EXPLORING THE LANGUAGE ENVIRONMENT OF TODDLERS WITH IDENTIFIED NEEDS AND THEIR TYPICALLY DEVELOPING PEERS IN HOME AND AT SCHOOL

BY

MIRANDA ALEXA ARAGON

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written by Miranda Alexa Aragon
has been approved for the Department of Speech Language and Hearing Sciences

Christine Yoshinaga-Itano, Ph.D., CCC-A
Committee Chair

Amy Thrasher, M.A., CCC-SLP
Committee Member

Susan Moore, JD, M.A., CCC-SLP
Committee Member

Date_____

The final copy of this thesis has been examined by the signatories, and we
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Abstract

Aragon, Miranda Alexa (M.A., Speech Language Pathology)

Exploring the Language Environment of Toddler with Identified Needs and their Typically Developing Peers in Home and at School

Thesis directed by Professor Christine Yoshinaga-Itano

A rich language environment is key to provide children with the optimal opportunity to develop their receptive and expressive language skills. In order to ensure that children with identified needs receive this optimal opportunity, it is important to conduct research regarding their language input in multiple environments including in home and at school. This descriptive study investigated the benefit of strategies utilized in the school setting and their impact on a more interactive language environment compared to their home setting. The study focused on the global language environment of children with identified needs compared to their typically developing peers in home and in a child learning center (CLC) at a public university. The Language ENvironment Analysis System (LENA) and a number of developmental questionnaires were utilized to better understand the language environment of toddlers with identified needs. The LENA system consists of a small recording device that captures the language environment of children and a computer analysis system that analyzes the data into numerous categories including adult word count, conversational turns and child vocalizations. Overall, this study found that children's language environments can be highly variable and the LENA System can provide information regarding adult word count, conversational turns and child vocalizations; however, these variables alone can not determine the success of strategies utilized in the CLC.

Contents

Introduction

This study was modeled after a previous study completed by Wiggin, Gabbard, Thompson, Goberis and Yoshinaga-Itano titled, *The School to Home Link: Summer Preschool and Parents (2012).* Their findings showed that the children participants received significantly more complex language in preschool than in the home environment. The researchers suggested that language strategies should be transferred from the preschool environment to the home environment. Although this study used a different population, the results from the previous study showed that the research using the Language ENvironment Analysis System (LENA) device can give great insight to the language environment of young children with and without identified needs. The current study describes the language environment of toddlers with identified needs and their typical developing peers at a childhood learning center toddler group (CLC) at a public university using a number of standardized assessments and the LENA System. INREAL Strategies and the Storybook Journey are used in the CLC Toddler Group. LENA will be used to describe the home and school environment of children in the CLC.

Language ENvironment Analysis (LENA)

The LENA System was created in 2004 in response to the Hart and Risley (1995) study published as a book entitled, Meaningful Differences in the Everyday Experience of Young American Children, in order to decrease the time spent on data collection and analysis. According to Gilkerson and Richards (2008), the Hart and Risley study extracted three key findings:

1. Variation in the children's IQs and language abilities is partially predicted by the amount parents speak to their children.

2. Children's academic successes at ages nine and ten can in part be attributed to the amount of talk they heard from birth to age three.
3. Parents of advanced children talk significantly more to their children then parents of children who are not as advanced.

Terrance and Judi Paul, the founders of the nonprofit LENA Foundation, invested in research to design a device that decreased the time spent collecting and analyzing conversational data in large quantities and the device was launched in 2004. This technology provided the framework for the development of advanced algorithms and statistical models for adult speech and child vocalizations.

The three-step LENA System is comprised of the recording device, specially manufactured LENA clothing, and the language environment analysis software (PC compatible). The first step is to record the child's language environment with the small LENA recording device. LENA provides special clothing that allows the recording device to comfortably and discretely fit into the child's clothes and assures that the clothing does not negatively impact the audio recording. After recording 10 to 16 hours, the recommended time to collect the most reliable data, the contents of the recorder are uploaded and processed through the language environment analysis software. The final step is the analysis of the language environment, which allows the user to see the data in visual graphs. This analysis provides the early intervention provider with information that can assist the family in developing a communication plan that takes into account all of the diverse communication environments experienced by the child and family.

According to Morrison, Lopez and Rodriguez (2009), LENA helps parents reflect on what they are doing, shows parents how they are talking to their children in real, everyday

settings and allows parents to discover for themselves goals and strategies. Gilkerson, Montgomery, Richards, and Xu (2009) found that children who are exposed to more words at infancy had better language skills later in life; replicating the Hart & Risley (1995) results that demonstrated how exposure to adult language positively impacts a child's language development.

Child Learning Center (CLC)

Six participants were recruited through a public university child learning center (CLC). The CLC provides developmentally appropriate learning opportunities for typically developing children and children with identified needs under the direction of the clinical supervisor with the certificate of clinical Competence in Speech-Language Pathology (CCC-SLP). The program's staff consists of the following individuals: a Program Director, a Teacher of Preschool and Toddler Groups, a Certified Speech Language Pathologist Supervisor with CCC-SLP, a Family Resource Coordinator, an Occupational Therapy Consultant and number of graduate student clinicians. Four graduate student clinicians supervised by clinical faculty with their CCC-SLP, are responsible for providing services, communicating with parents and obtaining data on two children in each group.

The CLC operates on a 14-week fall and spring semester calendar. The participants in this study attended the Toddler Group on Tuesday and Thursday from 9am-11am for a total of 14 weeks. The sessions maintained a routine daily schedule that consisted of: free play, music time, story time with snack, and free play either inside or outside depending on weather.

The CLC is dedicated to providing an optimal learning environment to all children by operating under the basis of two research-based philosophes, the Storybook Journey: Pathways

to Literacy through Story and Play, (McCord, 1995 & 2011) and the Interactive Learning Strategies (INREAL, Weiss, 1981).

Strategies in the CLC: Storybook Journey

The Storybook Journey aims at teaching literacy through the "selection and discussion of a story from children's literature (its main ideas, concepts, significant aspects, appeal, and special meaning to individual children) and a brainstorming of ideas that will link facets of the story to the lives of the children. Teachers link the experiences in the classroom around the story concepts, careful observation of the children, and the gathering of necessary props and materials for the facilitation of the journey" (McCord, 1995). The journey's success depends on the application of the stories' main ideas and concepts in the child's daily learning through play. *Figure 1*, below, provides a comprehensive visual of the process.

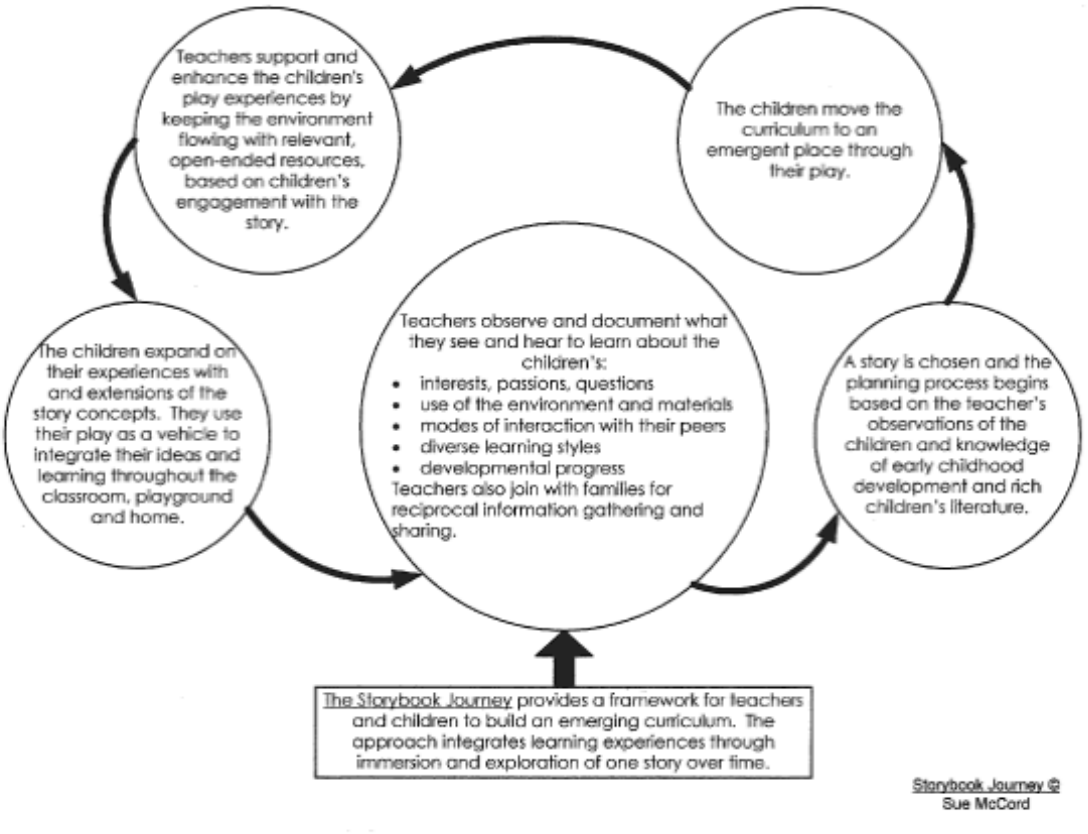

Figure 1. The Storybook Journey

The CLC teacher and team implemented the Storybook Journey Curriculum by carefully observing the interests and needs within the group of children and then created 3-4 units paired with appropriate books per semester. With each unit, the CLC room was equipped with appropriate toys, props and activities to support the books main themes and concepts of the book through child-initiated play. The Storybook Journey Curriculum provided the framework of the language environment of the CLC.

Strategies in the CLC: Interactive Learning Strategies (INREAL)

The INREAL strategies, created by Rita Weiss (1981), support language and learning in an interactive manner, in which conversation is based on a balance of turns between the child and the adult. Conversation may include nonverbal or verbal interactions, or a combination of both types of interactions. The adult joins in the play of the child by positioning himself or herself in a way that supports joint attention and seeks to follow the child's lead. The interventionist's goal is to match the child's level of communication and gradually scaffold the child to a higher level of communication in a natural group setting. In order to support this level of communication, the interventionists are encouraged to utilize SOUL (Silence, Observation, Understanding and Listening). This simple acronym reminds the adult to be a silent observer of the child to fully understand the meaning of the child's interaction with the world around them (Weiss, 1981). When utilizing SOUL, adults are better able to follow the lead of the child and engage in more meaningful communication exchanges and interactions with the child. During interactions, INREAL helps guide the adult's role in communication with the following six psycholinguistic techniques described in *Table 1*.

Mirroring	The specialist imitates the child non-verbally.
Self Talk	The specialist talks out his or her own participation during parallel play with the child. Example: "I want a turn."
Parallel Talk	The specialist talks out the child's participation during parallel play. Example: "You want to play with the boat."
Verbal monitoring and reflecting	(a) The specialist listens to the child and repeats non-punitively exactly what the child has said. Example: Young child says, "ba ba ba." Clinician repeats back: "ba ba ba." (b) The specialist listens to the child and non-punitively says back correctly what the child has said in error. Example: Child says, "The monkeys is eating." Clinician repeats back, "Yep, the monkeys are eating."

Expansion	The specialist listens to the child and responds by elaborating on what the child has said. Example: Child says, "One cake". The clinician repeats back, "One chocolate cake with vanilla icing."
Modeling	The specialist listens to the child and communicates conversationally without necessarily using the child's words. Example: When playing in a sensory table with the child, the clinician says, "Wow this water is really cold."

Table 1: INREAL Psycholinguistic Techniques

Current Study

The research questions that guide this study are:

1. What are the developmental profiles of the three children with identified needs and the three children who are typically developing?
2. What are the frequencies of the adult word count per hour in the preschool and in the home for the three children with identified needs and the three children with typical development?
3. What are the frequencies of child vocalizations per hour in the preschool and in the home for three children with identified needs and three children with typical development?
4. What are the frequencies of conversational turn counts per hour in the preschool and in the home for three children with identified needs and three children with typical development?
5. What is the Automatic Vocalization Analysis for each of the six children?

The hypothesis of this study is that the measurements from the LENA for adult word count, conversational turn-taking and child vocalization will be greater in the CLC than in the home environment because of the use of the Storybook Journey Curriculum and INREAL strategies.

Methods

Participants

The participants included 6 children recruited locally through the Child Learning Center (CLC) at the Speech Language and Hearing Center (SLHC) in a public university between the ages of 24 and 39 months. The study focused on three children with identified needs compared to three children who are typically developing. The CLC program enrolls children who have needs identified in any area of communication and may have additional needs in other areas of development as well. Identification of communication needs was completed by formal assessment prior to enrollment or by the clinical judgment of a certified speech-language pathologist upon enrollment. Identified Needs Participant A (IN-A) is diagnosed with Autism Spectrum Disorder and functions at a high level of expressive and receptive language. The family identified that the primary goal was to improve pragmatic language skills. Identified Needs Participant B (IN-B) was not formally diagnosed with a language disorder at the time of the study; however a diagnosis of Autism Spectrum Disorder was suspected by both the family and service providers. The participant's developmental delays are described below. Identified Needs Patient C (IN-C) is medically diagnosed with Down syndrome and uses sign language in addition to spoken language to communicate. Additional details of the participants are given in Table 2.

Participant Demographics		
	Identified Needs (n=3)	Typically Developing (n=3)
Age of Recording (Months)		
Mean	35	30
Range	30-39	24-33
Gender		
Male	2	0

Female	1	3
Maternal Education (Percentage)		
High School	0%	0%
Some College	0%	0%
College Degree or higher	100%	100%
Race		
Caucasian	1	2
Multiracial	1	1
No response	1	0

Table 2: Demographics

Measures

The study measured the participant's speech and language abilities through a number of developmental questionnaires and three recordings using the LENA system. Parents of children who were between 16 months and 37 months of age completed the *MacArthur Communicative Development Inventory*, a parent survey that asked questions about the child's communication development and the types of words that the child says/understands. There are 3 versions of this questionnaire; parents of children 8 months – 16 months of age completed the *Words and Gestures* version, parents of children 17 months – 30 months of age completed the *Words and Sentences* version and parents of children 31 months – 48 months of age completed the *MacArthur Communicative Development Inventory III*. In the case that the child's communication development was not commensurate with the age ranges identified by the three versions of the questionnaire, the version closest to the child's development was provided to the family.

Parents of children 16 months and older completed the *Child Development Inventory* (CDI). The CDI is a child development survey that asks questions about the child's gross/fine motor development, social development and language skills; it takes about 45 minutes to complete. The CDI is a measure that the Child Learning Center already uses twice per year.

Finally, all parents completed the *LENA Developmental Snapshot*. The *LENA Developmental Snapshot* is a parent questionnaire for children 2 months – 48 months that asks questions about the child's expressive and receptive language.

Participants also completed three 16-hour recordings within approximately 2 months using the LENA system. The variables recorded by the LENA system are defined in the Table 3, below (lenafoundation.org).

Adult Word Count	Total number of adult words spoken to and in the vicinity of the child during the course of the recording day.
Conversational Turns	A Conversational Turn occurs when a child vocalizes (initiates) and an adult responds, or an adult speaks (initiates) and a child responds. Each time that happens, one turn is counted. CT's are the only way to measure engaged interaction with a child, in order to enhance speech and language. Studies show an increase of Conversational Turns can lead to an increase in a child's later language and academic success. **Example:** Child Initiates: "ba de do ba" and Adult Responds: "That's right, that's your bottle." = One conversational turn **Example:** Adult Initiates: "Are you playing with your bear?" and Child Responds: "My bear." = One conversational turn.
Child Vocalizations	A child vocalization is continuous speech spoken by the Key Child that is either surrounded by a break or pause by the child greater than 300 milliseconds or is interrupted by a change in speakers or interfering noise. Cries, vegetative sounds, and other fixed signals are not counted as child vocalizations. Some examples of child vocalizations are: a. Canonical syllables: Baba, dada b. Protophones: squeals, growls, raspberries etc. c. Language dependent words and utterances
Percentage of Silence	Percentage of the day that sound is below 32-dB sound pressure level.
Percentage of Noise	Percentage of the day that is spent in noise both near and far.
Percentage of Television or Radio	Percentage of day that is spent listening to electronic sound both near and far.

Percentage of Distant Language	Percentage of the day that is spent in noise that consists of Male Adult Far, Female Adult Far, Key Child Far, Other Child Far, Overlapping language near and far.
Percentage of Meaningful Language	Percentage of the day that is spent in speech produced by Male Adult (Near), Female Adult (Near), Key Child (Near) and Other Child (Near).
AVA Score	AVA measures a child's expressive vocal production in Spoken English compared to an adult production of individual phones and combined phones. AVA also provides a standard score and percentile rank.

Table 3: LENA Variables

In addition to quantitative measures, qualitative measures were extracted from recordings by conducting partial coding to better describe the language environment of the participants. The coding was conducted by analyzing four five-minute language samples from the participants during the time at home and in school where the adult word count, conversational turns and child vocalizations were the greatest. The data was analyzed by describing the overall language environment including the activity in which the child was participating, the type of questions asked by parent and the type of INREAL strategies used.

Procedure

The parents were recruited via email to initiate the interaction. Consenting parents were provided with a packet of information regarding the study as well as the LENA Digital Language Processor device, specialized LENA clothing, a recording how-to booklet, recording reminders, the LENA Developmental Snapshot and the age/communication appropriate developmental questionnaires. The primary investigator explained how to do a recording using the LENA system and discussed the requirements of recording on a day that their child attends the CLC, so a better picture of the school environment versus the home environment can be obtained.

When the child woke up on the scheduled recording day, the parents turned on the recording device and slipped it into the specialized LENA clothing and allowed it to be powered on for 10-16 hours. The parents were instructed to take off the recording device and set it near the child if the child was sleeping or when the child was in the car seat. If for some reason the parents felt uncomfortable with that specific daily recording they had the right to request that the recording be deleted and a recording was made on another day. The parents then brought the recording to the CLC and received another packet containing a LENA Digital Language Processor device, specialized LENA clothing, recording how-to booklet and recording reminders. This process was repeated until all three recordings were obtained. The parents were also asked to submit all developmental questionnaires by the final recording date.

After the completion of their participation the parents were provided with the opportunity to review their child's LENA results with the primary investigator and, if requested, a certified speech-language pathologist. During this meeting, parents were provided with a copy of the LENA graphs and had the opportunity to discuss the results.

Results

Question 1: What are the developmental profiles of the three children with identified needs and the three children who are typically developing?

Developmental Questionnaires

The developmental questionnaires data provide an overall picture of each participant's global language skill and general development per parental survey. It is important to note that all developmental questionnaires by each family were not submitted due to extraneous circumstances. For more information please refer to the *discussion* section.

LENA Developmental Snapshot. The *LENA Developmental Snapshot* is a parent questionnaire for children 2 months – 48 months that contains questions about the child's expressive and receptive language (lenafoundation.org).

Table 4 below displays the expressive and receptive language skills of both identified needs and typically developing participants. Identified Needs Participant B's (IN-B) responses to the developmental questionnaire are unavailable. According to the data, all typically developing participants fell within normal limits or in the advanced range, Identified Needs Participant A (IN-A) had language skills in the advanced range, and Identified Needs Participant C (IN-C) was at risk for delayed communication development. IN-C's standard scores are unavailable due to his/her large delay.

LENA Developmental Snapshot				
	Difference in Chronological Age vs Developmental age (in months)	Standard Score	%	
IN A	+4	108.5	71	Advanced
IN B	***	***	***	***
IN C	-26	***	***	At Risk
TD A	+5	110.5	75	Advanced
TD B	+2	112	78	Borderline WNL/Advanced
TD C	+2	109.7	73	WNL*
				******- unavailable***
				****WNL- Within Normal Limits***

Table 4. LENA Developmental Snapshot

Child Development Inventory. The CDI is a child development survey that asks the parent to answer questions about the child's gross/fine motor development, social development and language skills.

In order to understand the child's global needs, the quotient was calculated for each category using the participants chronological age. The CDI results indicate that all participants

are delayed in the following categories: social, self-help, gross motor and fine motor. IN-B and IN-C were delayed in expressive language, skills, language comprehension, numbers and overall general development. IN-B's score was borderline for letters. IN-A was within normal range for expressive language skills, language comprehension, letters, numbers and overall general development. Table 5 shows the Child Development Inventory quotients for the three children with identified needs: IN-A, IN-B, and IN-C.

Identified Needs Participants.

Child Development Inventory Quotients: Identified Needs						
	IN-A		IN-B		IN-C	
CDI Scales	Quotient	Descriptor	Quotient	Descriptor	Quotient	Descriptor
Social	60.7	Delayed	58.6	Delayed	69.6	Delayed
Self Help	64.2	Delayed	68.9	Delayed	43.9	Delayed
Gross Motor	64.2	Delayed	51.7	Delayed	54.5	Delayed
Fine Motor	67.8	Delayed	65.5	Delayed	63.6	Delayed
Expressive Language	103.5	WNL	55.1	Delayed	56	Delayed
Language Comprehension	114.2	WNL	48.2	Delayed	54.5	Delayed
Letters	139.2	Advanced	82.7	Borderline	75.7	Delayed
Numbers	107.1	WNL	62	Delayed	56	Delayed
General Development	89.2	WNL	58.6	Delayed	57.5	Delayed
Advanced: Quotient 115+ **WNL: Quotient 85-115** **Borderline: 75-84** **Delayed: 75 and below**						

Table 5. Child Development Inventory: Identified Needs Quotient

Typically Developing Peers.

The Typical Developing Peers data is presented in Table 6., According to the CDI data and quotients describing chronological age, all typically developing participants fell within the normal range for all categories with the exception of three delayed categories; TD-A in Gross Motor, TD-B in Fine Motor and TD-C in Numbers.

Child Development Inventory: Typically Developing Peers						
	TD-A (Age score/Chronological age X100)		TD-B		TD-C	
CDI Scales	Quotient	Descriptor	Quotient	Descriptor	Quotient	Descriptor
Social	123.5	Advanced	111.5	WNL	93.9	WNL
Self Help	100	WNL	111.5	WNL	103	WNL
Gross Motor	58.8	Delayed	115.3	Advanced	90.9	WNL
Fine Motor	105.8	WNL	73	Delayed	103	WNL
Expressive Language	117.6	Advanced	111.5	WNL	118.1	Advanced
Language Comprehension	129.4	Advanced	119.2	WNL	93.9	WNL
Letters	141.1	Advanced	92.3	WNL	112.1	WNL
Numbers	105.8	WNL	115.3	Advanced	75.7	Borderline
General Development	116.6	Advanced	107.6	WNL	96.9	WNL
Advanced: 115+ **WNL: 85-115** **Borderline: 75-84** **Delayed: 75 and below**						

Table 6. Child Development Inventory: Typically Developing Quotient

MacArthur Bates Communicative Development Inventories. The MacArthur Communicative Development Inventory is a parent survey that asks questions about the child's communication development and the types of words that the child says/understands. There are 3

versions of this questionnaire; parents of children 8 months – 16 months of age completed the *Words and Gestures* version, parents of children 17 months – 30 months of age completed the *Words and Sentences* version and parents of children 31 months – 48 months of age completed the *MacArthur Communicative Development Inventory III*.

Identified Needs Participant A. The MacArthur Bates Communicative Development Inventories were not completed due to extraneous family circumstances. For more information regarding extraneous family circumstances, please refer to *discussion* section below.

Identified Needs Participant B. Although IN-B was older than standardized age of the questionnaire, the participant had communication skills commensurate with the MacArthur Bates: Word and Gestures survey. The participant was compared to 18-month norms by gender.

The MacArthur Bates Communicative Development Inventories: The Words and Gestures survey divides questions into what the child can understand and what the child is beginning to do or say in order to communicate. IN-B scores were within normal limits compared to 18-month norms; however, the quotient is provided to highlight IN-B's chronological age compared to developmental age in terms of age equivalency determined by the 50th percentile acquisition rate of the score. IN-B was delayed in overall phrases understood and his/her score fell at the 10th percentile compared to 18-month old peers. IN-B scores were also delayed in expressive skills, such as, imitating, labeling, words produced and gestures. It is significant that, although IN-B is 39 months old, his early gestures and later gestures are below the 5th percentile for children younger than 18-months old. These results are shown in Table 7.

IN-B MacArthur Bates: Words and Gestures				
PART 1: Early Words				
First Signs of Understanding	Question	Yes/No	Percentage of affirmative answers at this child's age	
	Responds when name is called?	Yes	100	
	Responds to "no no"	Yes	100	
	Responds to "there's mommy/daddy?"	Yes	100	
			Percentile (compared to 18-month norms)	Quotient (based on chronological age)
	Phrases understood	18 (of 28)	10	44.8
Starting to talk		Yes/No	Percentage of affirmative answers at this child's age	
	Imitation	No	94.6	
	Labeling	No	78.4	
Vocabulary Checklist			Percentile (compared to 18-month norms)	Quotient
	Words Understood	124 (of 396)	<5	46.5
	Words Produced	5 (out of 396)	5	37.9
PART II: Actions and Gestures				
			Percentile (compared to 18-month norms)	Quotient
	Early Gestures	11 (of 18)	<5	37.9
	Later Gestures	23 (of 45)	10	50

	Total Gestures	34 (of 63)	<5	46.5

Table 7. MacArthur Bates: Words and Gestures: IN-B

Identified Needs Participant C. Although IN-C was older than standardized age of the questionnaire, the participant had communication skills commensurate with the MacArthur Bates: Word and Gestures survey. The participant was compared to 18-month norms by gender.

According to parent report, IN-C's scores fell within average range for all "First Signs of Understanding" and words produced for children younger than 18 months of age; however, the quotient is provided to highlight IN-C's chronological age compared to developmental age in terms of age equivalency determined by the 50th percentile acquisition rate of the score. Table 8 shows IN-C's results for each of the subscales on Words and Gestures.

IN-C MacArthur Bates: Words and Gestures				
PART 1: Early Words				
First Signs of Understanding	Question	Yes/No	Percentage of affirmative answers at this child's age	
	Responds when name is called?	Yes	100	
	Responds to "no no"	Yes	100	
	Responds to "there's mommy/daddy?"	Yes	100	
			Percentile (compared to 18-month norms)	Quotient (based on chronological age)
	Phrases understood	24 (of 28)	45	51.5
Starting to talk		Yes/No	Percentage of affirmative	

			answers at this child's age	
	Imitation	No	94.6	
	Labeling	No	78.4	
Vocabulary Checklist			Percentile (compared to 18-month norms)	Quotient
	Words Understood	189 (of 396)	25	44
	Words Produced	81 (out of 396)	50	54.5
PART II: Actions and Gestures				
			Percentile (compared to 18-month norms)	Quotient
	Early Gestures	14 (of 18)	5	48.5
	Later Gestures	27 (of 45)	15	48.5
	Total Gestures	41 (of 63)	20	48.5

Table 8. MacArthur Bates: Words and Gestures: IN-C

Typically Developing Participant A.

All data from the MacArthur Bates: Words and sentences for TD-A fell within the normal range when compared to same age and gender norms. Table 9 shows TD-A's scores on Words and Sentences.

TD-A MacArthur Bates: Words and Sentences			
PART 1: Words Children Use			
Vocabulary Checklist			Percentile
	Words produced	403 (of 680)	55
How Children Use Words		Yes/No	Percent of Affirmative answers at this child's age
	Past:	Yes	84

	Future:	Yes	81
	Absent Object (production):	Yes	93
	Absent Object (comprehension):	Yes	100
	Absent Owner:	Yes	96
PART II: Sentences and Grammar			
Word Endings/ Part 1		Yes/No	Percent of Affirmative answers at this child's
	Plural (-s):	***	
	Possessive (-'s):	***	
	Progressive (-ing):	***	
	Past tense (-ed):	***	
Word forms			Percentile
		4 (of 25)	50
Word Endings		1 (of 45)	
Combining		Yes/No	Percent of Affirmative answers at this child's
Mean Length Utterance		4.3	
			Percentile
Complexity		10 (of 37)	65
			*** Not available

Table 9. MacArthur Bates: Words and Sentences: TD-A

Typically Developing Participant B.

The data from the MacArthur Bates: CDI III for TD-B fell below normal limits for the *Using Language subtest* when compared to same age and gender norms. Table 10 shows TD-B's scores on the MacArthur-Bates Communicative Development Inventory III.

TD-B MacArthur Bates: CDI III		
		Percentile
Vocabulary Checklist	57 (of 100)	15
Sentences	9 (out of 12)	25
Using Language	7 (out of 12)	10
MLU: Average of 3 longest utterances, as reported by parents	8.6	

Table 10. MacArthur Bates: CDI III: TD-B

Typically Developing Participant C.

All data from the MacArthur Bates CDI III for TD-C fell within the normal range when compared to same age and gender norms. Table 11 shows TD-C's scores on the MacArthur-Bates CDI III.

TD-C MacArthur Bates: CDI III		
		Percentile
Vocabulary Checklist	89 (out of 100)	70
Sentences	9 (out of 12)	25
Using Language	12 (out of 12)	99
MLU: Average of 3 longest utterances, as reported by parents	6	

Table 11. MacArthur Bates: CDI III: TD-C

Developmental Questionnaire Summary

The developmental questionnaires provided information regarding overall expressive and receptive language skills for each participant. The data showed that Typically Developing Participant A and C scored within normal limits on all tests. Typically Developing Participant B's scores fell within normal limits for all tests except the *Using Language* subtest of the MacArthur Bates CDI III.

The identified needs group demonstrated a wide variety of both expressive and receptive language skills. IN-A data displayed splinter skills in expressive language and receptive language categories in the CDI but was significantly below the normal range on the Social, Self-Help, Gross Motor and Fine Motor subscales. The LENA Snapshot was within normal range limits. IN-B and IN-C scores showed delays in overall communication skills in the majority of the developmental questionnaires.

LENA Results

The graphs below display LENA variables, including, adult word count, child vocalizations and conversational turns. Each variable is divided into four case studies, Identified Needs Participant A, Identified Needs Participant B, Identified Needs Participant C, and the Typically Developing control group. It should be noted that only one recording was obtained from Identified Needs Participant B, due to extraneous family circumstances. For more information regarding extraneous family circumstances, please refer to *discussion* section below.

The identified needs case studies display the average of the LENA variables per hour across three recording days. Each graph for the participants with identified needs displays data from three recording days, with the exception of Identified Needs Participant B. The typically developing control group data displays the average of the LENA variables per hour averaged across the three recording days. Therefore, each participant in the typically developing control group displays only the average per hour of LENA variables totals across three recording days.

Question 2: What are the frequencies of the adult word count per hour in the preschool and in the home for the three children with identified needs and the three children with typical development?

Adult Word Count.

Adult word count is measured by the total number of adult words spoken to and in the vicinity of the child during the course of the recording day (lenafoundation.org). The number of adult words spoken during the CLC environment was calculated by averaging the total adult words spoken per hour across the two hours that the participants were present in Toddler Group. To find the number of adult words spoken per hour during the home environment all hours, with a few exceptions, were averaged across their day. These exceptions included when the child was asleep, as documented by parent recording survey, or if there were fewer than 50 adult words spoken during that hour.

Identified Needs: Participant A.

Figure 2 shows that Identified Needs Participant A's (IN-A) language environment included a range of 1924-2438 adult words spoken per hour in the home setting. In the school setting, a range of 1174-2642 adult words were spoken per hour. Across the three recording days, IN-A had a slightly higher average of adult words spoken per hour in the home environment, 2116 adult words, compared to the school environment, 2082 adult words. In a projected 12-hour day, IN-A's environment included 19795 adult words per day, which was at the 95th percentile compared to LENA norms.

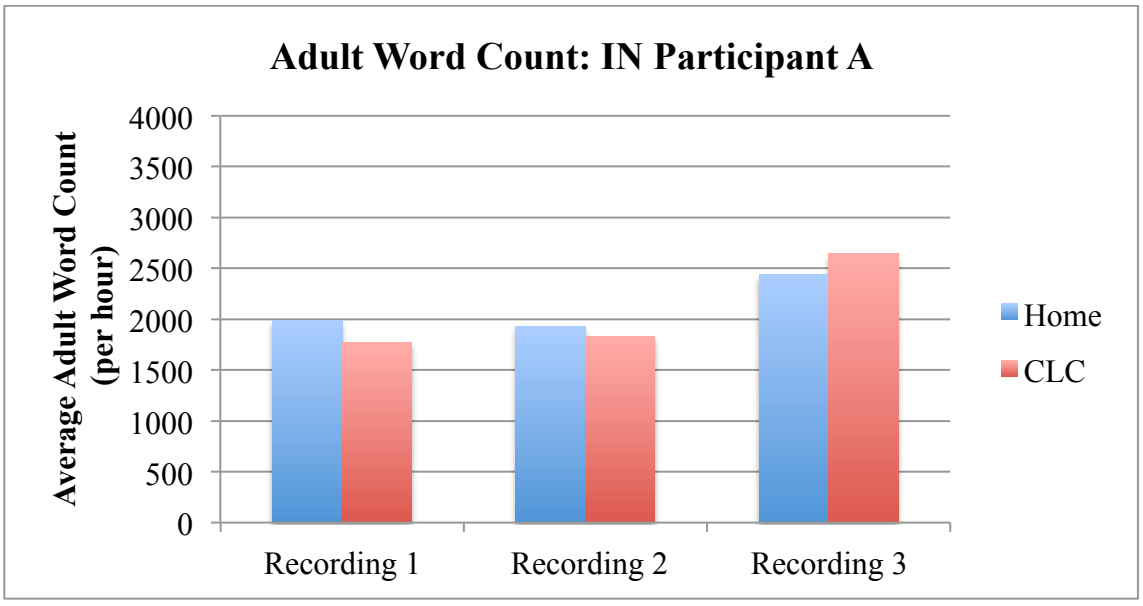

Figure 2. Adult Word Count: IN Participant

Identified Needs: Participant B.

Figure 3 shows that the home language environment of Identified Needs Participant B (IN-B) contained an average of 892 adult words spoken per hour. In the school setting, an average of 2312 adult words were spoken per hour. There were almost three times as many words spoken per hour in the school setting for this child than in the home. In a projected 12-hour day, IN-B's environment included 13547 adult words per day, which was at the 64th percentile compared to LENA norms.

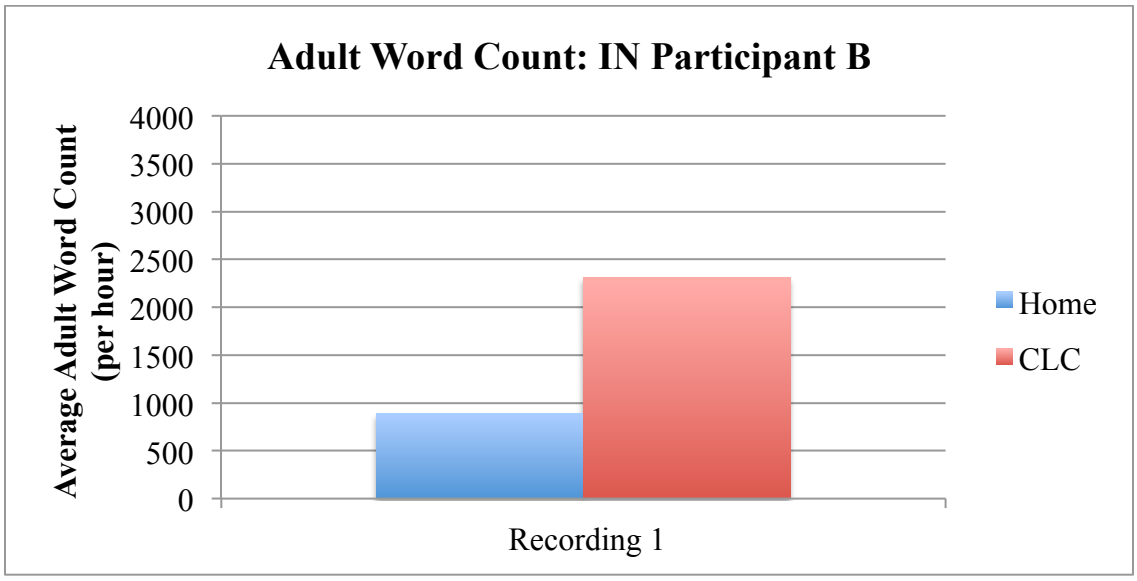

Figure 3. Adult Word Count: IN Participant B

Identified Needs: Participant C.

As shown in figure 4, Identified Needs Participant C's (IN-C) language environment included a range of 1524-2089 adult words spoken per hour in the home setting. In the school setting, a range of 1987-3009 adult words were spoken per hour. Across the three recording days, IN-B had a higher average of adult words spoken per hour in the school setting, 2612 adult words, compared to the 1897 adult words per hour in the home setting. In a projected 12-hour day, IN-C's environment included 24837 adult words per day, which was at the 99th percentile compared to LENA norms.

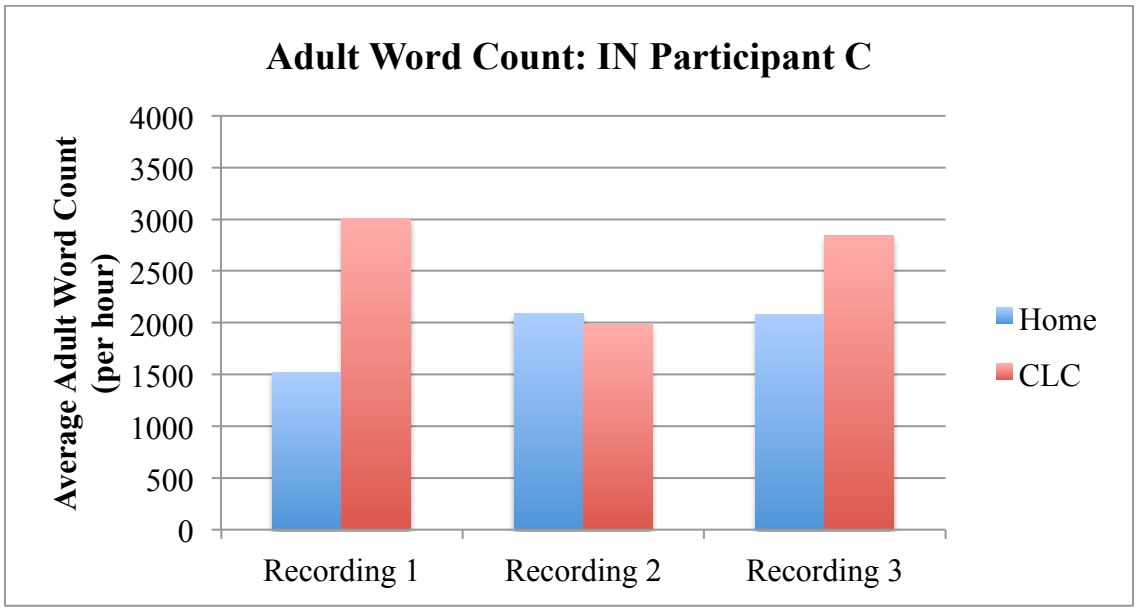

Figure 4. Adult Word Count: IN Participant C

Typically Developing Peers.

For the typically developing control group, the home environments contained a range of 1390-2135 adult words spoken per hour compared to 3255-3850 adult words spoken per hour in their school setting as shown by Figure 5. The typically developing control group, overall, had a larger number of adult words spoken per hour in their school environment, 3593 adult words, compared to their home environment, 1702 adult words. In a projected 12-hour day, the typically developing peers environment included an average of 23431 adult words per day, which was at the 98th percentile compared to LENA norms. Figure 5 shows the average across three recording sessions of the estimated adult words spoken per hour for each typically developing child.

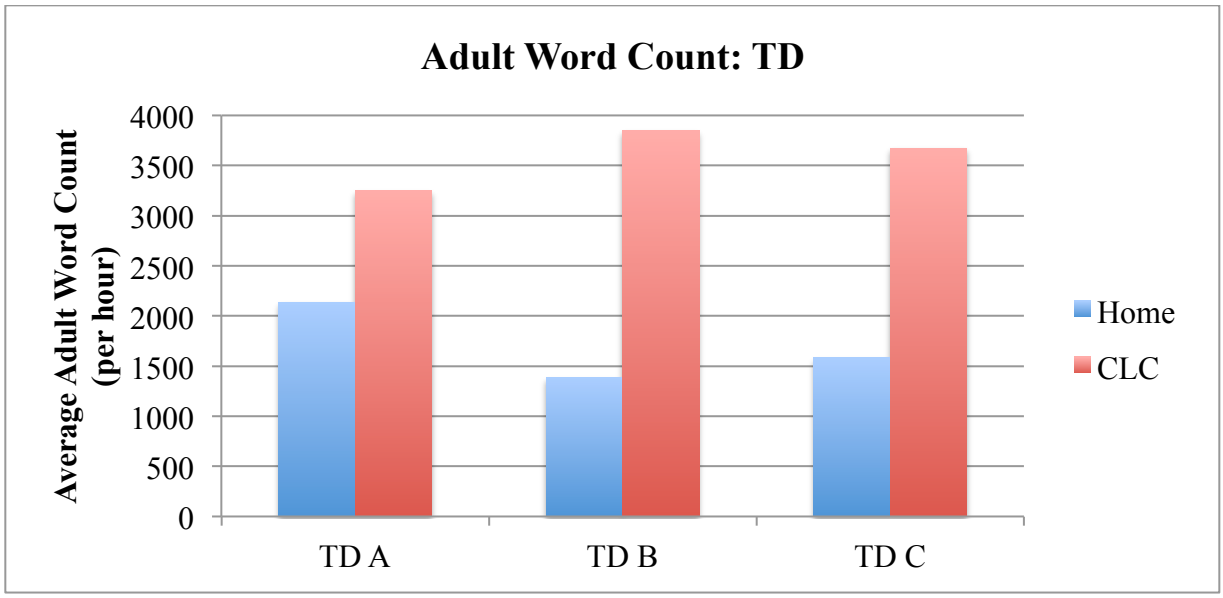

Figure 5. Adult Word Count: Typically Developing Control Group

Question 3: What are the frequencies of child vocalizations per hour in the preschool and in the home for three children with identified needs and three children with typical development?

Child Vocalizations.

A child vocalization is continuous speech spoken by the key child that is either surrounded by a break or pause by the child greater than 300 milliseconds or is interrupted by a

change in speakers or interfering noise. Cries, vegetative sounds, and other fixed signals are not counted as child vocalizations. (lenafoundation.org).

Identified Needs: Participant A.

Figure 6 shows that IN-A had a range of 370-508 vocalizations per hour in the home environment compared to 474-481 vocalizations per hour in the school setting. Overall, IN-A vocalized more in the school environment with an average of 477 vocalizations per hour compared to 431 vocalizations per hour in the home environment. In a projected 12-hour day, IN-A vocalized 4142 times per day, which was at the 95th percentile compared to LENA norms.

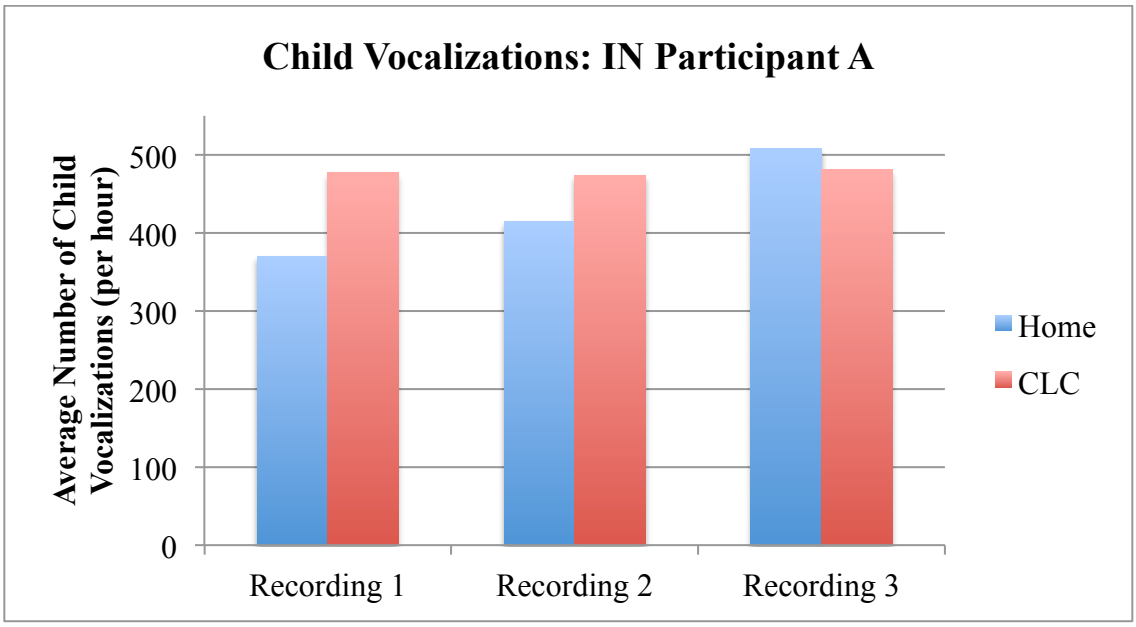

Figure 6. Child Vocalizations: IN Participant A

Identified Needs: Participant B.

Figure 7 shows that Identified Needs participant B had remarkably similar amounts of vocalizations per hour in the home environment compared to the school environment. At home IN-B vocalized 94 times per hour compared to 95 times per hour in the school environment. In a projected 12-hour day IN-B vocalized 1253 times per day, which was at the 14th percentile compared to LENA norms. IN-B's vocalizations are low in quantity and in the borderline range.

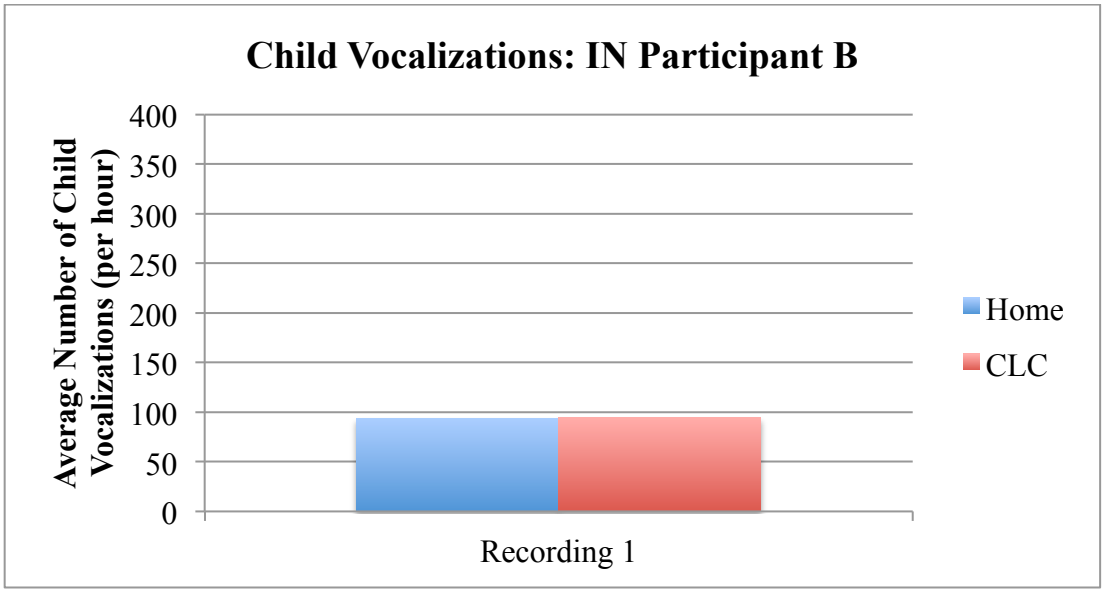

Figure 7. Child Vocalizations: IN Participant B

Identified Needs: Participants C.

Across the three recording days, IN-C had a range of 140-209 vocalizations per hour in the home setting compared to 77-212 vocalizations per hour in the school setting as shown by Figure 8. Overall, IN-C vocalized more in the home setting with an average of 180 vocalizations per hour compared to the school setting with 122 vocalizations per hour. It is important to note that IN-C also used single signs to communicate intermittently paired with vocalizations during the time of the recordings and that the LENA voice recordings can only provide a full picture of the expressive spoken language skills of IN-C. In a projected 12-hour day, IN-C vocalized 2129 times per day, which was at the 43rd percentile compared to LENA norms.

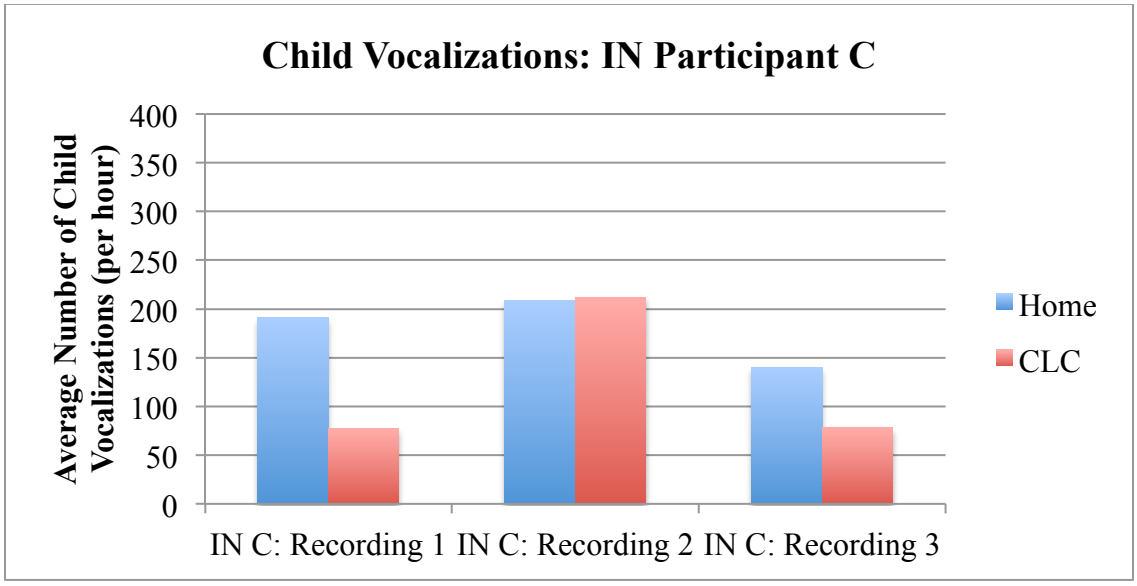

Figure 8. Child Vocalizations: IN Participant C

Typically Developing Peers.

In terms of child vocalizations, the typically developing control group ranged from 236-369 vocalizations per hour in the home setting compared to 135-238 vocalizations per hour in the school setting as shown by Figure 9. Overall, the typically developing control group on average vocalized more in the home environment compared to the school environment with nearly 106 more vocalizations per hour. In a projected 12-hour day, the typically developing peers vocalized an average of 3203 times per day, which was at the 80th percentile compared to LENA norms.

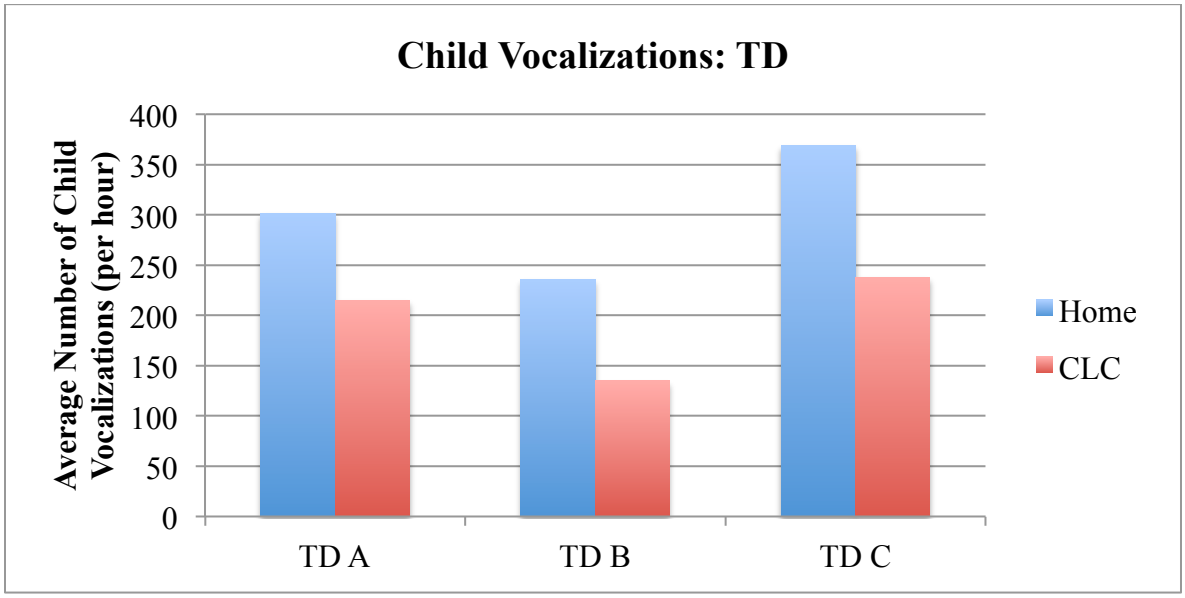

Figure 9. Child Vocalizations: Typically Developing Control Group

Question 4: What are the frequencies of conversational turn counts per hour in the preschool and in the home for three children with identified needs and three children with typical development?

Conversational Turns.

Conversational Turn is a vocal sound such as a coo, squeal, babble, or word initiated by a child with a subsequent response by an adult within five seconds, or vice versa. Overlapping

speech segments, coughs, cries, and other vegetative and fixed signals do not contribute to the Conversational Turns count (lenafoundation.org).

Identified Needs: Participant A.

Figure 10 shows that Identified Needs Participant A's language environment included a range of 108-130 conversational turns per hour in the home setting. In the school setting, a range of 115-149 conversational turns per hour. Across the three recording days, IN-A had higher average of conversational turns per hour in the school setting with 132 conversational turns, compared to the home setting with 119 conversational turns. In a projected 12-hour day, IN-A participated in 1137 conversational turns per day, which was at the 97th percentile compared to LENA norms.

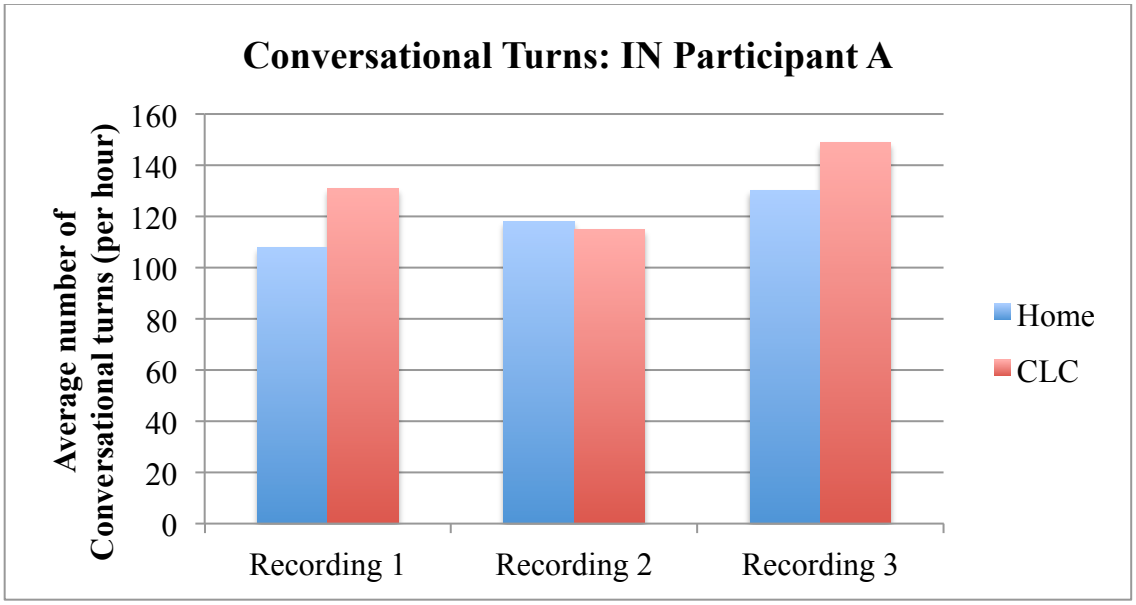

Figure 10. Conversational Turns: IN Participant A

Identified Needs: Participant B.

On average, IN-B participated in more conversational turns per hour in the school setting with 49 conversational turns in school compared to 24 conversational turns at home as shown by Figure 11. In a projected 12-hour day, IN-B participated in 331 conversational turns per day, which was at the 24th percentile compared to LENA norms.

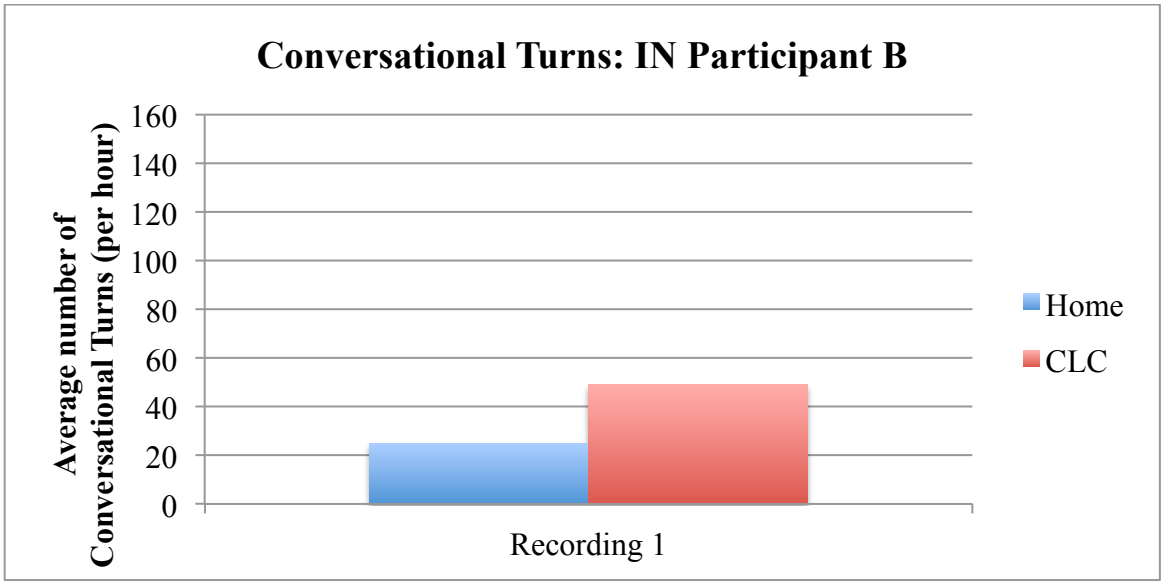

Figure 11. Conversational Turns: IN Participant B

Identified Needs: Participants C.

Across the three recording days, IN-C had a range of 34-55 conversational turns per hour in the home setting compared to 43-54 conversational turns per hour in the school setting as shown by Figure 12. Overall, IN-C participated in slightly more conversational turns in the school setting with an average of 48 conversational turns per hour compared to the home setting with 44 conversational turns per hour. In a projected 12-hour day, IN-C participated in 547 conversational turns per day, which was at the 58th percentile compared to LENA norms.

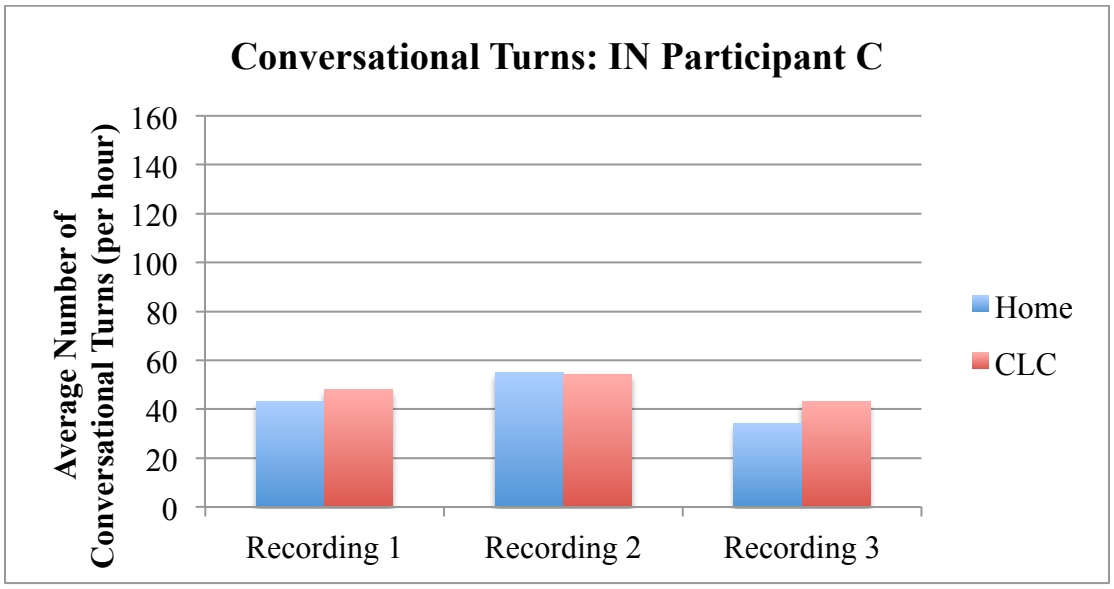

Figure 12. Conversational Turns: IN Participant C

Typically Developing Peers.

For the typically developing control group, their home environments contained a range of 54-131 conversational turns per hour compared to 71-107 conversational turns per hour in their school setting as shown by Figure 13. On average, the typically developing control group had the same amounts of conversational turns per hour in their home environment compared to their school environment with 94 turns per hour. In a projected 12-hour day, the typically developing peers participated in an average of 1035 conversational turns per day, which was at the 86th percentile compared to LENA norms.

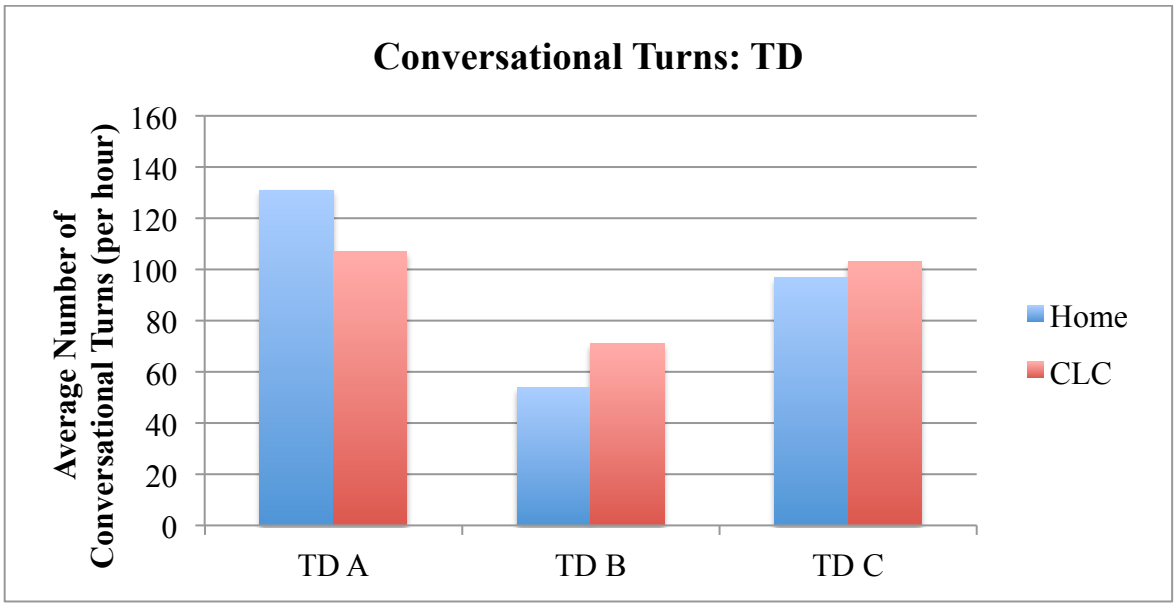

Figure 13. Conversational Turns: Typically Developing Control Group

Question 5: What is the Automatic Vocalization Analysis for each of the six children?

AVA Scores.

The AVA score estimates a child's speech development reported as a standard score and percentile rank (lenafoundation.org). The AVA score is calculated by mapping the child vocalizations produced onto consonants, consonant/vowels and vowel/consonants produced by

adults. The AVA scores provide important information regarding the speech development of the participants. IN-A's LENA data estimated the participant's speech development to be above average, while IN-B's and IN-C's fell below average limits. For the typically developing peers, their speech development fell within the average range.

AVA Scores			
	Average Standard Score	Percentile	
IN-A	114.96	83	Above Average
IN-B	83.75	13	Below Average
IN-C	84.52	15	Below Average
TD-A	109.76	74	Average
TD-B	102.74	56	Average
TD-C	103.02	57	Average
			Below Average: 9th-24th percentile Average: 25th-75th percentile Above Average: 76th-90th percentile

Table 12. AVA Scores

Discussion

The main objective of this study was to describe three children with identified needs and three children with typical development who participated in the CLC toddler group that included INREAL strategies and the Storybook Journey approach to curriculum. The LENA measures provided information from both the home and school environments regarding the amount of adult words that the children were exposed to, the amount of conversational turns and the amount of child vocalizations.

Identified Needs Participant-A

Although IN-A heard more adult words in home (home: 2116/hour, school: 2082/hour), the participant vocalized more (school: 477/hour, home: 431/hour) and had more conversational

turns (school: 132/hour, home: 119/hour) in the school setting, indicating that the strategies used in the school setting facilitated a greater amount of conversation. INREAL strategies guide adults interacting with children to match the child's number of conversational turns and their language level as well as providing a slightly more complex language model in order to support a better balance of conversational turns. This provides more opportunities for a child to vocalize in longer utterances and provide more language to their conversation partner. When analyzing the data qualitatively, matching the child's number of conversational turns and his/her language level as well as providing a slightly more complex language model were the goals of the language environment in school.

In the home, the large quantity of adult words may be attributed to many hours of professional intervention to support the participant and his/her family with the diagnosis of Autism Spectrum Disorder, as well as being an only child. The family and providers focused on reading books, identifying colors, identifying numbers and discussing abstract concepts such as problem solving. Future analysis of this family should include the implementation and coding of INREAL strategies used in the home. Emphasis on INREAL strategies and charting the use of INREAL strategies in the home could result in an increase in child vocalizations and conversational turns in a future study. Overall, this child's language skills fall in the average to advanced range in multiple categories and the use of INREAL strategies and the Storybook Journey Curriculum will continue to support language development; however, in future studies the language environment should be assessed for pragmatic language skills to determine the impact of INREAL strategies and the Storybook Journey Curriculum on social communication.

Identified Needs Participant-B

IN-B's overall language environment consisted of being exposed to more adult words (school: 2312/hour, home: 892/hour) and participating in more conversational turns (school: 49/hour, home: 24/hour) in school and having similar amounts of child vocalizations, 94/hour in home and 95/hour in school. For this participant the 12-hour projected adult word count was at the 64th percentile; however when listening qualitatively at the LENA recordings in the home environment, it was determined that the child is not interacting as much with language at home as they are in school. IN-B is considered to have suspected Autism Spectrum Disorder and is severely delayed in expressive language skills. During the time of the study, the participant used few instances of true and intentional speech sounds; however the subject participated in vocal play. This accounted for the equal amount of child vocalizations produced in school and at home. After analyzing the LENA recordings qualitatively it was determined that INREAL strategies were utilized in order to interact with this child. In the school setting, the child's vocal play was often imitated or expanded to a true speech utterance to attempt to create a better balance of conversational turns. In the home environment, the amount of imitation and language expansion strategies were less frequent than in the school setting, which resulted in fewer adult words and conversational turns produced per hour than in the school setting.

It is important to note that the family reported that they lived further away from the CLC and that school days typically require multiple hours spent in the car. In order to account for this, all hours were averaged and it was determined that adult word count and conversational turns were low across multiple hours throughout the day when the child was in the car. Future research with this child should include coding the types of strategies used in home and in school in addition to conversational turns and child vocalizations. These variables would provide a

description of the use of strategies and the relationship of these strategies to conversational turn-taking and child vocalizations.

Identified Needs Participant-C

IN-C's language environment consisted of being exposed to more adult words in school (school: 2612/hour, home: 1897/hour), participating in slightly more conversational turns (school: 48/hour, home: 44/hour) at school and vocalizing more (home: 180/hour, school: 122/hour) in the home setting. Although there is a difference of four more conversational turns per hour at school compared to the home environment, this difference is too small to be considered relevant to the study. Qualitative data analysis indicated that the child is supported in his/her overall language in the home and parents are highly responsive to the child's vocalizations and typically follow up with a response. For this child, it is difficult to determine if the use of INREAL strategies and the Storybook Journey Curriculum would benefit the overall language of the home environment without further research.

Typically Developing Peers

The results of the data for the typically developing peers showed three interesting points to be considered. The first is the large difference between the adult word count the typically developing children heard at school compared to their peers with identified needs. Typically developing peers heard nearly one thousand more adult words per hour compared to the largest amount of adult words heard by IN-C. This discrepancy is accounted for by the INREAL strategy of language expansion, where the adult expands onto the child's utterance or language abilities to support and model their communication development. The language expectations and needs of the typically developing participants were higher then those of the identified needs

participants and were, therefore, met with longer utterances from their adult conversational partners.

The second interesting finding is the large amount of child vocalizations being produced in the home compared to the school environment. The typically developing children produced on average 106 more vocalizations per hour in home then in the school environment. After analyzing the LENA recordings qualitatively, it was determined that the typically developing participants were producing a large amount of narration in their home environments. They were overall more adept to utilize self-talk to explore their environment at home than in school. A possible explanation for this may be that it is less pragmatically appropriate to narrate as much in a peer group situation.

The final interesting point of data was that the average number of conversational turns in home and at school equaled 94 turns per hour. Since the conversational turns on average are equal in both environments it is determined that, for this typically developing control group the INREAL strategies and the Storybook Journey Curriculum may not be needed to improve their language development; however this study did not analyze the use of and familiarity of the INREAL strategies in the home, the parents range in communication style and their overall responsive communication strategies. To determine the impact of INREAL strategies and the Storybook Journey Curriculum on child conversational turns or vocalizations in this population, further research is needed. This research should include an analysis of conversational turns and child vocalizations before and after a pilot program is implemented to teach parents how to use INREAL strategies in home.

Limitations

It is important to note that there were several limitations to this study. As discussed throughout this report, some data was unavailable due to extraneous family circumstances. These family circumstances included, transferring services from IDEA Part C to IDEA Part B and feeling overwhelmed with the expectations of meetings and paper work, as well as a natural disaster that affected many families in the Boulder area in the fall of 2013. In addition, the overall population of this study was heterogeneous in terms of socioeconomic status. Each family that participated in the study had a maternal education level of a college degree or higher and 2/6 of those mothers were also Speech-Language Pathologists. This high level of education and training in the importance of a rich language environment may have impacted the results of the study. The final limitation of the study is the small population size of participants with identified needs. These limitations highlight the importance of further research to obtain a larger, more diverse population in order to analyze the statistical differences made when utilizing the INREAL strategies and the Storybook Journey Curriculum in the school environment compared to the home environment.

Conclusion

The findings from this study indicate that LENA can provide an analysis of the amount of adult words, conversational turns and child vocalizations used in the home and in the school setting. The intent of this study was to determine if the use of INREAL strategies and the Storybook Journey Curriculum resulted in greater overall adult word count, conversational turns and child vocalizations in the CLC compared to the home environment; however these variables alone cannot determine the success of INREAL strategies and the Storybook Journey Curriculum. In order to determine the effectiveness of INREAL strategies, such as, imitation,

expansion, mirroring, further research must be completed. Future research should include coding of videos and transcripts, the utilization of LENA's Autism Screener and documenting changes of AVA scores overtime. These additional measures will allow a comprehensive analysis of the impact of the use of INREAL strategies in the language environment of children with identified needs. It is also recommended for future research that a pilot program to teach parents INREAL strategies and the Storybook Journey Curriculum be implemented and carried out to document how the LENA measures change over time to determine the effectiveness of INREAL strategies and the Storybook Journey Curriculum. Although this study was a descriptive and not a causal study of the impact of INREAL strategies and the Storybook Journey Curriculum the findings provided important quantitative data for the environments of six children in their home setting as well as their school setting. This study demonstrated the variety of language environments and abilities of children with identified needs and the importance of utilizing and exploring a variety of measures to describe their language environments. The results of this study have prompted future research questions to comprehensively present the language environment of children with identified needs and the role of INREAL strategies and the Storybook Journey Curriculum in their school environment.

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