

The Effect of Quality and Quantity of Linguistic Input and Maternal Education Level on
Vocabulary Development

by

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TABLE OF CONTENTS

ACKNOWLEDGMENTS	v
ABSTRACT	vi
SPECIFIC AIMS	vii
CHAPTER ONE	
Literature Review	1
CHAPTER TWO	
Methods	7
Participants	7
Procedure	8
Demographic Survey	8
Expressive and Receptive Vocabulary Size	9
Language Sample	9
Data Collection	9
Data Analysis	10
Analysis	15
CHAPTER THREE	
Results	18
CHAPTER FOUR	
Discussion	44
REFERENCES	49
LIST OF TABLES	
Table 2.1. Descriptive information on participants	8

Table 2.2 Coding terms defined	11
Table 2.3 Conversational quality measures	16
Table 3.1 Stepwise multiple regression models for expressive vocabulary	21

LIST OF FIGURES

Figure 2.1. Coding web used for analysis	14
Figure 3.1. ADW plotted against measures of semantic/syntactic quality: NDW and MLU	25
Figure 3.2. ADW plotted against measures of conversational quality: percent of indirect commands, percent of decontextualized utterances, and percent of contingent utterances	26
Figure 3.3. Mean length of utterance plotted against NDW, percent of decontextualized utterances, and percent of indirect commands by maternal education level	27
Figure 3.4. Relationships among various conversational quality measures by maternal education level: NDW plotted against percent of commands; TNW plotted against percent of decontextualized utterances	28
Figure 3.5. Differences in quantity measures by maternal education level	29
Figure 3.6. Differences in syntactic/semantic quality measures by maternal education level: MLU, NDW	30
Figure 3.7. Differences in conversational quality measures by maternal education level: percent of commands, percent of indirect commands	31
Figure 3.8. Differences in conversational quality measures by maternal education level: percent of negative feedback, percent of prohibitions	32
Figure 3.9. Distribution of EVT-2 scores by maternal education level at time point 1 and time point 2	33
Figure 3.10. Distribution of PPVT-4 scores by maternal education level at time point 1 and time point 2	34
Figure 3.11. Relationship between EVT-2 score at time point two and linguistic quantity measures AWC and proportion of meaningful speech by maternal education level	35
Figure 3.12. Relationship between EVT-2 score at time point two and semantic/syntactic quality measures NDW and MLU by maternal education level	36

Figure 3.13. Relationship between EVT-2 score at time point two and conversational quality measures percent of commands and percent of decontextualized utterances by maternal education level 37

Figure 3.14. Relationship between EVT-2 score at time point 2 and conversational quality measures percent of negative feedback, percent of prohibitions, and percent of indirect commands by maternal education level 38

Figure 3.15. Relationship between PPVT-4 score at time point two and linguistic quantity measures AWC and proportion of meaningful speech by maternal education level 39

Figure 3.16. Relationship between PPVT-4 score at time point two and semantic/syntactic quality measures MLU and NDW by maternal education level 40

Figure 3.17. Relationship between PPVT-4 score at time point two and conversational quality measures percent of decontextualized utterances and percent of commands by maternal education level 41

Figure 3.18. Relationship between PPVT-4 score at time point two and conversational quality measures percent of indirect commands and percent of prohibitions by maternal education level 42

Figure 3.19: Relationship between PPVT-4 score at time point two and percent of negative feedback by maternal education level 43

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ABSTRACT

Vocabulary size is a key contributor to children's academic success throughout their lives. Home language input has been shown to play an important role in children's vocabulary development, but the relationship between quality and quantity of input is relatively unknown. The purpose of this study was to examine differences in quality and quantity of input based on maternal education level, and determine how these difference impact vocabulary development one year later. Fifty-two children from a larger longitudinal project participated in this study. Vocabulary size was quantified via standard scores on norm-referenced vocabulary tests and quantity and quality of home language input was assessed via analysis of home language samples that were collected using the Language Environment Analysis (LENA) device. Language samples were transcribed and coded for semantic, syntactic, and pragmatic quality measures. Results indicated that various quantity and quality measures differed significantly based on maternal education level. There were significant correlations among quantity and quality measures, but the relationships were not particularly strong. One year later, children's vocabulary size was more strongly affected by quality measures, particularly parents' use of decontextualized language and amount of negative feedback, compared to quantity measures. Children's vocabulary size was not directly affected by maternal education level. However, an indirect effect of maternal education may have occurred by virtue of its influence on the linguistic quantity and quality measures. Typical parent-intervention focuses primarily on increasing quantity, but these results suggest quality may have a greater impact on vocabulary development. Further research is needed to determine if parents can be taught to modify their input quality as easily as they can increase quantity.

SPECIFIC AIMS

Children from low socioeconomic status (SES) families are at risk for lower academic performance and/or academic failure (e.g., Sirin 2005). These children tend to begin school with significantly smaller vocabularies than their peers and have slower rates of growth in vocabulary size throughout childhood (Rowe & Goldin-Meadow, 2009). These differences can be partially attributed to differences in parental language input during early childhood. Recently, several large-scale intervention programs have focused on improving children's language through increasing the amount of parental linguistic input. However, this type of intervention often overlooks the issue of the quality of language input, which is also a key variable in vocabulary growth. The relationship between the quality and quantity of linguistic input and its effect on vocabulary size is complex and warrants further investigation. This study specifically examined how measures of semantic/syntactic linguistic complexity and pragmatic complexity of language from parents with a range of education levels affect vocabulary development in a diverse sample of children. This study examined the relationship among linguistic quality, quantity, and vocabulary size by investigating the following questions:

- 1) What is the relationship between different measures of quantity and quality of home language input?
 - a. Does quality necessarily increase as quantity increase?
 - b. How is this relationship influenced by the specific measure of quantity or quality and how is it related to SES?
- 2) Is vocabulary growth better predicted by measures of home language quantity or quality?
 - a. Is this relationship influenced by SES?

Understanding the relationship among linguistic quality, quantity, and vocabulary size and how this relationship differs across SES levels is crucial for shaping children's language development. By furthering our understanding of linguistic input and its impact on vocabulary, we can make necessary modifications to early intervention programs to ensure children receive the greatest possible benefit. In addition, we can equip parents of children at risk for language disorders with knowledge of how to talk to their children

CHAPTER ONE

Literature Review

A major concern facing the educational system in the United States is the achievement gap. Numerous studies have found that there are differences in academic achievement among students based on socioeconomic status (SES) (Entwisle & Alexander, 1983; Vanneman et al., 2009; Duncan & Magnuson, 2005). Differences begin to emerge among students starting as early as kindergarten and persist over time. These differences are apparent in grades, reading scores, and standardized test scores. The gap also exists when comparing dropout rates, the number of students that enroll in 'gifted' or advanced placement courses, and the number of students admitted to universities (Ladson-Billings, 2005). Poverty, no matter how minimal, can have numerous detrimental effects on children's growth and development. Children in poverty are at greater risk for diminished physical health, emotional and behavioral problems, and nutritional problems due to food insecurity (Brooks-Gunn & Duncan, 1997). Food insecurity is defined as 'limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways' (U.S. Department of Agriculture). Food insecurity has been associated with lower physical function, less adaptive psychosocial functioning, and poorer academic performance.

One significant aspect of the achievement gap is vocabulary. Vocabulary size has been found to be a key predictor of school success, and children from low SES families tend to start school with smaller vocabularies compared to children from high SES families (Rowe & Goldin-Meadow, 2009). This disparity in vocabulary size begins as early as two years and continues throughout childhood. Research suggests that these differences in vocabulary size are related, at least in part, to differences in parental input. Hart and Risley (1995) conducted a longitudinal

study looking at the everyday language use of individuals with young children from professional, working class, and welfare families. Their results showed that the parents from higher SES backgrounds spoke approximately 215,000 words to their children each week, whereas lower SES parents spoke roughly 62,000 words. The study further implied that children from a lower SES background hear 30 million less words by age three compared to children from higher SES backgrounds. This ‘word gap’ was tied to significant differences in vocabulary at age 3 between the children in this study. These results are not specific to just one study; a longitudinal study by Hoff (2003) found that lower SES mothers spoke less to their children, and that one year later, these children had smaller vocabularies compared to higher SES children. Fernald and Weisleder (2015) found that at 24 months, children from lower SES families were six months behind their more advantaged peers in both vocabulary and lexical processing efficiency. Several other studies have found similar results in regards to vocabulary development (e.g., Pan et al, 2005; Huttenlocher et al, 1991).

The results from Hart and Risley (1995) and other studies like it have helped pave the way for a variety of early childhood intervention programs, including Head Start and the Hanen ‘More than Words’ program. These programs place an emphasis on increasing the quantity of words that children hear in order to boost their expressive vocabularies. However, Hart and Risley’s groundbreaking study is not without its flaws; there were a small number of participants overall, and just 6 families in the ‘low SES’ category. This limitation is not specific to Hart and Risley’s research; disadvantaged families or individuals living in poverty are rarely studied. At the 2010 International Conference on Infant Studies, less than 1% of 1000 research presentations reported including participants from disadvantaged families (Fernald, 2010). In addition, Hart and Risley’s data collection and analysis was done by hand. This means that an outside observer

was always present when the language input was recorded which may have resulted in a less natural interaction with the child. Furthermore, transcription requires a significant amount of time and increases the potential for human error. Today, technological advances provide us with the opportunity to simplify the process of collecting and analyzing language samples.

One such technological advance is the Language Environment Analysis (LENA) device. A LENA is a small digital auditory recorder, worn by the child in a specially designed vest or t-shirt, which records the surrounding environment for up to 16 hours. This type of device allows for a more natural representation of the child's true language environment, as opposed to having a researcher stand in the corner and take notes, or having a camera film the family throughout the day. LENA comes with a software program that generates automatic analysis of the language sample, providing data including the number of adult words spoken, number of contingent turns, and the percentage of background noise present including TV and radio. The LENA analysis software has been found to be a consistent and reliable measure through comparison of transcriptions of the program to those done by professional human transcribers. These comparisons have proven that the LENA system is at least 75% accurate in segmenting adult speech from child speech, differs 1-2% from humans in counting adult words, and reliably analyzes the sample over time with approximately 5% variability (Xu et al, 2008). These and other results indicate that LENA is a reliable and valid way to evaluate language samples.

LENA has been used to gather a wide variety of normative data on children's typical language use and their language environment. In addition, LENA has led to a number of intervention programs that target improving the quantity of children's language input through behavioral feedback. One such program is Providence Talks, based out of Providence, Rhode Island. Providence Talks is an early intervention program that uses the LENA system to

‘improve language development and school readiness of children in poverty.’ Parents receive bi-weekly coaching sessions and LENA reports to help them increase their number of words and conversational turns with their child (“About – Providence Talks”, n.d.). Access to quantitative data is a powerful tool that has been shown to significantly impact adult behavior. Suskind et al. (2013) gave caretakers weekly data on their child’s language while providing no discussion on the results. After six weeks, adult word counts increased by an average of 31% and conversational turn counts increased by an average of 25%. A similar study reported by the LENA Foundation (2008) found that caregivers increased their daily adult word count by an average of 55% when provided with LENA data.

LENA-based intervention programs typically emphasize the importance of increasing the quantity of words a child is hearing. However, quality of input must also be considered. In some studies, quality refers to the ‘richness’ of the parent’s vocabulary, including the types of words they use rather than the sheer number of words. Quality can also be categorized into a set of linguistic and conversational factors. Linguistic factors include lexical diversity and syntactic complexity, while conversational factors include parental responsiveness and the extent to which the language does not refer to the here and now (decontextualized language). Both types of quality influence children’s language development.

Linguistic quality has been linked with vocabulary development in numerous studies. Pan et al. (2005) found that parent word types (number of different words spoken, or diversity of vocabulary) was a stronger predictor of vocabulary growth in children compared to parent word tokens (number of words spoken). Other studies found that preschoolers whose parents used a higher proportion of rare vocabulary had larger vocabularies in kindergarten and second grade (Beals, 1997; Beals & Tabors, 1995; Weizman & Snow, 2001). Linguistic quality has been found

to differ based on maternal education and/or socioeconomic status. Dollaghan et al. (1999) evaluated play samples and determined that mothers who had graduated from college used a larger variety of words when talking to their children compared to mothers who had a high school diploma. Higher educated mothers also had a greater mean length of utterance (MLU). Other studies have found a similar relationship between education level and the ‘richness’ of maternal input (Rush, 1991; Hoff & Tian, 2004).

Conversational quality of input also contributes to language development. Rush (1999) reported that parental rates of positive feedback and requests for language were moderately correlated with child language measures. Salo et al. (2013) determined that children whose fathers used a greater amount of conversation-facilitating language used a greater number of words and had more diverse vocabularies. Like linguistic quality, conversational quality also varies based on maternal education level. Hoff-Ginsberg (1991) found that upper middle class mothers used a greater proportion of topic-continuing utterances compared to working class mothers. Working class mothers used a greater proportion of behavior-directing utterances, or commands, than conversation-eliciting utterances. Other studies have found that low SES mothers ask less conversation-eliciting questions, use more behavior directives, and less frequently produce contingent replies to child speech compared to high SES mothers (Hoff, 2003).

Numerous studies have illustrated that as quantity increases, both linguistic and conversational quality increase as well (Hoff-Ginsberg, 1991; Rowe, 2008). However, this relationship is complex and not fully understood. Rowe (2012) investigated differences in input quality between mothers of different education levels across several years. Results showed that parental education was related to children’s receptive vocabulary size over time, and that

education level was positively correlated with both quality and quantity. However, while use of quality measures increased over time for all parental education levels, quantity of words remained fairly constant across education levels. In addition, quality and quantity have differing effects on child language outcomes. Hirsh-Pasek et al. (2015) found that combined quality and quantity measures of maternal language accounted for 27% of variance in the expressive language of children from low-income families at 36 months. However, quality measures alone accounted for 16% of variance, whereas words per minute alone, or quantity, accounted for just 1% of variance.

Research indicates that quality and quantity of input both have a significant effect on the vocabulary development of young children; however, the relationship between these two variables is complex. The purpose of this study is to address two questions: first, what is the relationship between different measures of quantity and quality of home language input? Does quality necessarily increase as quantity increase? How is this relationship influenced by the specific measure of quantity or quality and how is it related to SES? Second, is vocabulary growth better predicted by measures of home language quantity or quality and is this relationship influenced by SES?

CHAPTER TWO

Methods

Participants

Participants were recruited throughout the Madison, Wisconsin, and Minneapolis, Minnesota, areas for a larger longitudinal study. All children were between the ages of 28 and 38 months when they enrolled in the study. Families returned one year later when they were between 40 and 50 months. All children were typically developing monolingual speakers of English, based on parent report and informal assessment by a speech-language pathologist (SLP) during their visit to the laboratory. Families were recruited with a range of maternal education levels: low (GED, high school diploma, or less), middle (associate's degree, trade school, or some college) and high (college diploma and/or graduate education). The language samples of a similar number of families from low ($n = 14$), middle ($n = 22$), and high ($n = 16$) maternal education levels were analyzed. All children in the low and middle maternal education group from the longitudinal research project were used in the analysis. Because there were many more children in the high maternal education level group ($n = 100$), participants from the high maternal education were chosen to match to the combined low and middle maternal education levels in terms of the male; female ratio and the mean age and age range of this group. Language samples were chosen on the basis of maternal education level only. The language samples from 6 participants from low and middle maternal education level families were excluded. Two participants were excluded because the file was too difficult to transcribe because of excessive background noise. One participant was excluded because the transcribers were unable to reliably identify the mother in the sample. One participant was excluded because she was the twin of another participant, and the two samples were nearly identical. Two participants were excluded

because there was a low number of child-directed utterances in the sample (less than 9 utterances). Table 2.1 provides descriptive information on participants.

Table 2.1: Descriptive information on participants. All information is from time point 1 unless otherwise specified.

Descriptors	Maternal education level		
	Low	Middle	High
Number of males/females	7/7	10/12	9/7
Mean age in months	33 (4)	32 (4)	33 (3)
Mean PPVT-4 standard score (SD in parentheses)	102 (21)	106 (12)	119 (19)
Mean EVT-2 standard score (SD in parentheses)	109(19)	103 (18)	121 (18)
Mean PPVT-4 standard score (time point 2, SD in parentheses)	101 (23)	113 (15)	125 (14)
Mean EVT-2 standard score (time point 2, SD in parentheses)	104 (23)	111 (15)	122 (18)

Procedures

Demographic Survey

When children were enrolled in the study, the parent or caregiver of each child was given a survey to obtain demographic information. The survey was administered on either an iPad or in paper form. Parents or caregivers were asked a series of questions targeting a variety of factors including: parental education, parental occupation, and total family income. Maternal education level was used as a measure of socioeconomic status (SES). The question about parental education level was a multiple choice question with six possible responses: less than high school, GED, high school diploma, some college or associate's degree or trade school, college degree, or

graduate degree. These responses were used to make three maternal education level groups: low maternal education (less than high school, GED, high school diploma), middle maternal education (some college, associate's degree, trade school), or high maternal education (college or graduate degree).

Expressive and Receptive Vocabulary Size

Each child was administered standardized assessments at both the initial assessment and at the second assessment one year later to determine his or her expressive and receptive vocabulary size. Children were given the *Peabody Picture Vocabulary Test, Fourth Edition* (PPVT-4) (Dunn & Dunn, 2007) and the *Expressive Vocabulary Test, Second Edition* (EVT-2) (Williams, 2007).

Language Sample

Data Collection. To collect a language sample in each child's home environment, each family was given a Language Environment Analysis (LENA) recording device. A LENA is a small digital auditory recorder, worn by the child in a specially designed vest or t-shirt, which records the surrounding environment for up to 16 hours. The LENA software then analyzes the recording and reports a variety of measures including the following: how many words were spoken by adults, how many vocalizations were produced by the child, and how many conversational turns occurred. Information on the auditory environment is also provided, including: proportion of meaningful speech (speech close to the child), percent distant speech, percent electronic noise, percent other noise, and percent silence. These measures are provided for various time intervals, including the entire day, hour-by-hour, and for each five-minute time period. Each family was instructed to have their child wear the device for the entirety of a 'typical day at a home', meaning a day in which the child spent the majority of their time with caregivers and did not attend day care.

Data Analysis. For each child, the hour with the highest conversational turn count (CTC) was selected for further analysis. The first thirty minutes of this hour was transcribed by trained graduate and undergraduate student researchers using the software program Computerized Language Analysis (CLAN) (Ratner & Brundage, 2013). A different thirty minute interval was chosen for analysis (either the second thirty minutes of the hour or the first thirty minutes of the hour with the second highest CTC) if it was determined that the first sample consisted primarily of interaction with a third party who was not the parent (e.g., a speech-language pathologist visited one of the participants in the hour with the highest CTC) or if the sample consisted almost entirely of book reading.

The language samples were orthographically transcribed in CLAN from the acoustic waveform. Both adult and child utterances were transcribed. Sentences were coded at the same time that they were transcribed. All of the semantic and syntactic measures were coded automatically using the built-in CLAN coding system. Semantic-syntactic measures included mean length of utterance (MLU), number of different words (NDW), and symbolic emphasis (% of nouns, adjectives, adverbs, and past participles). The built-in CLAN coding system works using programs such as KIDEVAL and MOR. KIDEVAL computes a variety of results, including mean length of utterance in morphemes (MLU-M), mean length of utterance in words (MLU-W), TTR, and clause density. KIDEVAL works using a program called MOR, which breaks each utterance into morphemes and determines the part of speech for each word within the utterance. KIDEVAL and MOR automatically compute these measures for each speaker within a language sample (MacWhinney, 2015).

The conversational quality measures were coded by the first author or one of two other trained transcriber/coders. Transcriber/coders met weekly to discuss difficult coding decisions.

All parental language was coded as either “child-directed speech”, “book-reading/prayer/songs” or “other-directed speech”. Each child-directed utterance was then coded for conversational quality measures. Each utterance was coded as either contextualized or de-contextualized. Utterances were considered contextualized if they discussed things occurring in the ‘here and now.’ Utterances immediately following child language were coded as contingent or non-contingent; for the purposes of this study, an utterance was considered contingent if it was in response to and/or related to the child’s utterance. Utterances in response to a child’s behavior were not considered contingent. Each utterance was then coded as belonging to one of four categories: question, comment, command, or other speech act. Questions were then coded as either yes or no questions, open-ended questions, or closed questions. Comments were coded as positive (expansions, repetitions, or other comments), neutral, or negative. Commands were coded as either prohibitions or other commands, as well as direct or indirect commands. For definitions and examples of each coding term, see Table 2.2. The coding system can also be seen in the coding ‘web’ in Figure 2.2.

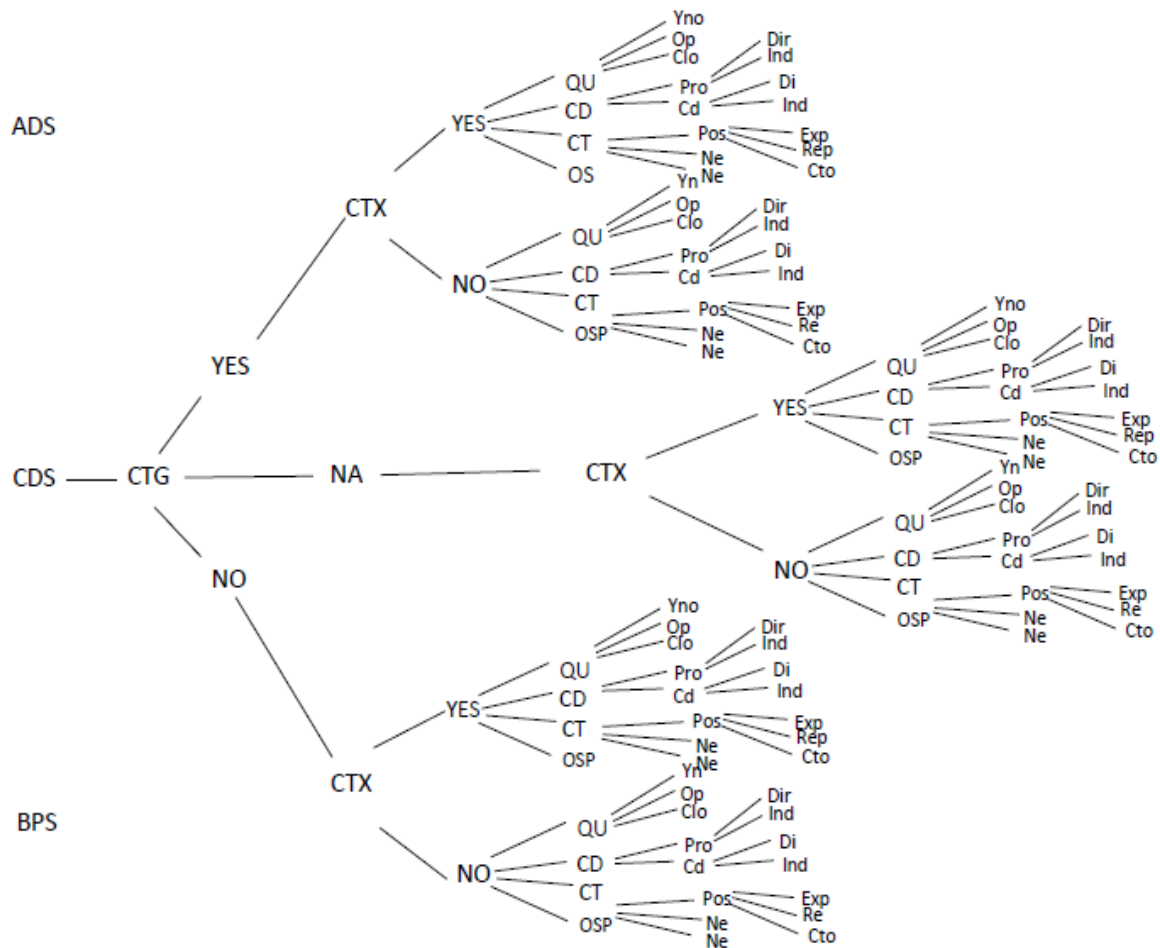
Table 2.2: Coding Terms Defined

	Code & Abbreviation	Definition	Example
For all utterances:	Other-Directed Speech (ODS)	An utterance that is spoken to anyone other than the target child	MOT: Honey can you help me with this?
	Book-Prayer-Song (BPS)	An utterance involving book reading, praying, or singing	MOT: Twinkle twinkle little star, how I wonder what you are?
	Child-Directed Speech (CDS)	An utterance spoken to the target child	MOT: What does a cow say?

If CDS then:	Contingent Utterance (CTG:YES)			An utterance immediately following child language that is contingent on that language	CHI: Mommy I'm thirsty. MOT: Alright I'll get you some milk.
	Non-contingent utterance (CTG:NO)			An utterance immediately following child language that is not contingent on that language	CHI: Can I have a cookie? MOT: Turn around.
	Non-Applicable Contingent Utterance (CTG:NA)			An utterance that does not immediately follow child language	MOT: What do you think about that? MOT: I like it a lot.
Regardless of Contingency:	Contextualized Utterance (Yes:CTX)			An utterance about the 'here and now'	MOT: Those carrots look so yummy!
	Decontextualized Utterance (No:CTX)			An utterance about something not in the 'here and now'	MOT: Remember what we saw at the park yesterday?
Regardless of Context	Question (QUE)	Yes or No Question (YNO):		A question in which the answer must be either yes or no.	MOT: Should we go outside?
		Open-ended question (OPN):		A question with a variety of possible answers	MOT: What do you want to do today?
		Closed question (CLO):		A question that has a limited number of answers	MOT: Do you want to stay up here or come downstairs?
	Command (CMD)	Prohibition (PRO)	Direct command (DIR)	A direct, explicit command with negation	MOT: Don't do that.
			Indirect command (IND)	An indirect command with negation	FAT: That doesn't go in your mouth.

		Other Command (CDO)	Direct command (DIR)	A direct command without negation	MOT: Put your shoes on.
			Indirect command (IND)	An indirect command without negation	MOT: Can you help me pick up the toys so we can make a fort?
	Comment (CMT)	Positive	Expansion (EXP)	An utterance that gives the child a better linguistic model that they could potentially say	CHI: Coat. MOT: yes that's your old coat isn't it?
			Repetition (REP)	An utterance in which the parent repeats the child's utterance (not necessarily verbatim).	CHI: goat! MOT: goat!
			Other Positive Command (CTO)	An utterance in which the parent affirms the child's behavior or offers praise.	MOT: I love you with all my heart.
		Negative (NEG)		A comment with negative intonation	MOT: I hate when you repeat after me.
		Neutral (NEU)		Any other comment made by the parent.	MOT: Alright let me get you some milk.
		Other Speech Act (OSP)			Any speech act that does not fit into the other three categories (i.e. fillers, attention getters, requests for repetition). MOT: Hey! Or MOT: What did you say?

Figure 2.1: Coding web used for analysis



Here is an example of a coded utterance from a participant's language sample transcript:

*MOT-CHI: Nessie pick out your jammies and bring them downstairs.

%spa: \$CDS:CTG:No:CTX:Yes:CMD:Cdo:Dir

The code denotes that this utterance was coded as: child-directed, non-contingent, contextualized, and a direct non-prohibition command.

There were five transcribers. I transcribed the language samples for 21 out of 52 participants and an undergraduate who was doing her thesis on a related topic transcribed 21 language samples of out of 52 participants. The remaining language samples were transcribed

by three other undergraduate transcribers (JD = 5, KW = 2, MK = 3). All coding was done by either myself or the undergraduate student who was also doing a thesis. Inter-rater reliability between myself and the other coder was assessed by the two coders independently re-coding approximately 20% of the files (11/52). Pairwise correlations between each of the quality measures were as follows: percent of decontextualized utterances ($r = .78, p = .04$), percent of commands ($r = .98, p < .001$), percent of prohibitions ($r = .95, p < .001$), percent of negative feedback ($r = .96, p < .001$), percent of indirect commands ($r = .89, p < .001$), percent of expansions ($r = .70, p = .016$), and percent of contingent utterances ($r = .38, p = .25$). A possible explanation for the poor inter-rater reliability for contingent utterances is a confusion over when to code utterances as N/A for contingency versus not-contingent.

Analysis

Question 1 was: What is the relationship between different measures of quantity and quality of home language input? Does quality necessarily increase as quantity increase? How is this relationship influenced by the specific measure of quantity or quality and how is it related to SES? To address this question, a series of analyses were run. All linguistic quantity measures were correlated with all morphological/semantic and conversational quality measures of interest. The linguistic quantity measures were derived from the LENA reports: adult word count (AWC) and proportion of meaningful speech. The semantic/syntactic quality measures were number of different words (NDW), total number of words (TNW), and mean length of utterance in morphemes (MLU). The conversational quality measures were: % decontextualized utterances, % contingent utterances, % indirect commands, % commands, % negative feedback (negative comments and prohibitions), and % expansions. The conversational quality measures were defined as described in Table 2.3. One-way ANOVAs were then run with quantity and quality

measures of interest as listed above as the independent variables and maternal education level as the independent variable to determine group differences in quality and quantity measures.

Table 2.3: Conversational quality measures

Quality measures	Numerator	Denominator
Percent of contingent speech	# of contingent utterances	# of contingent utterances + # of non-contingent utterances
Percent of decontextualized utterances	# of decontextualized utterances	# of decontextualized utterances + # of contextualized utterances
Percent of commands	# of direct and indirect prohibitions + # of direct and indirect 'other' commands	Total number of utterances
Percent of prohibitions	# of direct prohibitions + # of indirect prohibitions	Total number of commands
Percent of indirect commands	# of indirect prohibitions + # of indirect 'other' commands	Total number of commands
Percent of negative feedback	# of direct and indirect prohibitions + # of negative comments	Total number of utterances
Percent of expansions	# of expansions	Total number of comments

Question 2 was: Is vocabulary growth better predicted by measures of home language quantity or quality? Is this relationship influenced by SES? To address this question, again, a series of correlations were between the linguistic quantity and quality measures described above and measures of expressive and receptive vocabulary. The measures of vocabulary included both measures of vocabulary size (PPVT-4 and EVT-2 growth score values at ages 3;6 to 4;0) as well as standardized measures of vocabulary size (PPVT-4 and EVT-2 standard scores at ages 3;6 to 4;0). Eight different step-wise regression models were run, four for expressive vocabulary and

four for receptive vocabulary. These models are described in detail below. The dependent variable was the vocabulary measure and the independent variables were all of the input measures that were significantly correlated with this measure of vocabulary as well as maternal education level.

CHAPTER THREE

Results

Relationships among quantity and quality measures of home language input and maternal education level. The first series of questions addressed by this study were the following: What is the relationship between different measures of quantity and quality of home language input? Does quality necessarily increase as quantity increases? How is this relationship influenced by the specific measure of quantity or quality and how is it related to SES?

To address these questions, a series of correlations were run between the quantitative input measures from LENA (adult word count [AWC], proportion meaningful speech), the syntactic/semantic measures from CLAN (MLU in morphemes [MLU], number of different words [NDW], total number of words [TNW]), and the conversational quality measures from CLAN (percent contingent utterances, percent decontextualized utterances, percent prohibitions, percent commands, percent indirect commands, and percent negative feedback). AWC was correlated with MLU ($r = .29, p = .049$), NDW ($r = .37, p = .010$), TNW ($r = .42, p < .01$), percent of contingent utterances ($r = .38, p = .010$), percent of decontextualized utterances ($r = .30, p = .04$), and percent of indirect commands ($r = .38, p = .010$). Proportion of meaningful speech was not significantly correlated with any quality measures. These results suggest that there were some relationships between quantity and quality measures of home language input, but these relationships were inconsistent. Figures 3.1 to 3.2 illustrate these relationships.

Insert Figures 3.1 – 3.2 about here

I also examined whether measures of lexical and morphological quality (MLU, NDW, and TNW) were correlated with the conversational quality measures through a series of correlations. MLU was correlated with percent of decontextualized utterances ($r = .39, p < .01$),

NDW ($r = .64, p < .01$), and percent of indirect commands ($r = .42, p < .01$). NDW was correlated with the percent of commands ($r = -.61, p < .01$) and TNW was correlated with the percent of decontextualized utterances ($r = .30, p = .02$). Figures 3.3 to 3.4 illustrate these relationships.

Insert Figures 3.3 – 3.4 about here

Finally, I examined whether there were significant differences in any of the quantity or quality measures of home language input as a function of maternal education level. I ran a series of one-way ANOVAs. The dependent measures were the quantity measures (AWC and proportion of meaningful speech), the lexical/morphological quality measures (MLU, NDW, TNW), and the conversational quality measures. Maternal education level was the independent variable.

A number of the ANOVAs yielded statistically significant differences as a function of maternal education level. These were the following: AWC ($F[2, 43] = 6.141, p < .01$), MLU ($F[2, 49] = 4.09, p = .02$), NDW ($F[2, 49] = 3.46, p = .03$), percent of commands ($F[2, 49] = 3.69, p = .03$), percent of indirect commands ($F[2, 49] = 3.52, p = .03$), percent of prohibitions ($F[2, 49] = 4.04, p = .02$), and percent of negative feedback ($F[2, 49] = 3.11, p = .05$). There was a marginally significant difference between groups for proportion of meaningful speech ($F[2, 43] = 2.95, p = .06$) and percent of decontextualized utterances ($F[2, 49] = 2.48, p = .09$). Figures 3.5 to 3.17 show the quantity and quality measures for which there were significant group differences.

Insert Figures 3.5 – 3.8 about here

Post-hoc comparisons (Scheffe method) were used to examine differences between each two of the three groups for the ANOVAs with significant group differences. The low maternal education level was significantly different from the high maternal education level for AWC ($p = .007$), NDW ($p = .052$), and percent of negative feedback ($p = .047$). The middle maternal education level was marginally different from the high maternal education level for AWC ($p = .062$). With two exceptions, the low and middle education groups did not differ from each other and had significantly lower values than the high maternal education group. The low maternal education level was significantly different from the middle maternal education level for percent of commands ($p = .04$) and percent of prohibitions ($p = .03$). There were no significant paired comparisons for percent of contingent utterances or percent of decontextualized utterances.

Vocabulary growth and measures of home language quantity and quality. The second set of questions addressed by this study were the following: is vocabulary growth better predicted by measures of home language quantity or quality? Is this relationship influenced by maternal education level?

Figures 3.9 to 3.10 show EVT-2 and PPVT-4 standard scores by maternal education level at both time points. A series of correlations were run between the linguistic quantity and quality measures described above, as measured at time point 1 (when children were 2 ½ to 3 years) and expressive and receptive vocabulary size (as quantified by standard scores on the EVT-2 and PPVT-4) one year later at time point 2 (when children were 3 ½ to 4 years).

Insert Figures 3.9 to 3.10 about here

Expressive vocabulary size at time point 2 was significantly correlated with two measures of quantity of linguistic input at time point 1: proportion of meaningful speech ($r = .33, p = .04$) and AWC ($r = .42, p < .01$). Expressive vocabulary size at time point 2 was also significantly

correlated with two lexical/syntactic measures of quality of linguistic input at time point 1: MLU ($r = .45, p < .01$) and NDW ($r = .36, p = .01$). Finally, expressive vocabulary size at time point 2 was significantly correlated with five measures of conversational quality of linguistic input at time point 1: percent commands ($r = -.33, p = .02$), percent of indirect commands ($r = .46, p < .01$), percent prohibitions ($r = -.32, p = .03$), and percent of negative feedback ($r = -.38, p = .01$), and percent of decontextualized utterances ($r = .51, p < .01$). These relationships are illustrated in Figures 3.11 to 3.14.

Insert Figures 3.11 – 3.14 about here

Receptive vocabulary score at age 3;6 to 4;0 was correlated with two measures of quantity of linguistic input at time point 1: proportion of meaningful speech ($r = .35, p = .02$) and AWC ($r = .35, p = .02$). Receptive vocabulary size at time point 2 was also significantly correlated with two lexical/syntactic measures of quality of linguistic input at time point 1: MLU ($r = .49, p < .01$) and NDW ($r = .41, p < .01$). Finally, receptive vocabulary size at time point 2 was significantly correlated with 5 measures of conversational quality of linguistic input at time point 1: percent decontextualized utterances ($r = .29, p = .04$), percent commands ($r = -.33, p = .02$), percent prohibitions ($r = -.43, p < .01$), percent negative feedback ($r = -.48, p < .01$), and percent indirect commands ($r = .39, p < .01$). Figures 3.14 to 3.19 illustrate these relationships.

Insert Figures 3.14 – 3.19 about here

We then ran four stepwise multiple regression models with a measure of expressive vocabulary as the dependent variable and four stepwise multiple regression models with a measure of receptive vocabulary as the dependent variable. Table 3.1 describes the four models for expressive vocabulary and the models for receptive vocabulary were exactly analogous to

this. For both expressive and receptive vocabulary, one model included standard scores as the dependent variable and the other model include growth score values as the dependent variable. Growth score values are a transformation of the raw score. The advantage of growth score values is that they are linear and therefore appropriate for statistical analyses, while raw scores are not linear. Growth score values are a more direct measure of vocabulary size, while standard scores are normalized for age. In addition, for both the expressive and receptive vocabulary models, one of the two models included the relevant vocabulary measure at time point 1 and the other model did not.

The independent variables were all of the quantity and quality measures that were significantly correlated with either EVT-2 or PPVT-4 standard scores. Maternal education level was also included as a predictor with low maternal education level as the reference condition.

Table 3.1 Stepwise multiple regression models for expressive vocabulary

	Model 1	Model 2	Model 3	Model 4
Dependent variable	EVT standard score at time point 2	EVT standard score at time point 2	EVT growth score value at time point 2	EVT growth score value at time point 2
Vocabulary score at time point 1 included	yes	no	yes	no

For model 1, there were three significant predictors of EVT-2 standard scores at time point 2. Together, they predicted 72% of the variability in the EVT-2 standard score. These were EVT standard score at time point 1 ($\beta = .56$, S.E. = .09, $t = 6.18$, $p < .001$), AWC ($\beta = .01$, S.E. = .005, $t = 2.30$, $p = .03$), and MLU ($\beta = 4.19$, S.E. = 1.51, $t = 2.78$, $p = .009$). All other variables,

including maternal education level were not significant predictors. For model 2, when EVT-2 standard score was not included as a predictor in the model, there were again three significant (but different) predictors. Together, they predicted 49% of the variability in the EVT-2 standard score. The significant predictors were proportion of meaningful speech ($\beta = 117.59$, S.E. = 46.47, $t = 2.53$, $p = .02$), percent of decontextualized utterances ($\beta = 83.97$, S.E. = 26.04, $t = 3.22$, $p = .003$), and percent of negative feedback ($\beta = -108.74$, S.E. = 48.49, $t = -2.24$, $p = .03$).

The results for models 3 and 4, with growth score values as the dependent variable, were similar. For model 3, there were three significant predictors and together they predicted 74% of the variability in the EVT-2 growth score values at time point 2. These were EVT growth score value at time point 1 ($\beta = .50$, S.E. = .08, $t = 6.49$, $p < .001$), AWC ($\beta = .009$, S.E. = .004, $t = 2.37$, $p = .02$), and MLU ($\beta = 3.26$, S.E. = 1.15, $t = 2.83$, $p = .008$). For model 4, when EVT-2 growth score values were not included as a predictor in the model, there were three significant and together, they predicted 49% of the variability in the EVT-2 standard score. The significant predictors were proportion of meaningful speech ($\beta = 82.26$, S.E. = 36.73, $t = 2.24$, $p = .03$), percent of decontextualized utterances ($\beta = 70.33$, S.E. = 20.59, $t = 3.42$, $p = .002$), and percent of negative feedback ($\beta = -81.67$, S.E. = 38.32, $t = -2.13$, $p = .04$).

For receptive vocabulary for model 1, there were three significant predictors and two marginally significant predictors of PPVT-4 standard scores at time point 2. Together, they predicted 81% of the variance in PPVT-4 standard scores. The significant predictors were: PPVT-2 standard score at time point 1 ($\beta = .62$, S.E. = .08, $t = 7.38$, $p < .001$), MLU ($\beta = 2.73$, S.E. = 1.16, $t = 2.35$, $p = .02$), and maternal education level (low to middle maternal education level comparison: $\beta = 9.63$, S.E. = 3.69, $t = 2.61$, $p = .01$; low to high maternal education level comparison: $\beta = 8.72$, S.E. = 3.84, $t = 2.27$, $p = .03$). The two marginally significant predictors

were proportion of meaningful speech ($\beta = 54.82$, S.E. = 27.31, $t = 2.01$, $p = .053$) and percent of negative feedback ($\beta = -58.81$, S.E. = 29.43, $t = -2.0$, $p = .053$). For model 2, when PPVT-4 standard score at time point 1 was not included in the model, there were three significant predictors and together, they predicted 49% of the variance in PPVT-4 standard scores. These were: proportion of meaningful speech ($\beta = 105.61$, S.E. = 41.27, $t = 2.56$, $p = .01$), MLU ($\beta = 5.65$, S.E. = 1.69, $t = 3.34$, $p = .002$), and percent negative feedback ($\beta = -134.04$, S.E. = 42.84, $t = -3.13$, $p = .003$).

For receptive vocabulary models 3 and 4, with growth score values as the dependent variable, the results were similar. For model 3, there was one significant predictor and two marginally significant predictors and they predicted 80% of the variability in PPVT-4 growth score values at time point 2. The significant predictor was PPVT growth score value at time point 1 ($\beta = 0.65$, S.E. = 0.08, $t = 8.04$, $p < .001$). The two marginally significant predictors were MLU ($\beta = 2.11$, S.E. = 1.17, $t = 1.79$, $p = .08$), and percent of negative feedback ($\beta = -55.90$, S.E. = 29.81, $t = -1.87$, $p = .06$). For model 4, when PPVT-4 growth score values were not included as a predictor in the model, there were three significant predictors and one marginally significant predictor. Together, they predicted approximately 47% of the variability in the PPVT-4 standard score. The significant predictors were proportion of meaningful speech ($\beta = .79$, S.E. = .12, $t = 2.23$, $p = .03$), MLU ($\beta = .80$, S.E. = .42, $t = 3.52$, $p < .001$), and percent of negative feedback ($\beta = -.15$, S.E. = .46, $t = -3.35$, $p < .001$). The marginally significant predictor was TNW ($\beta = -.10$, S.E. = .54, $t = -.19$, $p = .06$).

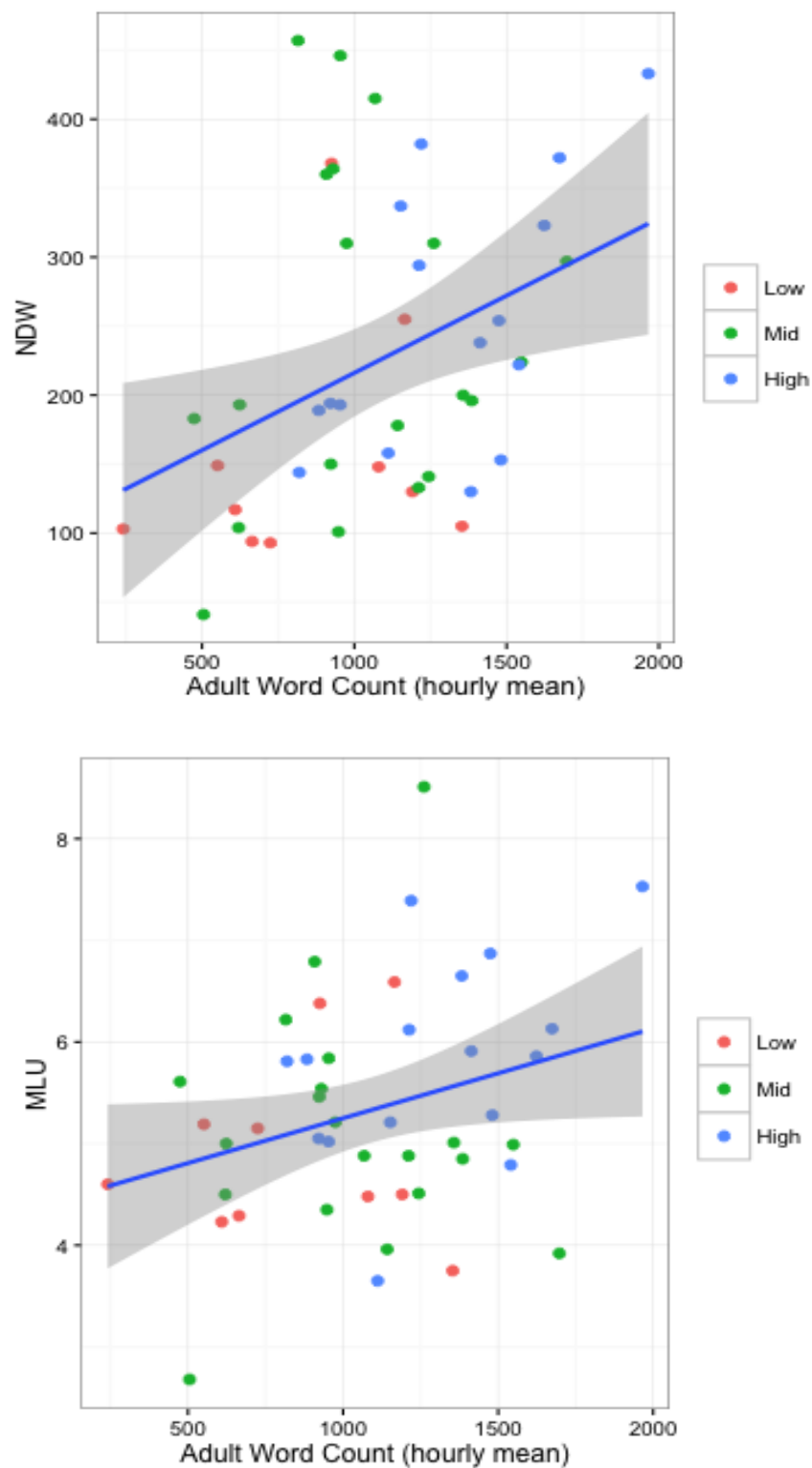


Figure 3.1. ADW plotted against measures of semantic/syntactic quality: NDW (top) and MLU (bottom)

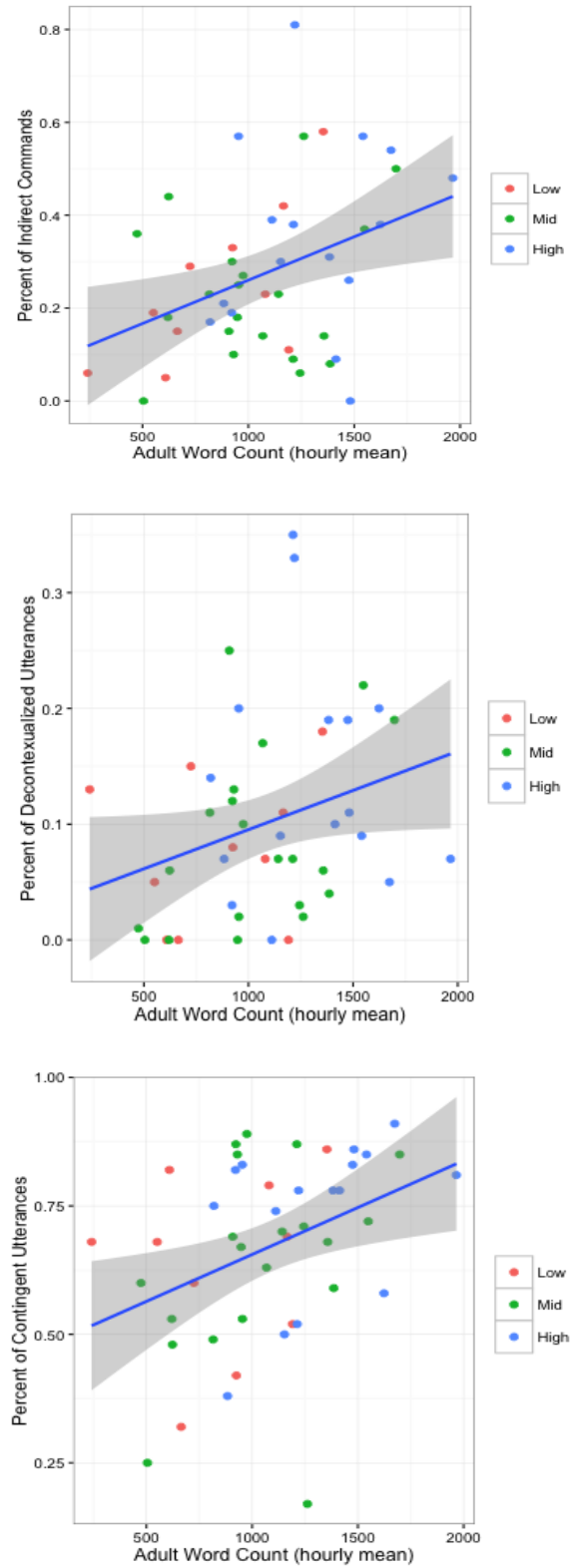


Figure 3.2. ADW plotted against measures of conversational quality: percent of indirect commands (top), percent of decontextualized utterances (middle), and percent of contingent utterances (bottom)

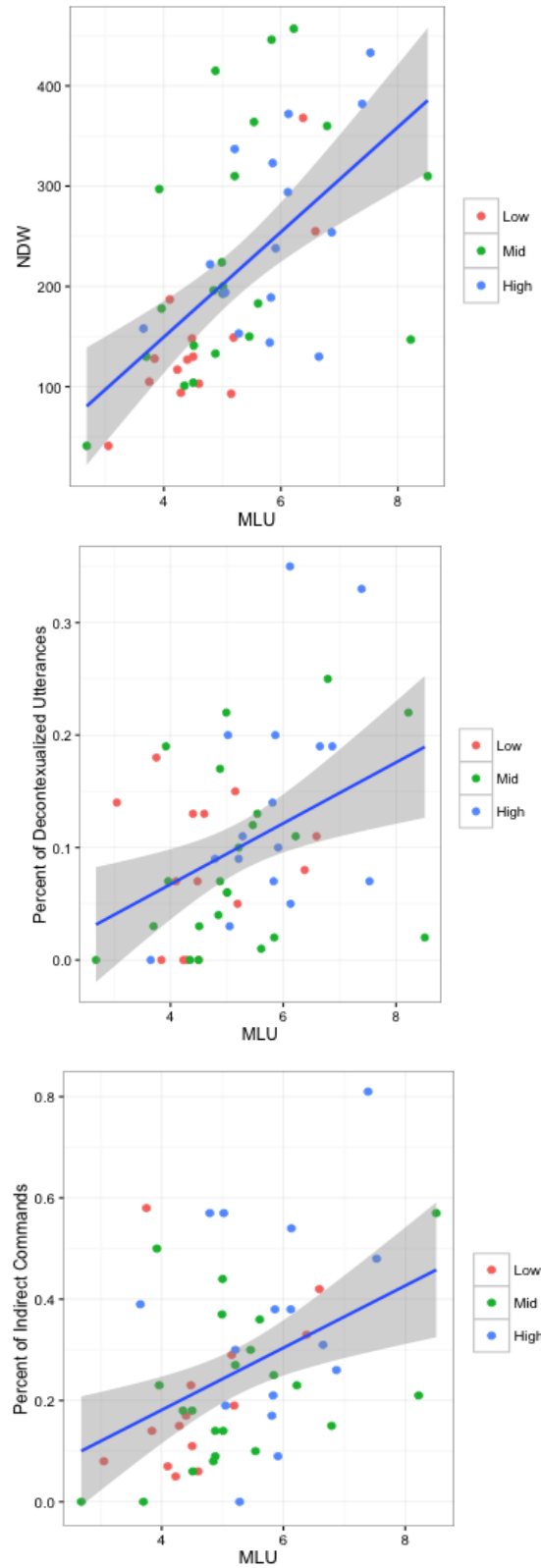
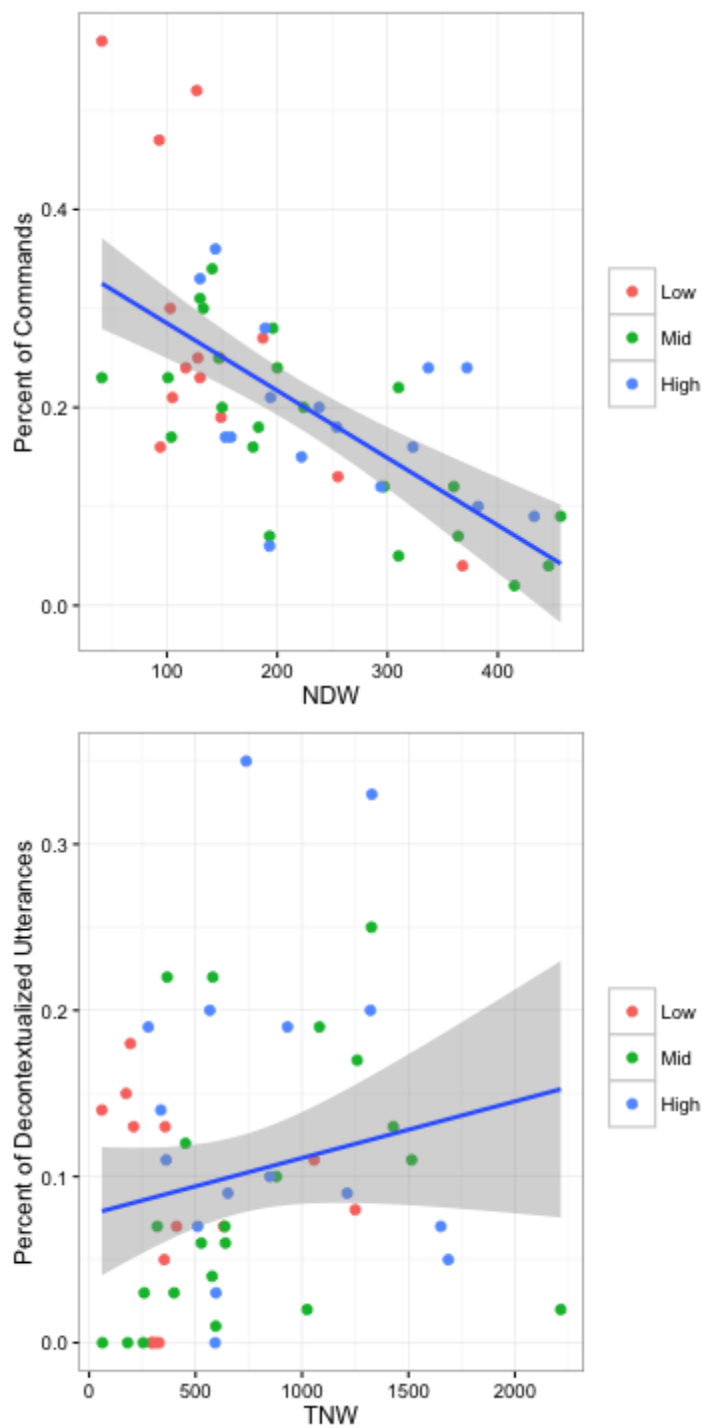


Figure 3.3. MLU plotted against NDW (top), percent of decontextualized utterances (middle) and percent of indirect commands (bottom) by maternal education level



Figures 3.4. Relationships among various conversational quality measures by maternal education level: NDW plotted against percent of commands (top); TNW plotted against percent of decontextualized utterances (bottom)

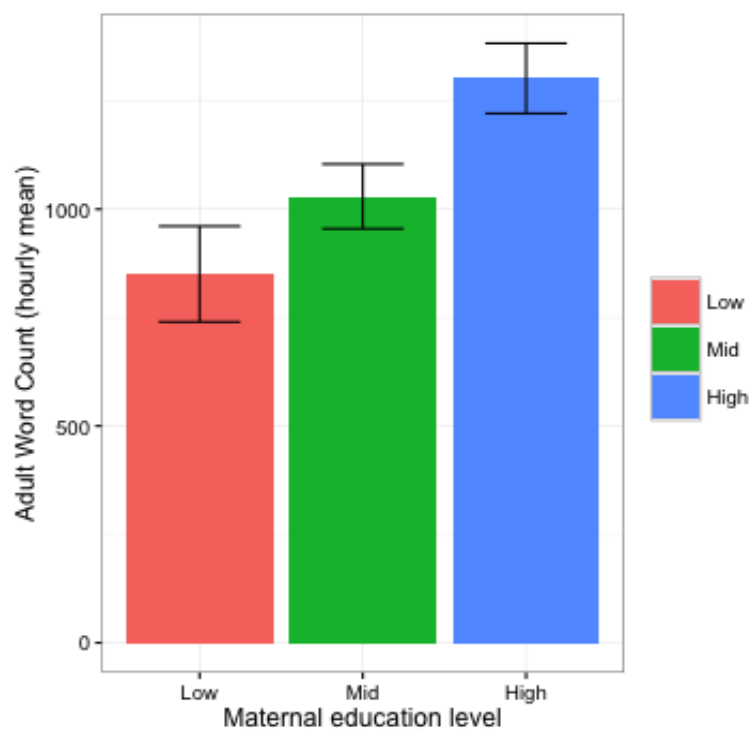
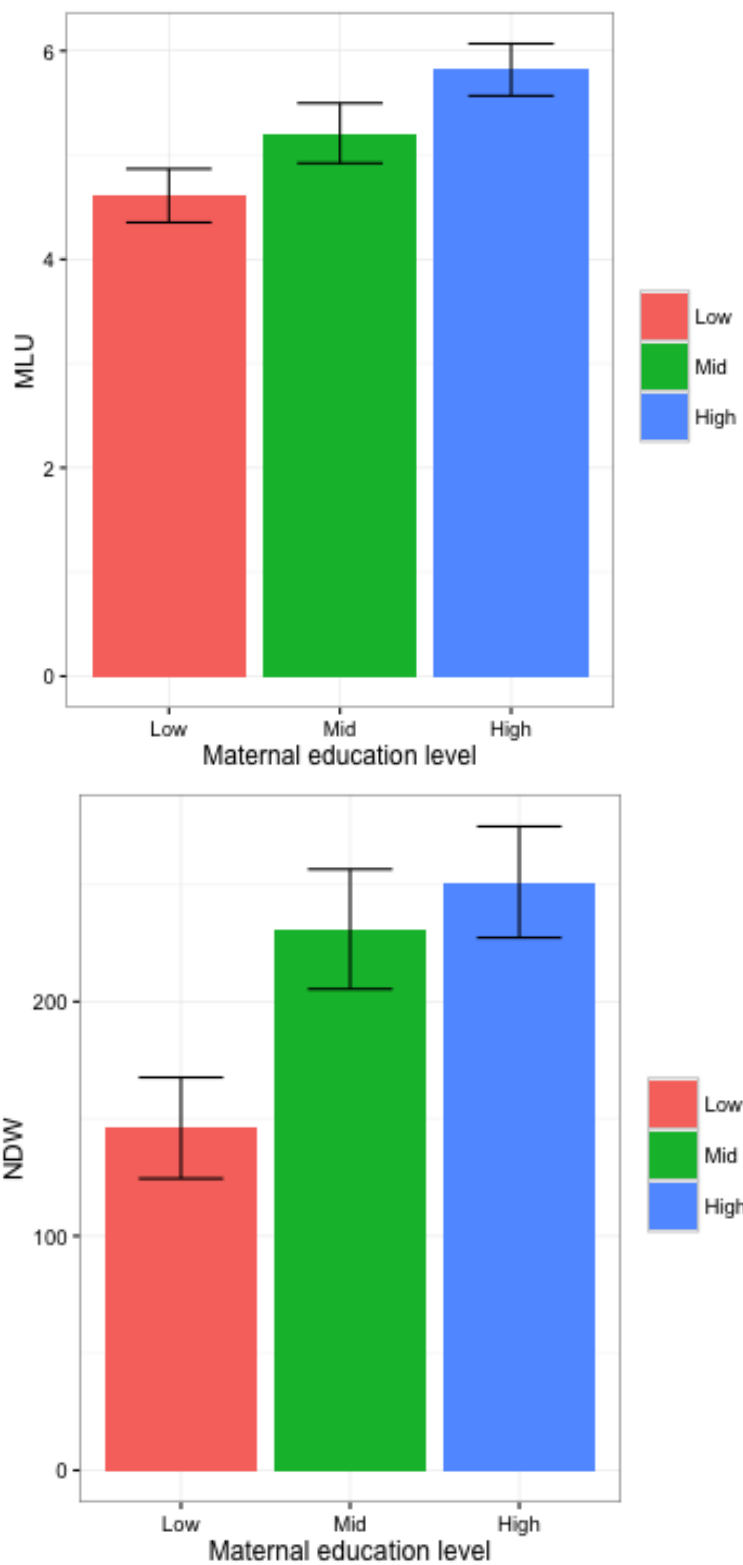
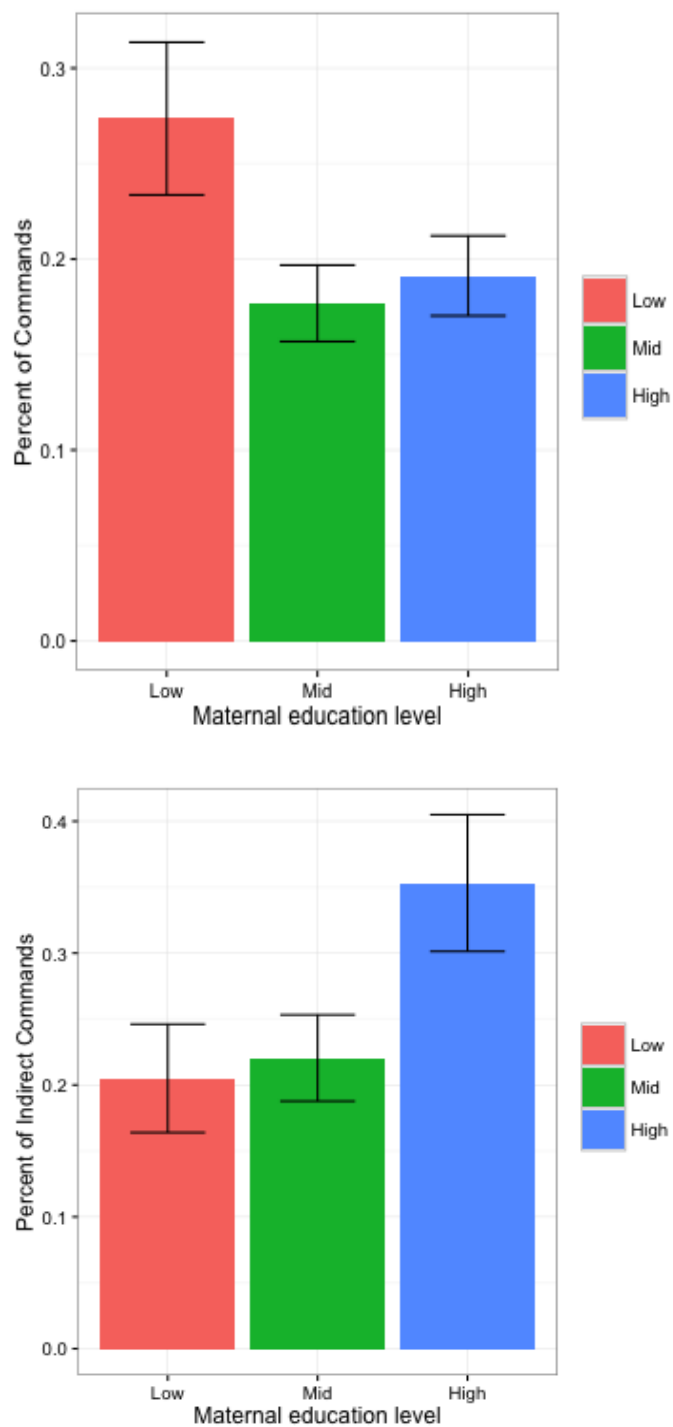


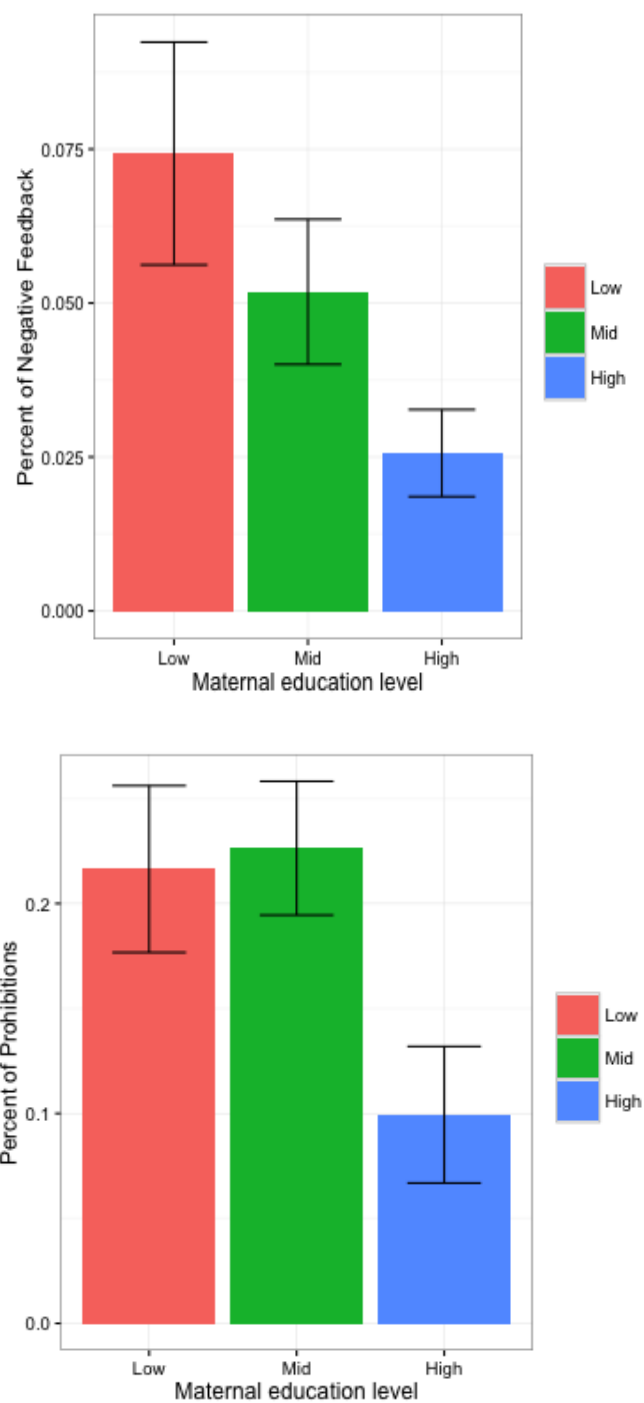
Figure 3.5. Differences in quantity measures (AWC) by maternal education level



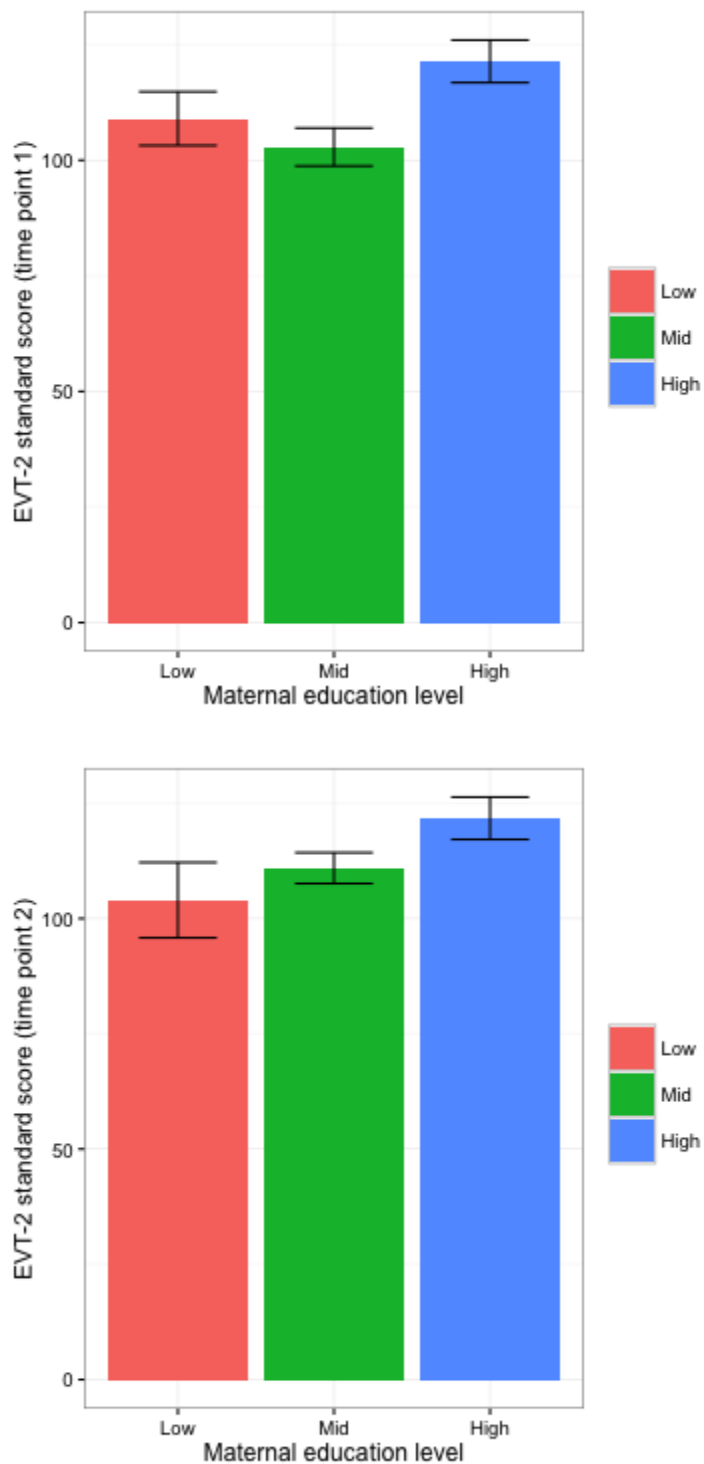
Figures 3.6. Differences in syntactic/semantic quality measures by maternal education level: MLU (top), NDW (bottom)



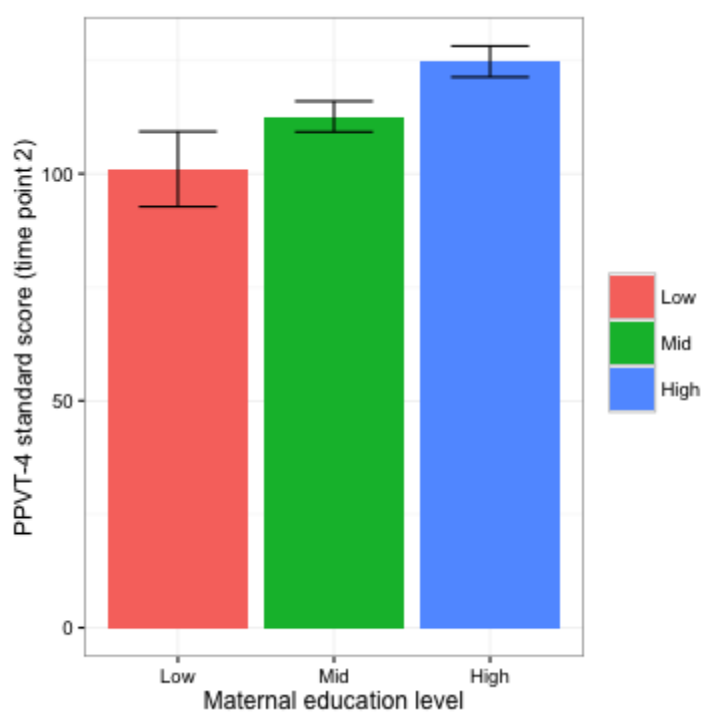
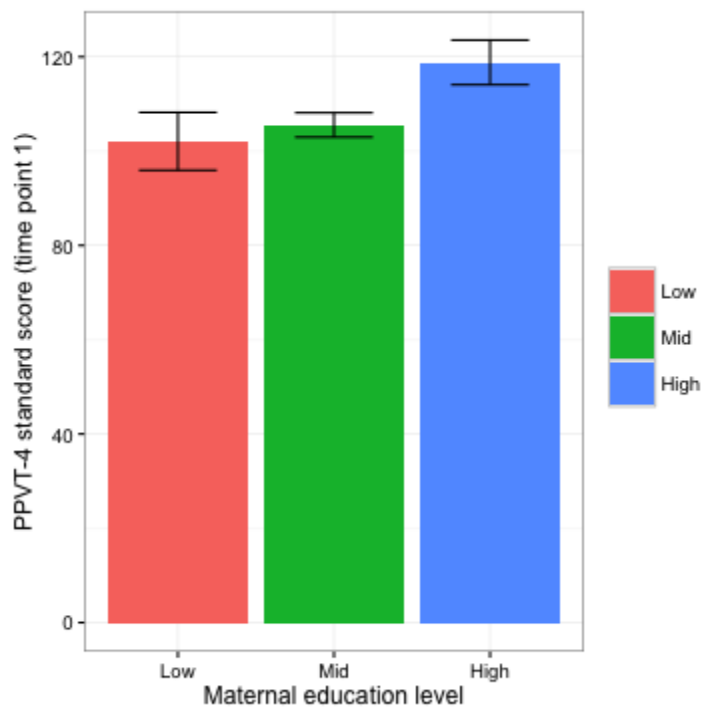
Figures 3.7. Differences in conversational quality measures by maternal education level: percent of commands (top), percent of indirect commands (bottom)



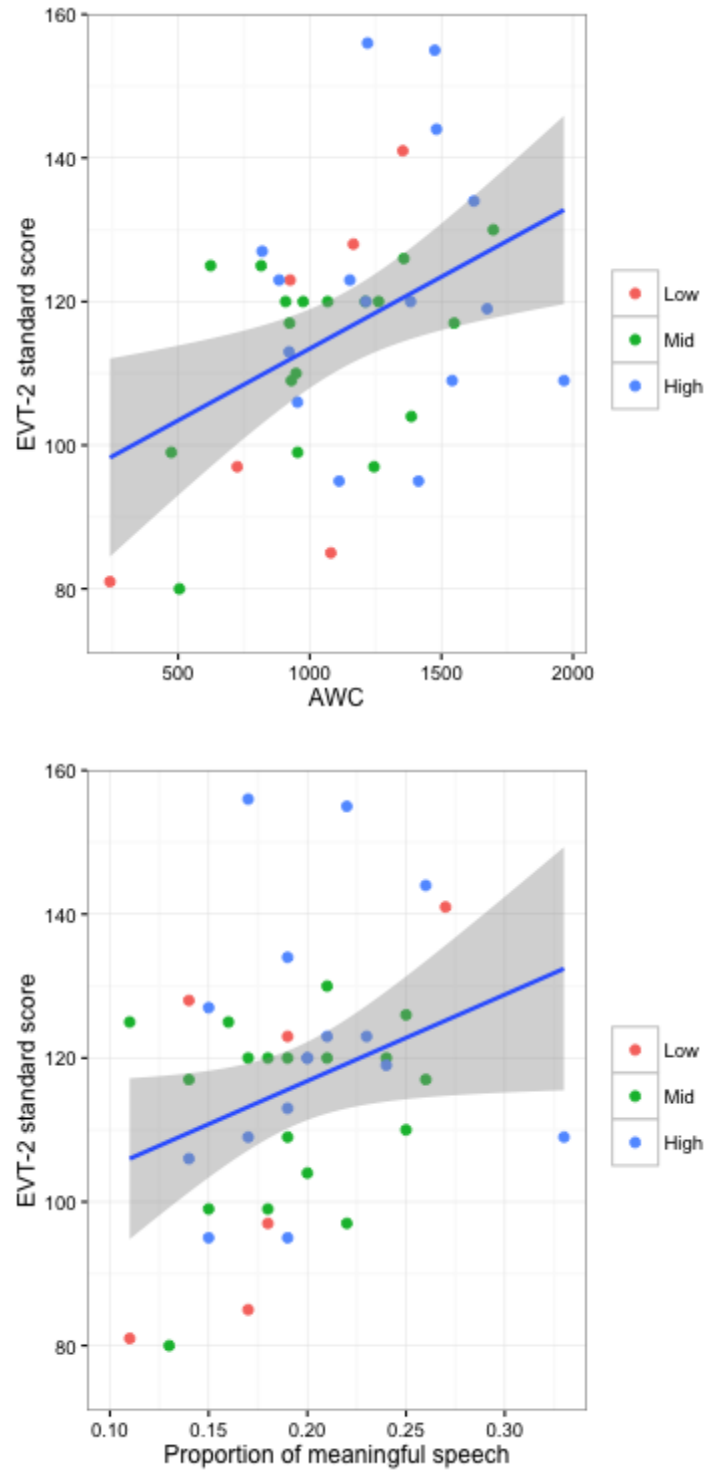
Figures 3.8. Differences in conversational quality measures by maternal education level: percent of negative feedback (top), percent of prohibitions (bottom)



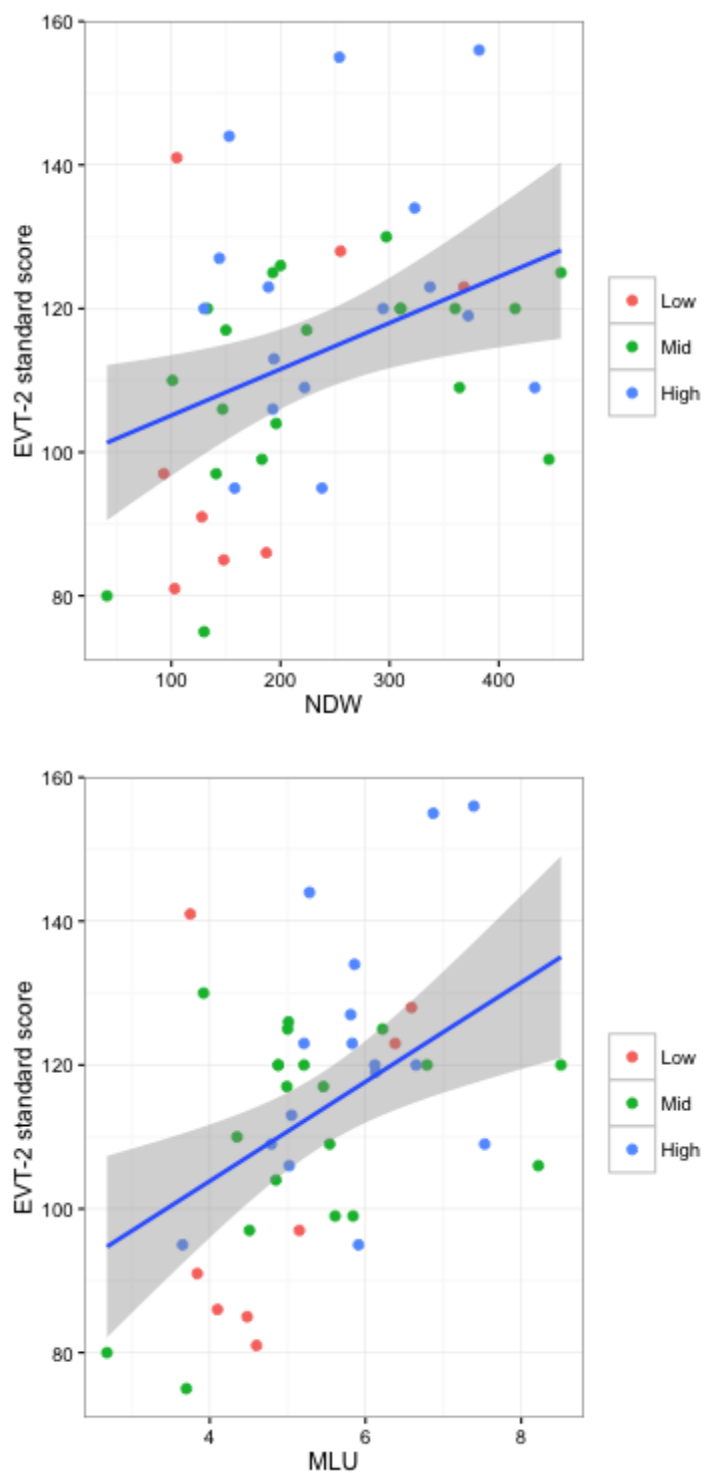
Figures 3.9. Distribution of EVT-2 scores by maternal education level at time point 1 (top) and time point 2 (bottom)



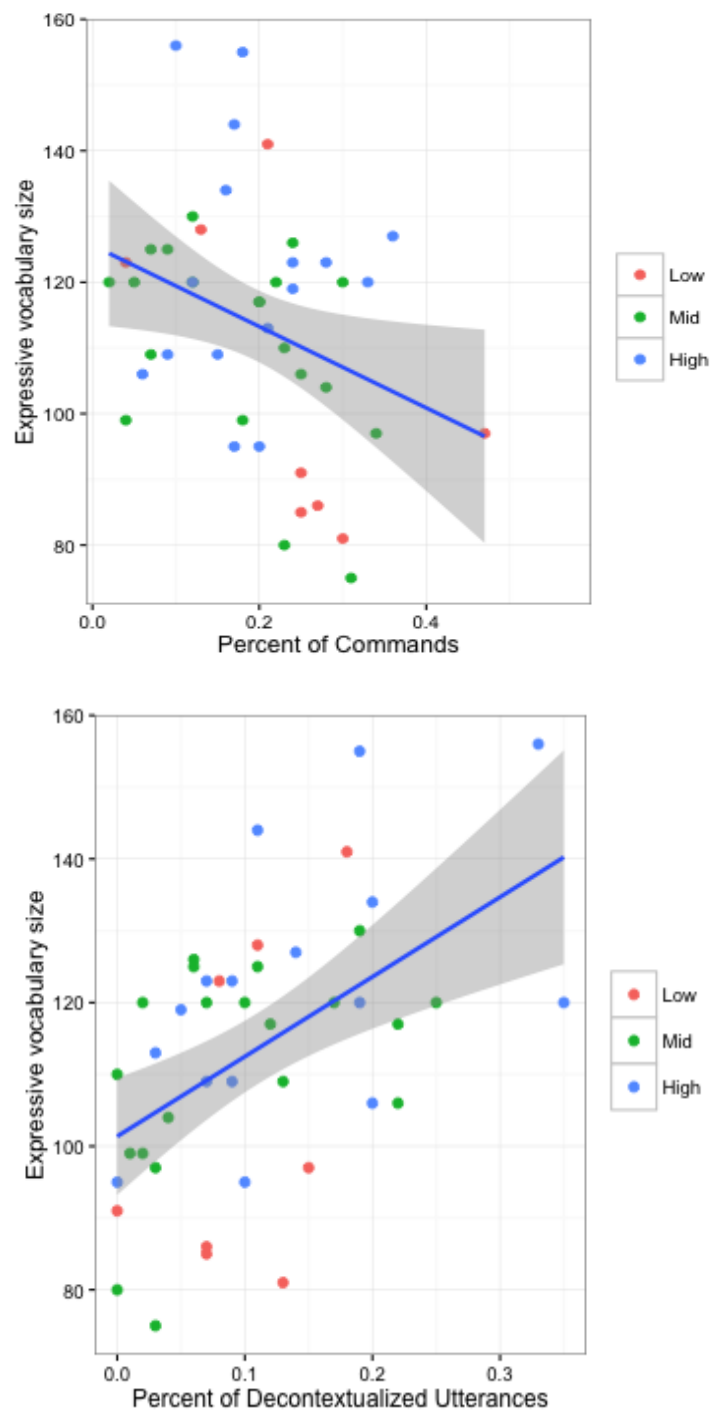
Figures 3.10. Distribution of PPVT-4 scores by maternal education level at time point 1 (top) and time point 2 (bottom)



Figures 3.11. Relationship between EVT-2 score at time point two and linguistic quantity measures AWC (top) and proportion of meaningful speech (bottom) by maternal education level



Figures 3.12. Relationship between EVT-2 score at time point two and semantic/syntactic quality measures NDW (top) and MLU (bottom) by maternal education level



Figures 3.13. Relationship between EVT-2 score at time point two and conversational quality measures percent of commands (top) and percent of decontextualized utterances (bottom) by maternal education level

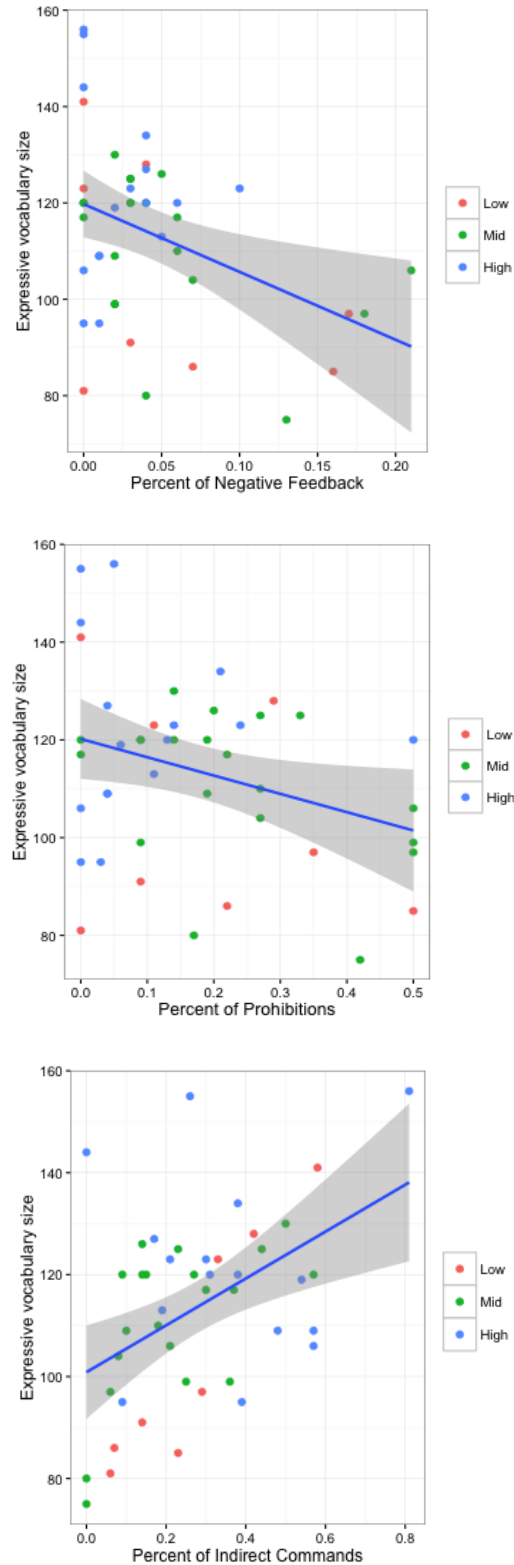


Figure 3.14. Relationship between EVT-2 score at time point 2 and conversational quality measures percent of negative feedback (top), percent of prohibitions (middle) and percent of indirect commands (bottom) by maternal education level

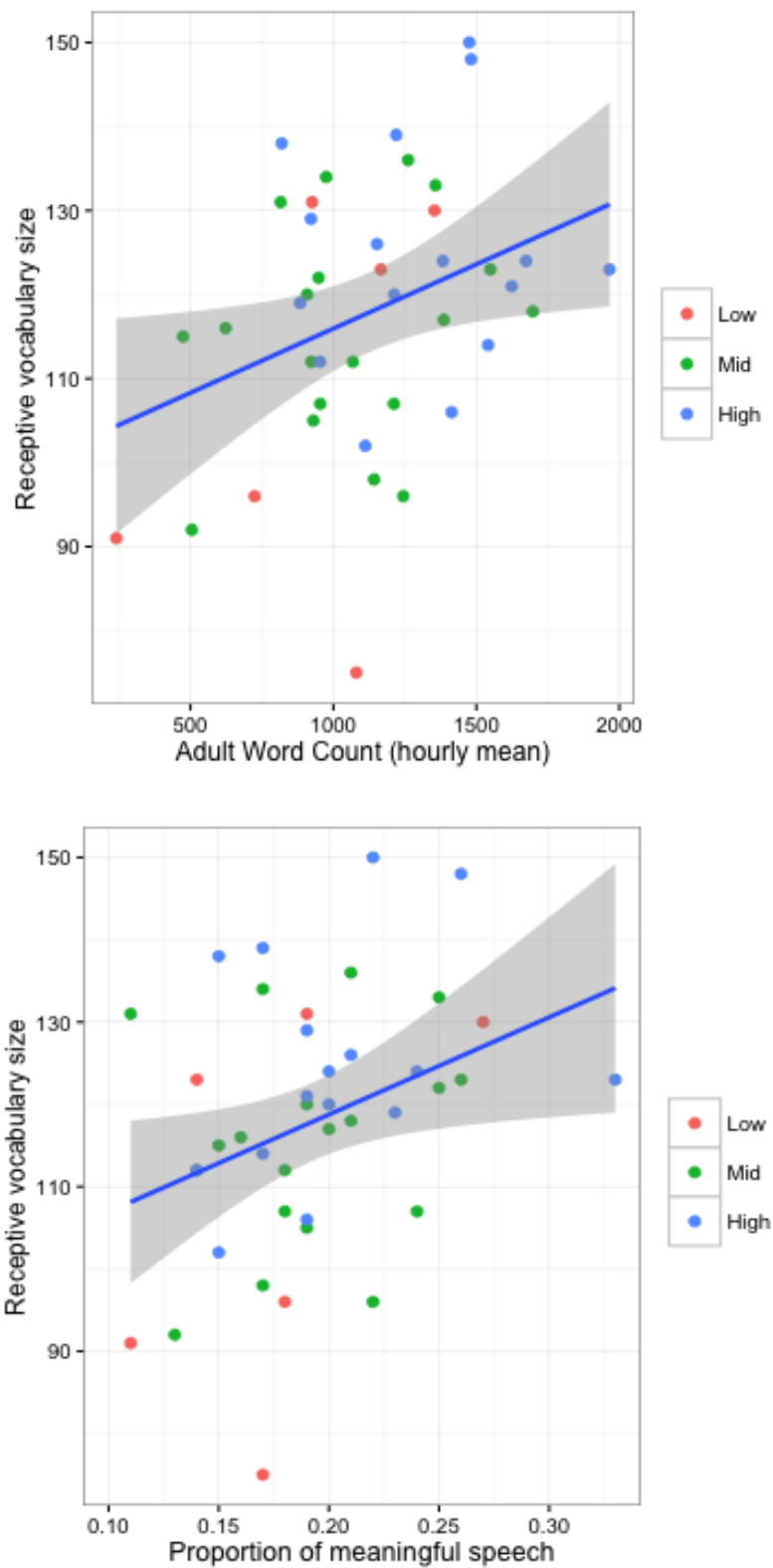
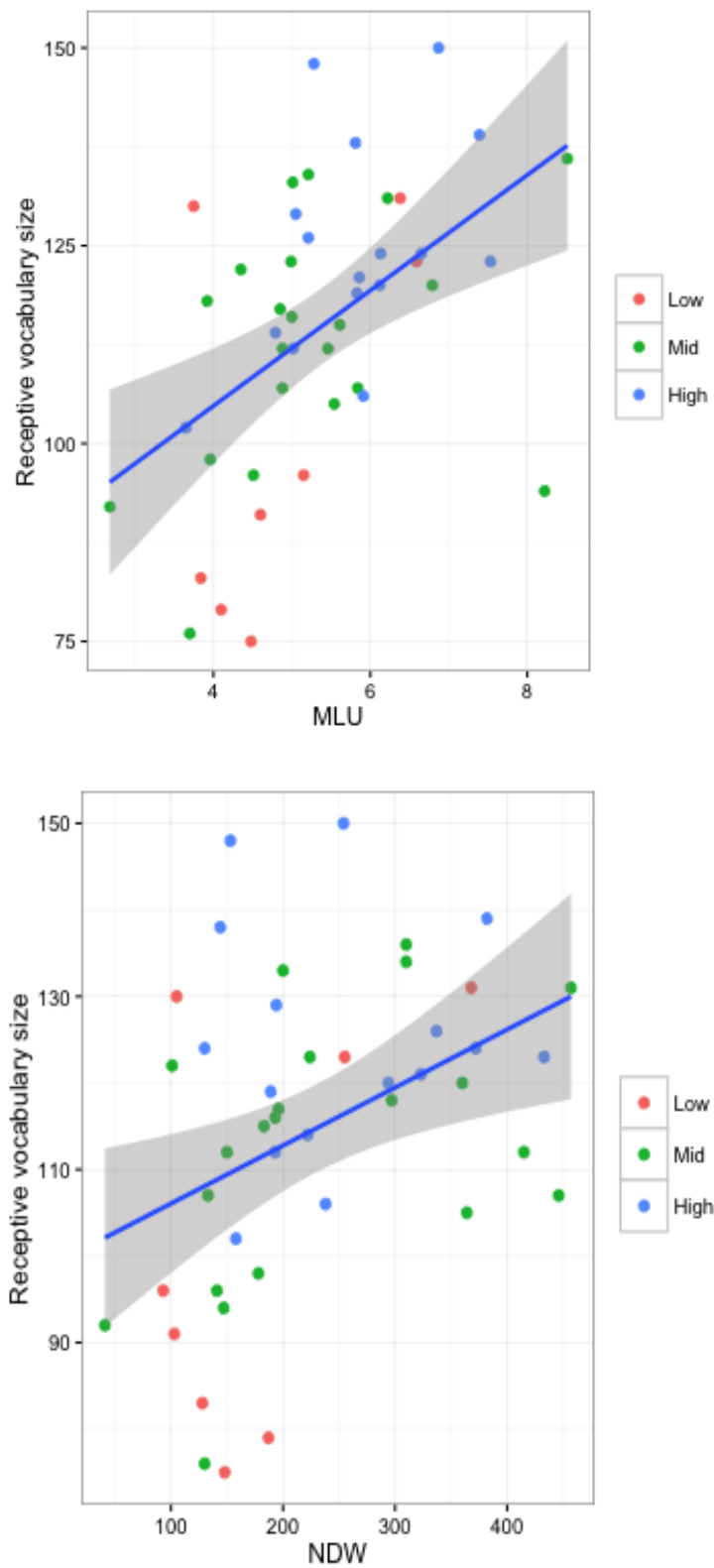
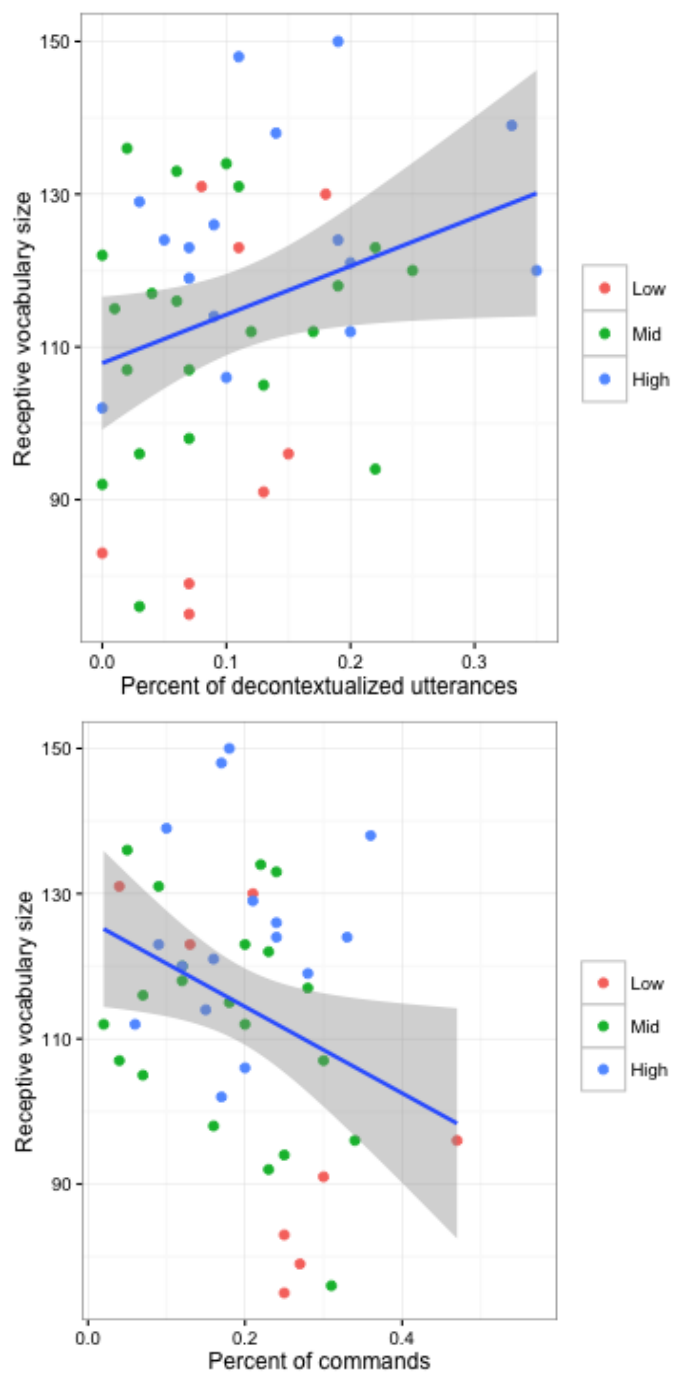


Figure 3.15. Relationship between PPVT-4 score at time point two and linguistic quantity measures AWC (top) and proportion of meaningful speech (bottom) by maternal education level



Figures 3.16. Relationship between PPVT-4 score at time point two and semantic/syntactic quality measures MLU (top) and NDW (bottom) by maternal education level



Figures 3.17. Relationship between PPVT-4 score at time point two and conversational quality measures percent of decontextualized utterances (top) and percent of commands (bottom) by maternal education level

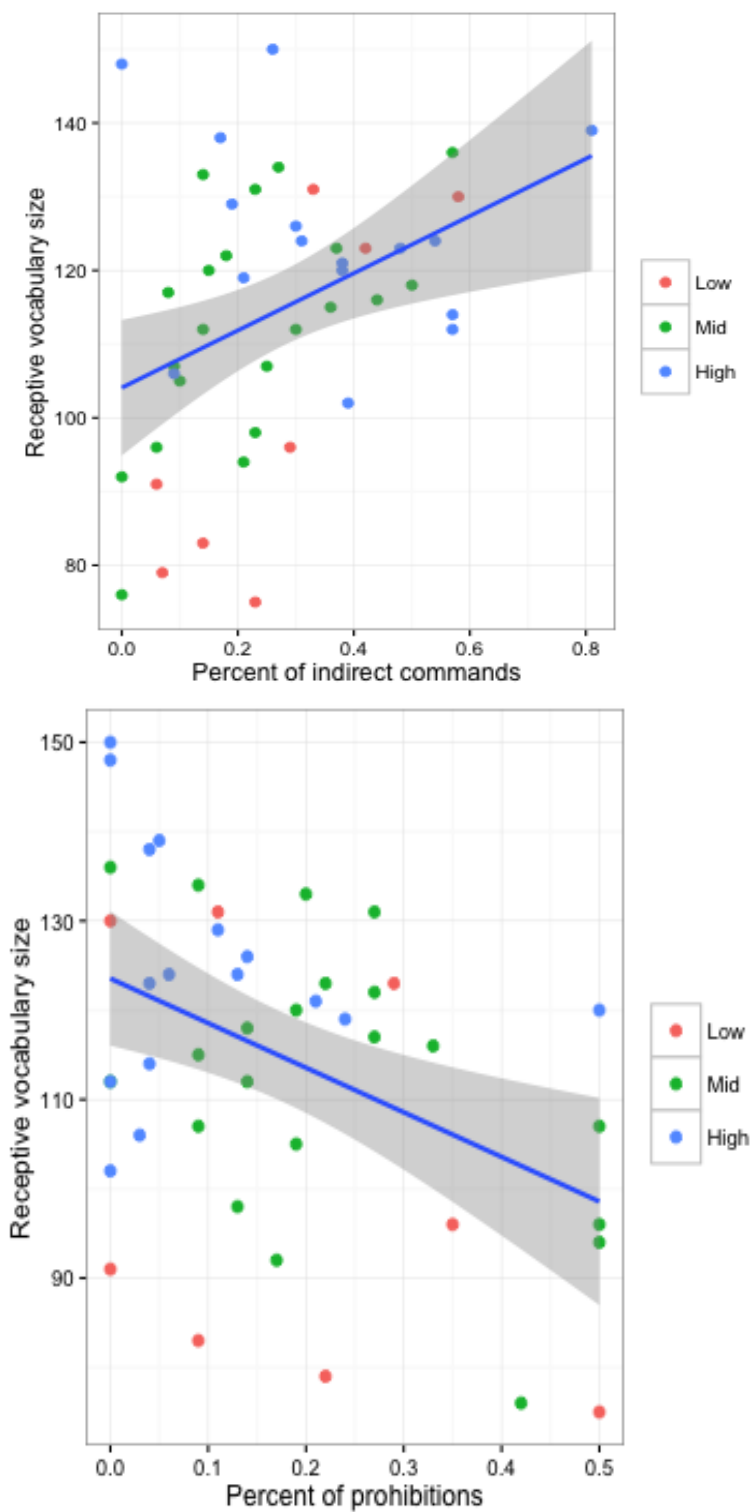


Figure 3.18. Relationship between PPVT-4 score at time point two and conversational quality measures percent of indirect commands (top) and percent of prohibitions (bottom) by maternal education level

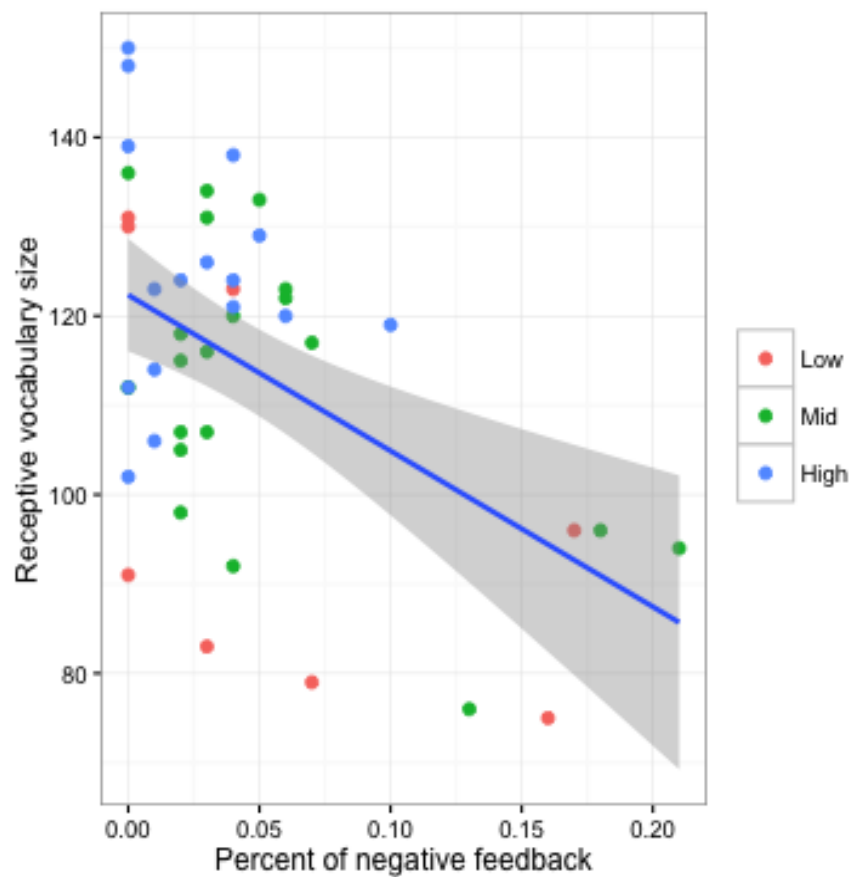


Figure 3.19. Relationship between PPVT-4 score at time point two and percent of negative feedback by maternal education level

CHAPTER FOUR

Discussion

Two questions were addressed in this paper. The first question examined the relationship between linguistic quality and quantity of home language input, and whether or not this relationship was influenced by maternal education level. The results suggested that the relations between the measures of linguistic quantity and quality were not particularly strong or surprising. The proportion of meaningful speech was not correlated with any of the linguistic quality measures. While adult word count was correlated with some of the linguistic quality measures, these tended to be, for the most part, measures that were quantitative in nature. For example, adult word count was correlated with number of different words, total number of words, and MLU. There were relatively few significant correlations between AWC and the conversational quality measures. There were also relatively few significant correlations observed between the morphological/semantic quality measures (MLU, NDW, and TNW) and a number of the conversational quality measures, suggesting that having a large vocabulary or using complex syntax does not necessarily lead to being a responsive and contingent conversational partner. As in previous research (Hart & Risley, 1995; Dollaghan et al., 1999; Rush, 1991; Rowe, 2012), maternal education level was associated with significant differences in a number of the quantity and quality measures of home language input, including ADW, MLU, NDW, and percent of commands, indirect commands, prohibitions, and negative feedback. The small number of participants in each group ($n = 15; 22; 14$) and large variability within groups may explain why other differences were not found to be statistically significant.

The second question focused on how the quantity and quality of home language input when children are 2 ½ to 3 years of age influenced their expressive and receptive vocabulary size

one year later. The results here are complicated. As expected, the best predictor of vocabulary size at age 3 ½ to 4 is vocabulary size at age 2 ½ to 3. However, even when vocabulary size at time point 1 was included in the models, there were additional significant predictors. For expressive vocabulary, two quantity measures (AWC and proportion of meaningful speech) were predictive. Conversational quality measures that predicted expressive vocabulary size were percent of decontextualized speech and percent of negative feedback. MLU was also a significant predictor of expressive vocabulary size. Receptive vocabulary size was predicted by just one measure of quantity (proportion of meaningful speech) and one conversational quality measure (percent of negative feedback). Across models, receptive vocabulary size was consistently predicted by MLU. With one exception, maternal education level did not directly influence vocabulary size, although it may have had an indirect effect by influencing the linguistic quantity and quality measures. As noted above, maternal education level led to significant differences in a number of the quantity and quality measures of home language input. In summary, the measures that had the greatest impact on expressive vocabulary size were: AWC, proportion meaningful speech, MLU, percent of decontextualized utterances, and percent of negative feedback. The measures that had the greatest impact on receptive vocabulary size were proportion of meaningful speech, MLU, and percent of negative feedback. This further emphasizes the role that quality of input has on vocabulary development.

The results of this study are consistent with previous research investigating the relationship between vocabulary development and linguistic quality. These findings build on previous research by Hoff (2003), which found differences in linguistic quality based on maternal education level. For example, the data suggests that mothers with a lower education level tend to use more direct commands, whereas mothers with a higher education level tend to

use a greater proportion of indirect commands. These differences at least in part can result in differences in vocabulary size. Rush (1999) found that positive feedback was positively correlated with child language development, and these results suggest the inverse is true as well; negative feedback can adversely affect language development. Other research (Salo et. al, 2013; Hoff-Ginsberg, 1991; Hoff, 2003) emphasized the effect of contingent utterances on vocabulary development, whereas this research suggests that contingency is less important than whether or not parent language is complex and contextualized. Previous research relating parent input and vocabulary development has often looked at children's vocabularies starting in kindergarten and following them throughout the school years. This study examined children's vocabulary size at least one full year before they started kindergarten, which adds further evidence to support the effect that input quality has on early language development.

There were some limitations of this study, including the small number of participants. The number of low and middle maternal education level participants was restricted by the available number of participants from the larger longitudinal project. In addition, I originally set out to have a larger number of high maternal education level participants, so that each low and middle maternal education level participant had an age and gender-matched peer in the high maternal education group. Time constraints prevented me from doing this. In addition, while inter-rater reliability was measured for the reliability of coding, inter-rater reliability for transcription was not assessed. Vocabulary size was operationally defined only by the children's standardized test scores, which may be an inaccurate or incomplete measure of vocabulary. Other limitations include that maternal education level was used as the sole measure of socioeconomic status, rather than also considering other factors that influence maternal education level such as occupation and income-to-needs ratio. Furthermore, this study did not include

family composition, demographic information, or maternal age in the analyses. I was also unable to examine parents' use of rare words, which has been previously found to be a significant predictor of vocabulary in children this age (Rowe, 2012).

It should also be noted that how each conversational quality measure was defined may have influenced the outcomes. For example, expansions were defined extremely narrowly. An utterance needed to include additional linguistic complexity (e.g., child: *doggie*; mother: *a big doggie*) to be coded as an expansion. Consequently, expansions were only 3% of comments across the entire group and even parents from high maternal education level families only used expansions 4% of the time. If this category had been defined more broadly, the results might have been different.

Future studies should attempt to answer this research question using various measures of children's vocabulary, and with a larger number of participants. In addition, now that it has been established that quality of input has a significant effect on vocabulary development, it must be determined if parents can be taught to modify the quality of their speech. Previous research shows that parents can be taught to increase the quantity of their language through parent intervention programs and access to data (Suskind et al, 2013). However, teaching parents to reduce their use of commands or increase their use of decontextualized language is a much more complex task. Furthermore, it may be unrealistic to expect parents to use less prohibitions, particularly if they are single parents. Research must be done to determine if these are feasible expectations for parents of young children.

In any case, this study has significant implications for future parent-coaching intervention techniques. Many parent-coaching programs, particularly programs like "Providence Talks" and the Thirty Million Word Project, focus solely on having parents increase the number of words

they speak every day and bombarding their children with language input. Parents should be encouraged to increase the quality of their input, rather than simply the quantity of their language, including increasing the length of their utterances. Parents, regardless of their educational background or socioeconomic status, should be encouraged to discuss more abstract, decontextualized concepts with their children to boost their receptive and expressive vocabulary. In addition, parent coaching techniques should focus on avoiding excess amounts of negative feedback, as this may have a negative effect on vocabulary development.

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