12	9.8%
	buy	1	0.8%
	carry (carrying)	0 (1) = 1	0.8%
	celebrate	2	1.6%
	cut	3	2.5%
	draw (drew)	0 (4) = 4	3.3%
	get	2	1.6%
	glue (glued)	0 (1) = 1	0.8%
	go (goes, went)	0 (5, 10) = 15	12.3%
	help (helped)	5	4.1%
	look	2	1.6%
	make	5	4.1%
	open	8	6.6%
	play	10	8.2%
	run (ran)	0 (1) = 1	0.8%
	read	2	1.6%
	ride (rode)	0 (3) = 3	2.5%
	slide	1	0.8%
	swim (swam)	0 (2) = 2	1.6%
	talk (talked)	0 (1) = 1	0.8%
	tell	3	2.5%
	walk	2	1.6%
	wore	1	0.8%

Table A5. *Carmen's Production of Inflection (Emergence, Verb Type, Event Category, and Frequency)*

				Inflection type		
Observation	Verb	Event category	Tokens	-ing	-ed	-s
2	feel	Stative	1		1	
3	go	accomplishment	1		1	
3	buy	accomplishment	1		1	
6	want	Stative	2			2
8	go	activity	1	1		
Total:	5 types		6	1	3	2

Table A6. *Mateo's Production of Inflection (Emergence, Verb Type, Event Category, and Frequency)*

				Inflection type		
Observation	Verb	Event category	Tokens	-ing	-ed	-s
1	love	Stative	1	1		
2	cook	activity	1	1		
2	roll	activity	1	1		
2	swim	activity	1	1		
5	dance	activity	1		1	
5	watch	activity	2		2	
6	go	accomplishment	3	3		
7	go	accomplishment	1		1	
7	feel	Stative	1		1	
7	ride	activity	1		1	
Total:	10 types		13	7	6	0

Table A7. *Kareem's Production of Inflection (Emergence, Verb Type, Event Category, and Frequency)*

				Inflection type		
Observation	Verb	Event category	Tokens	-ing	-ed	-s
4	go	accomplishment	10	8		2
5	have	Stative	4			4
Total:	10 types		14	8	0	6

Table A8. *Julia's Production of Inflection (Emergence, Verb Type, Event Category, and Frequency)*

				Inflection type		
Observation	Verb	Event category	Tokens	-ing	-ed	-s
1	go	accomplishment	8		8	
1	forget	Stative	1		1	
2	eat	activity	8		8	
2	feel	Stative	6		6	
2	glue	accomplishment	1		1	
2	make	accomplishment	2		2	
2	ride	activity	2		2	
2	swim	activity	1		1	
3	draw	accomplishment	4		4	
3	wear	accomplishment	1		1	
3	help	activity	1		1	
4	carry	activity	1	1		
4	play	activity	2		2	
4	see	Stative	7		7	
4	talk	activity	1		1	
5	tell	activity	2			2
5	walk	activity	1		1	
6	open	accomplishment	1		1	
8	go	accomplishment	5		5	
Total:	19 types		55	1	47	7

Appendix B. Study Two Tables

Table B1. *Glosses and Abbreviations*

Abbreviation	Linguistic Constituent
Sbj	subject
V	verb
Cop	copula
Obj	object
COPCOM	copula complement
Adv	adverb
Mod	Modal
N	Noun
Inf	Inflection
Connector	Connector
Poss	Possessive
Prep	Preposition
Art	article
Ex	Existential

Table B2. *Carmen's Clause Constructions by Observation, Complexity, Number of Units, and Number of Turns*

Obs.	Construction	Score	Units	Turns
1	V	1	1	1
	Sbj+COP+COPCMP	3	3	1
	(Poss)Sbj+V+particle	4	4	2
	S+V+Pre+O(N+N)	6	6	1
2	COP+COPCMP	2	2	1
	Adv[Q+N]+V	2	3	1
	Sbj+COP+COPCMP	3	4	7
	Sbj+COP+COPCMP	3	5	12
	Sbj+COP+COPCMP	3	3	3
	Sbj+V+(prep)Obj/Adv	4	5	1
	Sbj+(mod)(inf)V+Obj	5	7	1
3	Sbj+COP+COPCMP[(Inf)V+Obj]	6	6	3
	V	1	1	1
	V+Obj	2	2	3
	Sbj+COP+COPCMP	3	3	1
	Sbj+COP+COPCMP	3	3	1
	V+(poss)Obj, V, V	3	5	4
	V+Obj, V+Obj	4	6	8
	Sbj+V+V+Obj	4	7	1
	V+(prep)Obj	4	3	1
	Adj+Sbj+V+(poss)Adj	5	5	4
	(poss)Sbj+(inf)V+Obj+(art)	6	5	1
	Sbj+V+Adj+Obj+Obj[N+N]	7	6	1
	Sbj+Mod+(inf)V+(prep)Obj/Adv	7	7	2
	Mod+(inf)V+(prep)(art)Obj	7	6	1
	Sbj+COP+CMPCOP[(Inf)V+(prep)Obj]	7	7	1

Obs.	Construction	Score	Units	Turns
4	Sbj+V	1	8	3
	V	1	1	1
	Verb+Obj/Adv	2	3	1
	Sbj+COP+CMPCOP	2	5	2
	Sbj+COP+COPCMP	3	4	1
	Sbj+CMPCOP	3	2	2
	Sbj+Adv+V	3	9	1
	Sbj+COP+COPCMP	3	4	1
	Sbj+V+Obj	3	5	2
	(mod)(inf)V	3	5	1
	(mood)V+(Adj)Sbj	4	5	1
	Sbj+V+(prep)(poss)Obj/Adv	5	6	2
	(poss)SBJ+(mod)V+Particle	5	6	1
	Sbj+V+(prep)(poss)Obj/Adv	6	6	1
	Sbj+(mod)(inf)V+((poss)poss)Obj/Adv	6	7	3
	Sbj+V+(prep)Obj+Adv[Nposs+N]	9	8	2
	Sbj+(mod)(neg)V+(inf)COP+CMP+Connective+[Sbj+Ex+CMPEx]	12	15	5
	V	1	2	1
	COP+COPCMP	2	2	1
	COP+COPCMP1	2	2	1
5	Sbj+COP+COPCMP	3	3	1
	Sbj+V+Obj/Adv	3	3	1
	Sbj+V+Obj/Adv	3	3	1
	Sbj+COP+COPCMP	3	4	1
	Sbj+(neg)COP+CMPCOP	4	5	1

Obs.	Construction	Score	Units	Turns
	Sbj+V+Obj/Adv+(prep)Obj/Adv	6	5	1
	Sbj+V+[prep]Obj/Adv+Obj/Adv	7	6	1
	COP+COPCMP+connective+Sbj+COP+COPCMP	7	9	5
	Sbj+V+(art)Obj/Adv[N+N]+(prep)Obj/Adv	9	7	1
	Verb+Obj/Adv [posse] [ADJ]	4	6	1
6	COP+COPCMP	2	2	1
	V+Obj	2	2	1
	COP+COPCMP	2	2	1
	COP+COPCMP	2	2	1
	Sbj+COP+COPCMP	3	3	1
	Sbj+COP+COPCMP	3	3	1
	Sbj+V+V	3	3	1
	Sbj+V+V	3	4	2
	Verb+(prep)Obj/Adv	4	3	1
	V+(inf)V+Obj	4	5	2
	Verb+(prep)Obj/Adv	4	4	1
	Sbj+(aux)(neg)V	4	4	1
	Sbj+(mod)(neg)V+Obj/Adv	5	5	1
	CMPCOP[quant+Adj.]+Sbj[(inf)V+V]	5	5	2
	connective+Adv+V+(poss)Obj	5	5	1
	S+V+(to)V+Obj	5	5	1
	Sbj+V+Obj+(art)Obj	6	5	4
	Sbj[N+and+N]+(inf)Poss+Obj	6	6	1
	(Sbj)+(neg)Poss+Obj+(prep)Adv	7	6	1
	connective+(poss)Sbj+COP+(quant)CMPCOP	7	5	1
	(Sbj)+COP+COPCMP+Connector+(Mod)(inf)Verb+Obj/Adv	9	9	2
	Sbj+COP+COPCMP+(prep)(poss)Obj+particle+Adv	9	8	3

Obs.	Construction	Score	Units	Turns
	Adv+Sbj+(inf)V+(prep)Adv[N]+connective+V+Sbj+V+Obj+Obj	14	14	7
7	V	1	1	1
	Verb+Obj/Adv	2	2	1
	Verb+Obj/Adv	2	2	1
	Sbj+(neg)V	3	3	1
	Sbj+(aux)(neg)V	4	4	1
	Sbj+(prep)+V+Obj/Adv	5	4	1
	Sbj+(inf)Ex+(prep)COPEx	6	4	1
	connective+V+(prep)Obj	6	4	1
	connective+Sbj+(quant)(adj)CMPCOP	6	5	1
	Sbj+V+(prep)Obj/Adv[N+N]	7	6	1
	connective+Sbj+V+(prep)Obj	7	5	1
	Sbj+V+(posse)Obj/Adv+(prep)(poss)Adv	8	7	1
	(prep)Adv+SBJ+V+(poss)Adv+(prep)Adv	10	9	1
	connective+Sbj[N+N+N+N]+V+(quant)(adj)Obj	10	10	1
	Sbj+(prep)+V+Obj/Adv+(inf)V+(poss)Obj+(poss)Adv[N+N]+(prep)Adv[N+N+no.]	17	15	7
8	V	1	11	1
	V	1	1	1
	COP+CMP	2	2	1
	COP+CMPCOP	2	2	1
	Sbj+(ADJ)COPCMP	3	3	1
	Sbj+V+Obj/Adv	3	5	1
	Sbj+V+Obj/Adv	3	3	1
	Sbj+V+Obj/Adv	3	3	1
	Sbj+(mod)(neg)V	4	4	3
	COP+[ART]CMP	4	3	2
	connective+V+Obj	4	3	1

Obs.	Construction	Score	Units	Turns
	(poss)(Adj)Sbj+COP+COPCMP	5	5	1
	Sbj+COP+(art)COPCMP	5	4	1
	COP+CMPCOP+(prep)Obj/Adv	5	4	3
	conective+Sbj+COP+CMPCOP	5	4	2
	Sbj+V+(prep)(art)Obj/Adv	7	5	1
	Adv+Sbj+V+(inf)V+(poss)Obj	7	7	4
	connective+Sbj+(mod)(inf)V+(poss)Obj/Adv	8	7	1
	Sbj+(inf)V+(prep)(poss)(poss)Obj/Adv	8	7	1
	(prep)(Adv)+Sbj+(Aux)(neg)V+Obj/Adv	8	7	1
	Sbj+COP+(quant)COPCMP+connective+Sbj+(aux)(neg)V+Obj+Adv	12	11	1
	Sbj+V+Obj+connective+Sbj+V+(prep)Obj+(prep)Adj	13	11	2
	COPCOPCOM	2	2	1
Total				

Table B3. *Kareem's Clause Constructions by Observation, Complexity, Number of Units, and Number of Turns*

Obs.	Construction	Score	Units	Turns
2	Sbj+(mod)V+Obj	4	4	4
3	Sbj+V+Obj	3	3	3
	(art)Sbj+V+Obj	5	4	5
	Sbj+(mod)(inf)V+(inf)Obj	6	6	8
	Sbj+V+(prep)(art)Obj/Adv	7	5	20
	(art)S(pl)+COP+COPCMP	6	5	8
	Sbj+COP+(art)COPCMP+Adj+V	7	10	6
	Sbj+V+(inf)Obj	4	4	8
4	Sbj+V+Obj	3	3	1
	Sbj+(mod)(inf)V+ (art)(inf)Obj	8	6	11

Obs.	Construction	Score	Units	Turns
	Sbj+(mod)(inf)V+ (art)(adj)(inf)Obj	9	8	10
	Sbj+V+(inf)Obj	4	4	3
	Sbj+V+(adj)Obj	4	4	6
	Sbj+V+(adj)(inf)Obj	5	6	9
	Sbj+(inf)(inf)V+(prep)(art)Obj	9	7	11
	Sbj+(inf)(inf)V+(prep)(art)Obj+(prep)(Poss)Obj	13	10	19
	Sbj+(mod)(inf)V+(inf)Obj	6	6	5
5	Sbj+V+(art)Obj	5	4	9
	Connective+Sbj+Poss+(art)(adj)Obj	8	6	12
	Sbj+COP+(art)CMPCOP	5	4	13
	Sbj+COP+CMPCOP	3	3	4
	Sbj+COP+(inf)CMPCOP(N+N)	5	5	6
6	Sbj+V	2	2	1
	Sbj+(mod)(inf)V+(prep)(inf)Obj	8	7	5
	Sbj+V	2	2	1
	Sbj+V	2	2	1
	Sbj+V+Obj	3	3	1
	Sbj+COP+(art)CMPCOP	5	4	5
	Sbj+V	2	3	2
	Sbj+(mod)(inf)V+Obj(N+N)	6	6	6
	V+Sbj	2	2	1
	(Poss)Sbj+COP+COMCOP	4	4	12
	(poss)Sbj[N+and+N]+(inf)COP+CMPCOP	7	7	11
Total				

Table B4. *Mateo's Clause Constructions by Observation, Complexity, Number of Units, and Number of Turns*

Obs.	Construction	Score	Units	Turns
1	(Inf)V	2	2	1
	V	1	1	1
	S+V+Obj[N+N]	4	5	6
	COP	1	1	1
	COP+COPCMP	2	2	3
	V	1	1	1
	V	1	1	1
2	(inf)V	2	2	1
	V	1	1	1
	(inf)V	2	2	1
	(inf)V	2	2	3
3	S+V	2	2	4
	S+(inf)V	3	3	2
	S+V+Obj	3	3	7
	S+V+(inf)Obj	4	4	20
	(poss)Sbj+COP+CMPCOP	4	4	25
	(poss)Sbj+COP+CMPCOP	4	5	10
4	Sbj+Poss+Obj[N+N]	4	4	17
	Sbj+Poss+(Inf)Obj	4	4	9
	Sbj+V+(Inf)Obj+(prep)Adv	7	6	7
	Sbj+V+(prep)Obj, Sbj+V+Obj	8	7	24
	SBJ+(Inf)V	3	3	15
5	Sbj+(Inf)V+Obj[N+N]	5	5	21
	Sbj+(inf)COP+CMPCOP	4	4	16
	Sbj+(mod)(inf)V+(prep)(art)Obj	10	8	20

Obs.	Construction	Score	Units	Turns
	Sbj+COP+CMPCOP	3	3	9
	Sbj+V+Obj	3	3	5
	Sbj+(mod)(inf)V+Obj	5	5	8
6	Sbj+COP+CMPCOP	3	3	8
	Sbj+(inf)COP+CMPCOP	4	4	9
	(poss)Sbj+V	3	3	19
	Sbj+(inf)(inf)Aux+(inf)V	6	6	10
	Sbj+(inf)(inf)Aux(inf)V+(prep)Adv	9	8	8
	V	1	1	1
	Sbj+V+Obj[(inf)N+N]	6	6	16
	Sbj+(mod)(inf)V+(prep)Obj	7	6	14
7	Sbj+COP+CMPCOP	3	3	2
	Sbj+(aux)(aux)(inf)V	5	5	8
	Sbj+(inf)V	3	3	1
	Sbj+(inf)V+Obj	4	3	10
	V	1	1	2
	Sbj+V+Obj	3	3	8
	Sbj+(inf)V+CMPCOP	4	4	8
	Sbj+(mod)(inf)V+(prep)Obj	7	6	10
Total				

Table B5. *Julia's Clause Constructions by Observation, Complexity, Number of Units, and Number of Turns*

Obs.	Construction	Score	Units	Turns
1	(inf)V	2	1	1
2	Sbj+V+Obj	3	3	1
	V	1	1	1
	Sbj[N+and+N]+V	4	4	1
	V+Obj	2	2	3
3	Sbj+V+Obj(prep)(art)	7	5	4
	Sbj+(inf)V+Obj	4	4	3
	Sbj+(inf)V+Obj	4	4	4
	V	1	1	1
	S+(inf)V	3	3	1
4	Sbj[N+and+N+and+N]+(inf)V+(prep)Obj+(inf)V+Obj	13	12	7
	Sbj+(inf)V+(prep)Obj. (inf)V+Obj+connective+Obj[N+and+N]	14	12	1
	V	1	1	1
	SBJ+V+Obj	3	3	1
	(inf)V+(prep)(poss)Obj+Adv	7	6	1
	V	1	1	1
	Sbj+V+Obj+Adv	4	4	1
5	Sbj+(inf)V+Obj	4	4	8
	Sbj+(inf)V+(art)Obj	6	5	9
	V	1	1	2
	(inf)V	2	2	1
	(inf)V	2	2	1
	Sbj+V+connective+(inf)Obj	6	5	8
	V	1	1	1
	Sbj+(inf)V+Obj[N+N]	5	5	8
6	V	1	1	2
	(inf)V	2	2	4
	Sbj+(inf)V+Obj	4	4	5
	Sbj+(inf)V+(inf)Obj	5	5	10

Obs.	Construction	Score	Units	Turns
7	(inf)V	2	2	1
	V	1	1	1
	Sbj+V+(art)(Obj)+(inf)V	7	6	9
	V+Obj	2	2	1
	V+Obj	2	4	4
	(inf)V+Obj	3	3	1
8	CMPCOP+COP+Sbj	3	3	1
	(art)Sbj+(inf)V+(prep)Obj	8	7	9
	Sbj+(neg)Aux+V	4	4	1
	Sbj+COP+COPCMP	3	3	3
	Sbj+inf(Poss)+(inf)Obj	5	5	3
	Sbj+V	2	2	2
	Sbj+V	2	2	1
	Sbj+V+Obj	3	3	3
Total				

Table B6. *Carmen's Grammatical Errors*

Grammatical Errors	N	Percentages	Utterance	Target sentence	Element missing/misuse
copula missing	5	4.3	She nice woman handsome	She IS A nice handsome woman	Is- 4 Am - 1
article missing	19	16	She nice woman handsome	She IS A nice handsome woman	The- 13 a- 6
auxiliary missing	5	4.3	I going to my grandma home	I AM going to my grandm'S home	Are – 1 Do – 2 Am – 1 Is - 1
Connective missing	1	0.9	Prince is handsome, big, nice. And	THE Prince is handsome, big AND nice.	And - 1
Modal missing	1	0.9	Mary, Mary you go on light	THE light should go on	Should- 1

Grammatical Errors	N	Percentages	Utterance	Target sentence	Element missing/misuse
Possessive-missing	7	6	I to go Carmel to see dad sister grandma party birthday on March Sunday 11.	I GO TO Carmel to see dad'S sister AT grandma'S birthday party on March Sunday 11.	‘s- 7
Adverb-incorrect use of	1	0.9	because Allie, Mary, Max, Sam make too much loud noisy	because Allie, Mary, Max, Sam make too much loud NOISE	noisy
Preposition-Incorrect use	23	N- 24 21%	I miss you because I we work with you on everyday	I miss you because I we work with you everyday	
Preposition Missing	1	0.9	After Valentine’s day Tia Mary come my house to sleep over	After Valentine’s day Tia Mary comeS TO my house to sleep over	During- 1 To-12 At – 2 With – 2 In – 4
inflection Incorrect	2	N= 30 26%	Go to away.	Go Away	to
inflection missing	28		Sir Sergio feed bowl dog food	Sir Segio feedS THE dog food with a bowl.	3S- 18 (60%) ing- 1 to -5 Pl- 1 ED-2 ED irreg-1
word worded incorrect use	14	N-14 12%	I to go Carmel.	I GO TO Carmel.	
Pronoun: Incorrect use	7	6%	Her look in the book	SHE lookS in the book.	SHE- 3 Him-2 I – 21 They-1
Modifier-Incorrect use	1	0.9	Miss M you don’t can pretend to be Tia Mary, Because Tia Mary have black hair.	YOU CANNOT pretend to be Tia Mary	cannot
Total	115	100%			

Table B7. *Kareem's Grammatical Error*s

Grammatical Errors	N	Percentages	Utterance	Target sentence	Element missing/misuse
Word order	3	27.3	I want bed sleep	I want to sleep in bed	S+(mod)O+V
Preposition missing	2	18.2	I want bed sleep	I want to sleep **in** bed	in
Inflection (infinitive)	1	9.1	I want bed sleep	I want **to** sleep in bed	to
Inflection (3s)	1	9.1	The cartoon look dinosaur	The carton lookS LIKE A dinosour	3s
Article missing	4	36.3	I want car	I want A car	a
Total	11	100%			

Table B8. *Julia's Grammatical Errors*

Grammatical Errors	N	Percentages	Utterance	Target sentence	Element missing/misuse
Inflections/missing	3	17%	I like car	I like cars	Plural S (2) , ED,
Preposition missing	1		Walk Trick-or-treat	Walk FOR Trick-or-treat	For, to
Preposition incorrect	4	N-5 27%	Tio John and Tio Mark and Tia Allie went with New York play/ed soccer ball	J Tio John and Tio Max and Tia Allie went TO New York AND play/ed soccer ball	With>to
Word order	1	6%	We cut (hurt) scissors with the.	We cut WITH THE scissors	
article missing	7	39%	I wore costume	I wore A costume	A
Connective missing	2	11%	Tio Mark and Tio Max and Tia Allie went with New York play/ed soccer ball	Tio Mark and Tio Max and Tia Allie went TO New York AND play/ed soccer ball	AND
Total	18	100%			

Table B9. *Mateo's Grammatical Errors*

Grammatical Errors	N	Percentages	Utterance	Target Clause	Element missing/misuse
Mishit	1	33%	I me read commic book	I read commic book	me
Inflection missing	1	33%	My stomach hurt	My stomach hurtS	3S
Article missing	1	33%	We rode train	We rode THE train	The
Total	3	100%			