Relationships among non-mainstream American English, vocabulary size, and lexical processing efficiency in preschool-aged children

by

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TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX

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ABSTRACT

Children who speak Nonmainstream American English (NMAE) are at risk of being misdiagnosed with a speech and/or language disorder more frequently than their peers who speak Mainstream American English (MAE). Previous literature examining dialect use in children has found conflicting results regarding the impact of dialect density on academic achievement. The purpose of this study was to investigate how the use of NMAE is related to vocabulary development in preschool children who have yet to receive significant exposure to MAE. I examined the relationship among dialect density (as measured from a language sample), vocabulary size (as measured via standardized testing), and lexical processing efficiency (as determined via an online looking-while-listening task). It was found that age influenced all three measures (dialect density, vocabulary size, and lexical processing efficiency), and that there was a relationship between vocabulary size and lexical processing efficiency. However, once age was taken into account, dialect density (morphological, phonological, overall, or non-age-dependent) was not a significant predictor for any of the variables of interest in this group of preschool-aged children.

CHAPTER 1

Introduction

As compared to peers who speak Mainstream American English (MAE), children who speak Nonmainstream American English (NMAE) are at risk of being misdiagnosed with a speech and/or language disorder at higher rates. Furthermore, children who speak NMAE perform significantly lower on reading achievement and language tests (Craig & Washington, 2002; Patton Terry & Connor, 2012). According to Patton Terry and Connor (2012), children beginning school instruction who use substantial amounts of NMAE are at risk for experiencing reading failure and negative outcomes at school due to dialect mismatch. This finding seemingly contradicts earlier work by Craig and Washington (1994), who found that preschool-age children who used more features of their native dialect used more complex syntax.

The work of Craig and Washington (1994) focused on preschool-aged children, while the work of Patton Terry, Connor, Thomas-Tate and Love (2010) focused on school-age children. While both studies examined the use of NMAE, they found contrasting results. As such, it may be the case that high levels of dialect density means something different in preschool aged children vs. in school-aged children. In preschool-aged children, high dialect density may reflect good learning of one's native dialect; in contrast, high dialect density in school-aged children may reflect poor learning of dialect shifting. Although there are multiple studies examining the use of NMAE in young school-age children, we do not currently understand the relationship between dialect density and language development among preschool-aged children exposed primarily to NMAE.

The purpose of this study was to investigate the relationship among NMAE, expressive vocabulary, and lexical processing speed to determine how dialect use is related to vocabulary development, a basic measure of language acquisition, in young children. There is little previous research on the relationship between dialect density and lexical development in preschool-aged children. By assessing preschool-aged children who have yet to receive much exposure to MAE, I am able to examine the relationship between dialect use/dialect density and language acquisition in young children who speak NMAE. To examine the relationships among NMAE, vocabulary size, and lexical processing, I measured children's dialect density from a language sample, their lexical processing speed on a eye tracking task, and their vocabulary size, as assessed via standardized testing. I examined the relationships among these measures using regression analysis. This study will provide much needed information about how NMAE use at a young age can influence school readiness and academic success.

Literature Review

Standard American English (also referred to as Mainstream American English) is the primary dialect that children encounter at school. AAE, an NMAE dialect, is a dialect spoken by many African-American children at home and in the community. While NMAE and MAE share many features, child AAE can be characterized by at least 40 different morphosyntactic and phonological features that vary from other varieties of English (Craig, Thompson, Washington, & Potter, 2003; Hinton & Pollock, 2000; Oetting & McDonald, 2001; Washington & Craig, 2002; Horton-Ikard & Miller, 2004, 2005; Jackson, 2001).

Children who speak NMAE are at greater risk of being misdiagnosed with a speech and/or language disorder than their MAE speaking peers. Prior studies have demonstrated that children who speak AAE have a lower level of performance on most standardized tests of language (Craig & Washington 2002; Charity, Scarborough and Griffin, 2004; Patton Terry et al., 2010). Furthermore, children living in poverty or who are a racial minority are often observed to have poor academic achievement (National Assessment of Educational Progress, 2007); these are often children who speak NMAE (Horton-Ikard & Miller, 2004; Craig & Washington, 1998). Children who begin formal reading instruction using substantial amounts of NMAE are at risk for experiencing reading failure later in school (Patton Terry, 2012; Patton Terry & Connor, 2012).

Contradictory findings regarding the relationship between NMAE use, language, and literacy skills have been shown in previous studies. One of the earliest studies on this topic studied the relationship between dialect use and language skills in preschool-aged children. Craig and Washington (1994) examined the complex syntax of 45 preschool aged African-American children using spontaneous language samples. Language samples were collected during free play and picture description; utterances were then evaluated for the presence of complex syntax and AAE features. Results from this study indicated that the amount of complex syntax was positively related to the frequency of occurrence of utterances containing an AAE form. Lower amounts of complex syntax occurred in language samples of children using lower amounts of AAE, while higher amounts of complex syntax occurred in language samples of children using higher amounts of AAE. In other words, there was a positive relationship between the complexity of syntax produced and the amount of dialect density (i.e. the number of AAE forms produced) across subjects. In this study, preschool-aged children who used more features of their native dialect exhibited a higher use of complex language. Similarly, Ross, Oetting and Stapleton (2004) found a positive relationship between the use of AAE forms and narrative complexity. In their study examining the language samples of 93 4- and 6-year-old children who spoke AAE, the 6-year-old children who produced the highest level of narratives used the most tokens of *had +Ved* (an AAE feature).

Similarly, Connor and Craig (2006) conducted a study involving preschool-aged children. Their study included 63 African-American preschoolers and explored the relationship between their use of AAE and emergent literacy skills. In this study, children's use of AAE was examined during a sentence imitation task and an oral narrative task. For the oral narrative task, the percentage of dialect used (dialect density measure [DDM]) was calculated for each participant. For the sentence imitation task, two scores were computed: a raw score computed as described in the manual, and a second score which accounted for productions that would have been otherwise marked as incorrect due to the production of an AAE feature. Results from this study indicated that there was a U-shaped relation between the dialect density and phonological awareness (rhyming), sentence imitation, and letter-word recognition skills. Children who used AAE features either very frequently or very infrequently in the oral narrative elicitation task demonstrated stronger emergent literacy skills than children who use AAE with moderate frequency.

Although both the Craig and Washington (1994) and the Connor and Craig (2006) studies focused on the use of dialect in preschool-aged children, they found contrasting results. In both studies, children who used high amounts of dialect were shown to produce more complex language or to have better phonological awareness. In Connor and Craig (2006), however, children with very low dialect density performed similarly to children with very high dialect density on emergent literacy measures. By contrast, Craig and Washington (1994) found that children with low dialect density had poorer language skills. There are several factors that may account for the differences in these findings. Unlike Connor and Craig (2006), Craig and Washington (1994) only looked at group differences; therefore it was not possible to determine whether there were children with low DDM who used complex syntax. Additionally, the measures used to evaluate DDM varied between the two studies. Craig and Washington (1994) quantified dialect density as the number of dialect features (morphosyntactic and phonological) produced during language samples collected during free play and picture description; Connor and Craig (2006) quantified dialect density as the number of morphosyntactic features only during an oral narrative. As noted above, the language elicitation task and the way dialect features are counted may influence dialect density. Dialect density may be higher in a more natural context (language samples) vs. a context that explicitly encourages the use of MAE (oral narrative).

While there are only a small number of studies that have investigated dialect density and language ability in preschool-aged children, many more studies have assessed the relationship between dialect use and language and literacy measures in school-aged children. Similar to the studies with preschool children, different relationships have been found between language measures and dialect use in different studies. The U-shaped relationship of Connor and Craig (2006) has been observed, as has as a negative relationship between dialect use and language and literacy measures, highlighting the fact that the relationship between dialect use and academic achievement is complex.

In a recent study, Patton Terry et al. (2010) investigated dialect use and various language and literacy measures (specifically vocabulary, phonological awareness, and reading skills) at the beginning of first grade. 617 children participated in this study, 47% of whom were African-American. Each child in the study received the Diagnostic Evaluation of Language Variation Screening Test (DELV-S). Developed by Seymour et al. (2003), the DELV-S is a screening tool designed for use with children who speak MAE and variations of MAE (or NMAE). The purpose of the DELV-S is to distinguish children who use NMAE due to a dialect differences from children who may have a language disorder. Part I of the DELV-S is used to determine whether a child speakers with strong, some, or no variation from MAE. Children are asked to describe actions in pictures or respond to questions about pictures, and their responses are then scored for the production of mainstream or nonmainstream forms. From Part I of this screening tool, a dialect variation (DVAR) score is calculated. DVAR represents the percentage of items that were observed to vary from MAE. Part II of the DELV-S is used to determine children’s risk for language disorder by assessing their morphosyntactic knowledge and linguistic processing ability (through the use of *wh-* questions, verbs, and nonword repetition).

Results from this 2010 study indicated significant relationships; however, these relationships were not always negative. Children's vocabulary showed a negative and nonlinear relationship as compared to DVAR scores, but this varied by school SES: at high-SES schools, SES had little effect on vocabulary, while an increasingly negatively relationship was found between DVAR and vocabulary at average and low SES schools. The association between phonological awareness and DVAR was negative and linear—the more children used NMAE features, the lower their phonological awareness scores. A U-shaped relationship was observed between DVAR and word reading: children with very high DVAR scores and very low DVAR scores performed similarly on the word recognition measure; this, however, as mediated by school SES as well—the U-shaped relationship was in greater evidence at high SES schools than at lower SES schools. Overall, this study demonstrated that there is a complex relationship between dialect differences and language measures associated with early reading achievement.

Although Patton Terry (2010) found varying results between NMAE use and language and literacy measures, Charity et al. (2004) was one of the first in a set of recent studies to observe a strictly negative relationship between NMAE use and a language measure, specifically a sentence imitation task. 217 African-American children in kindergarten though second grade were involved in this study. The purpose of this study was to assess how familiar these children were with MAE by seeing how well they could reproduce phonological and grammatical features of MAE during a sentence imitation task. Results of this study indicated two things: (1) Children who had more exposure to MAE were better able to accurately complete the sentence imitation task, and they also demonstrated better outcomes on reading and language measures than children with less exposure to MAE; and (2) the familiarity that children had with MAE varied significantly depending on grade. Although younger children (i.e. children in kindergarten) were familiar with MAE, they were less able to fully imitate all of the phonological and morphological features during the sentence imitation task than children in first and second grade. This suggests that, unsurprisingly, as children advance in school, they have increased familiarity with both phonological and grammatical aspects of MAE. Overall, children in this study who were more familiar with MAE (or children who were better at reproducing MAE features during the sentence imitation task) demonstrated an advantage in early reading skills.

Similarly, Patton Terry, Connor, Petscher, and Conlin (2012) found a negative relationship between the use of NMAE, letter-word reading, and passage comprehension skills. This study examined a subset of 49 first and second graders from a larger longitudinal study who were considered to be moderate to strong NMAE speakers (as measured by the DELV-S). Results indicated that as these children progressed through the first grade, they increased their spoken production of MAE (i.e. had a more negative change in DVAR, change in DVAR representing the change in NMAE use over time) and maintained these production levels into second grade. Children with stronger vocabulary skills at the beginning of first grade increased their MAE use more quickly (e.g. had a greater decrease in change in DVAR between kindergarten and 1st grade) that those with weaker skills. Additionally, the children who increased their use of MAE at a faster rate demonstrated a greater growth in reading skills between first and second grade than the children whose MAE production remained stagnant or decreased. Using the same subset of participants, Patton Terry and Connor (2012) found a similarly negative relationship between DVAR (the percentage of dialect variation), letter-word reading, and phonological awareness. Although the relationship between these three variables was negative, the authors found that the change in NMAE use in these children was not significantly associated with a change in their reading skills from kindergarten to first grade.

The purpose of the present study was to examine the relationship among NMAE, expressive vocabulary, and lexical processing efficiency to determine how dialect use is related to vocabulary development in young children. Very little research has been done regarding how dialect density in preschool-age children is related to online lexical processing. In principle, dialect density and lexical processing should be unrelated because there is no theoretical reason why the denseness of a speaker's dialect should be related to the efficiency of their lexical processing. However, a series of recent studies by Marchman and Fernald (e.g., Fernald, Perfors, & Marchman, 2006; Marchman & Fernald, 2008) have shown a relationship between vocabulary size and lexical processing speed. Based on these studies, we considered lexical processing efficiency to be a measure of overall language skill. As such, lexical processing is an additional measure that can be used to address the question of how dialect density and language ability are related in preschool-aged children who speak a NMAE.

The looking-while-listening (LWL) paradigm provides a way to measure online lexical processing. In the LWL paradigm, children are presented with pictures of familiar objects on a computer screen. They hear a verbal prompt containing the name of one of the objects and their eye gaze patterns as they respond to the verbal prompt are recorded and analyzed for accuracy (how long they looked at the target picture relative to a set period of time) and reaction time (RT) (how long it took the child to direct their gaze from the distractor to the target picture). This allows for researchers to assess the lexical processing efficiency – that is, how quickly and consistently children respond to a familiar object name.

In a series of studies assessing online lexical processing, Fernald, Marchman, and colleagues (e.g., Fernald et al., 2006; Marchman & Fernald, 2008) found that 25-month-old children with higher expressive vocabularies (as measured by the MacArthur-Bates Communicative Development Inventory, Fenson et al., 2006) had faster reaction times to familiar object-names as compared to children with smaller expressive vocabularies. They also found that reaction time to familiar object-names at 18 months was a predictor of vocabulary size at age 8. Fernald, Marchman and Weisleder (2013) found that SES was a predictor of lexical processing speed on the LWL task. Even as young as 18 months, there was a disparity in the efficiency of online lexical processing between children from higher SES families and children from lower SES families. Children from higher SES families were more accurate overall in looking to target words and had faster reaction times than children from lower SES families. Children from lower SES families were found to reach the same levels of speed and accuracy at 24-months that children from more advantaged families reached at 18 months, exemplifying about a 6-month gap the development of vocabulary and processing speed between the two groups. While Fernald and colleagues have examined lexical processing in children from low-SES families, they have not examined lexical processing in children who speak AAE; furthermore, their studies do not vary the dialect of the experimental stimuli in studies with children from low-SES families, even though most children from low-SES families speak a NMAE. To date, there is virtually no research on online lexical processing in children from low-SES families who speak AAE.

To summarize, much of the research done thus far has examined the relationship between the use of AAE and language and literacy skills in school-aged children. Investigating the relationship between AAE, expressive vocabulary, and lexical processing speed in children who have limited experience with formal education/schooling and written text will provide further insight as to the role that the use of NMAE at a young age plays in later language and literacy skills. In the long run, it is hoped that the results of this research will help to develop strategies to alleviate the achievement gap and promote school readiness and academic success and reduce rates of misdiagnoses of speech and/or language disorders.   I hypothesized that dialect density may have different meanings for different age groups. For preschool-aged children, high dialect density may be associated with being a better language learner. By contrast, for school-aged children, high dialect density may be associated with problems with learning how to dialect shift. Although the current literature is contradictory, I predicted that the preschool aged children in this study would have a negative or U-shaped relationship between vocabulary measures and dialect density. If children had high dialect density, then they were considered good learners of their native dialect of AAE. If children had very low dialect density, I hypothesized that were likely to be speakers of MAE. If children had moderate dialect density, I suspected that they were AAE speakers who were less good language learners (they hadn't learned to produce all of the features of their native dialect). Therefore, I expected them to be less proficient on the vocabulary measures. To evaluate this hypothesis, I examined the relationship between dialect density, vocabulary size (expressive and receptive), and lexical processing speed. All tasks were presented in the children's native dialect of AAE when possible. I predicted that there would be a U-shaped relationship between vocabulary and dialect density. Children with low and high levels of dialect density are predicted to have better receptive and expressive vocabulary than children who had moderate levels of dialect density. I similarly expected a U-shaped relationship lexical processing speed and dialect density. Children who had high and low levels of dialect density were expected to have better lexical processing than children who had mid-level dialect density. In terms of vocabulary and lexical processing speed, I expected to find a positive linear relationship, as seen in previous studies (Fernald, Perfors & Marchman, 2006).

CHAPTER 2

Participants

Thirty-two African-American preschoolers (14 boys, 18 girls) from Madison, Wisconsin participated in this investigation. The children ranged in age from 28 months-69months (2;4 to 5;9), with a mean age of 46.09 months (SD=10.58). Some of the children (n = 9) were a part of a larger longitudinal study, the *Learning to Talk* project, which examined the relationship between vocabulary growth and phonological development in preschool-aged children and the other children were recruited specifically for this study. Each child's primary caregiver completed a background questionnaire that elicited information about exposure to literacy, demographic information, and information about developmental history. All of the participants were typically developing according to parent report, and none were enrolled in any special education services. Each child passed a bilateral hearing screening at 25dB for 1000, 2000, and 4000 Hz. All of the participants were from lower socioeconomic status households as determined by the demographics of the children's communities, the reported education of the primary caregiver, and the total family income (see Table 1).

Table 1. Mean descriptive information of participants (standard deviations in parentheses)

Age	Maternal Education[a]	Total Family Income [b]	EVT-2 Standard Score	PPVT-4 Standard Score [c]
46.09 (10.58) Range: 28- 69	2.84 (1.25) Range: 1-5	1.21 (0.50) Range: 1-3	92 (10) Range: 67-119	92 (11) Range: 70-131

[a] The 6-step scale for education level was: 1 = less than high school degree, 2 = GED, 3 = high school degree, 4 = some college/trade school, 5 = college degree, and 6 = post-graduate degree.
[b] The 5-step scale for total family income level was: 1 = below $20,000/year, 2 = $20,000 to $40,000/year, 3 = $41,000 to $60,000/year, 4 = $61,000 to $100,000/year, and 5 = above $100,000/year.
[c] PPVT scores were not available for all participants (n=7). This score represents the mean of the subset of the participants who completed the assessment (n = 25).

All participants were speakers of African-American English (AAE); that is, they all produced at least some features of African-American English on an elicited language sample.

Standardized Testing

Each child's expressive vocabulary was assessed using the *Expressive Vocabulary Test, 2nd edition* (EVT-2, K. Williams, 2006). Most, but not all children (n = 25) also received the *Peabody Picture Vocabulary Test, 4th edition* (PPVT-4, Dunn and Dunn, 2007) to assess receptive vocabulary.

Stimuli for 4 AFC Task

Because the children in this study were preschool-aged children, a two-picture LWL paradigm may be too easy for this age group and ceiling effects are likely to be observed (A. Fernald, personal communication to Jan Edwards, June 6, 2011). Therefore, this task was redesigned to make it more challenging for older children who have developed greater lexical knowledge (Schneeberg & Edwards, 2013). A four alternative forced-choice (4AFC) was used instead of a two alternative forced-choice (2AFC); additionally, a phonological foil and a semantic foil was included for each target, as well as an unrelated object to make the task more challenging. Words were selected using published databases that provided information on age of acquisition (CDI, Fenson, Marchman, Thal, Dale, Reznick, & Bates, 1993; Morrison, Chappell, & Ellis, 2010; PPVT-4, Dunn & Dunn, 2007). The target words were pictureable nouns, all of which had an age-of-acquisition between 38.5 and 56.5 months (see Appendix A). There were two blocks of 24 trials. In each block, each word appeared once as the target word and three additional times as a semantic, phonological, or unrelated foil (see Figure 1).

Different pictures and different repetitions of each word were used in the two blocks of 24 trials. Each target word was represented by two color photographs, one for each block. All photographs were normed in two preschool classrooms, a classroom at the Waisman Early Childhood Preschool (children from middle-SES families) and a Head Start Classroom (children from low-SES families). Photographs that were not recognized by at least 80% of children were replaced. For more detailed information on how target words/images were chosen and normed, see Schneeberg and Edwards (2013).

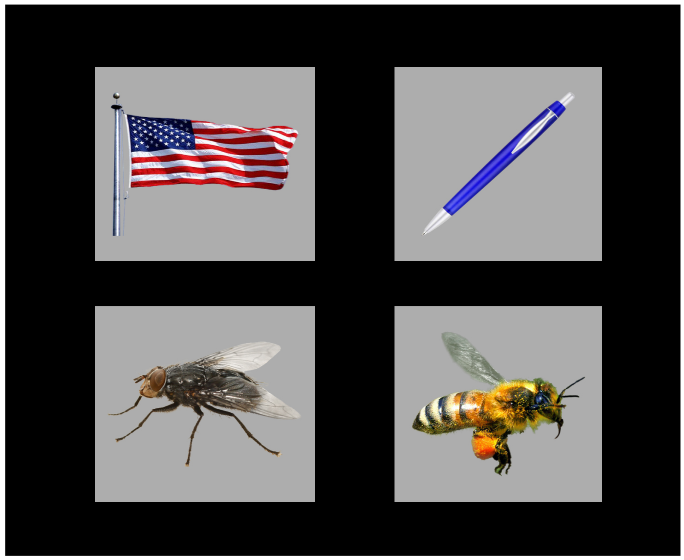

Figure 1: Sample of a stimulus presentation. Four images are presented: flag (phonological foil), pen (unrelated foil), fly (target word), and bee (semantic foil).

Sound stimuli were recorded in a sound treated booth by a young adult female who spoke AAE. The speaker used a child-directed speech register to produce the target words within the phrases, "Find the ____", and "See the ____." All words were normalized for both duration and intensity. Additional information on the auditory stimuli can be found in Schneeberg and Edwards (2013). For this task, all children were tested in their native dialect of AAE.

Language Sampling Procedures

Language samples were collected during adult-child discourse with an African-American female examiner who used AAE forms when interacting with the children. The examiner was one of two AAE speakers on a team of researchers with experience testing children. Elicitation was done within a free play context using three sets of toys: a farm set; an airport play set; and a sandwich making set.

Conversation samples consisted of at least 50 utterances produced by the child. If more than 50 utterances were produced during a sample, the coder analyzed the final 50 utterances of the sample, as children were likely to be more comfortable and speak more as the language sample progressed. Language samples were recorded using a Marantz audio-recorder and an Audio Technica 4040 microphone was placed near the participant. The examiner interacted with the child in a child-directed conversation and formulated encouraging responses to the child's utterances. The examiner also formulated responses for clarification as needed.

Eye Tracking Procedure

The experiment was programmed in ePrime and ran on a Tobii T60XL Tracking system. The Tobii T60XL eye-tracker uses an infrared camera to measure the x,y position of the eyes. The experiment was presented to the children as "watching movies," and a short booklet explaining the task was sent to families prior to their arrival to the lab so that parents could prepare their child for the task. At the beginning of each trial, a calibration was run using Tobii Studio to ensure that the child's eye movements were being tracked accurately. "Track status" in Tobii Studio was used to verify that the child was approximately 60cm away from the monitor during the task. For each trial, children saw four pictures on a large monitor. After 2000 ms, the phrase "*find the* ____" or "*see the* ______" was presented. After 1000 ms, a reinforcing phrase (*way to go, good job*, etc.) was presented, and then a black screen was presented for 500 ms before the next trial. Following each block of six trials, a brief 3-second movie of a familiar animated image was presented moving across the screen and ended in the middle to provide reinforcement to the child.

Data Analysis

Dialect density. Language samples were transcribed orthographically from recordings using a script within Praat (Boersma, 2001). The transcribers were either MAE speakers or AAE speakers, but all orthographic transcriptions were subsequently checked by an AAE speaker and corrected before coding commenced. For each participant, the mean length of utterance in words (MLU) and the number of different words (NDW) were calculated in SALT (Miller & Chapman, 2000).

Speakers of a dialect do not necessarily use all features of that dialect; some dialect speakers speak a more dense dialect while others speak a less dense dialect. This is true in child speech as well as in adult speech. Several ways to measure dialect density of children's speech have been proposed. Oetting and McDonald (2001, 2002) describe three methods of calculating dialect density: listener judgment, type-based counts, and token-based counts. In their 2002 study, Oetting and McDonald used listener judgments to measure dialect density. They asked three European American doctoral students to listen to segments of language samples that had been collected from a series of 4 previous studies. Listeners were blind to the age, race, sex, and language ability of the children. Listeners were asked to make a holistic judgment as to the type and rate of each child's dialect using 2 different seven-point scales (one based on Southern African-American English [SAAE] and the other on Southern White English [SWA]). Listeners were also asked to rate the confidence of their decision on a 3-point scale, and to indicate which linguistic features they used to make their judgments about each participant (paralinguistics, phonology, syntax/morphology, vocabulary). Overall, listener judgment accurately classified between 85% and 92% of the speakers as either SWE or SAAE speakers.

The second method that has been used to determine dialect density is through the use of type-based counts. Type-based methods provide a count of the different nonmainstream pattern types used by speakers. Oetting and McDonald (2002) examined the percentage of children who produced each of 35 nonmainstream dialect features to determine whether certain dialect features were used by more children in one dialect group than the other. The authors found that the patterns *had+Ved* and *I'ma* for *I'm going to* were produced solely by African-American children, while *completive done* and the use of *existential* *it/they* were produced by European American children only. The percentage of production was highest of the use of *had+Ved* (50%), while the other features produced by solely African-American or European American children had productions of less than 6%. The remaining 31 patterns were produced by both European American and African-American children. Overall, of the ten patterns that were produced by the greatest number of children in each racial group, seven patterns appeared on both lists, further highlighting the extent to which mainstream and nonmainstream dialects overlap in their features. Overall, analysis showed that 95% of the children were correctly identified as speakers of SWE or SAAE using a type-based count.

The third measure that Oetting and McDonald (2002) analyzed was the use of token-based counts. There were three token-based methods that they examined: (1) percent of utterances with one or more mainstream patterns; (2) percent of nonmainstream patterns as a function of words spoken (number of features divided by number of words); and (3) percent of nonmainstream patterns as a function of utterances spoken (number of features divided by number of utterances). The authors found that although there was consistency across all three approaches, methods 2 and 3 generated outcomes that could be used to characterize nonmainstream dialects (since method 1 did not examine individual patterns). Across participants, Oetting and McDonald found that method 3 generated a greater range of scores, which allowed for the individual differences across participants to be maximized. Overall, the use of token-based methods allowed for approximately 97% of the children to be correctly classified as an SWE or SAAE speaker.

Still another way to examine NMAE use is via the DELV-S. In her doctoral dissertation, Conlin (2009) found that the DELV-S is successful in differentiating children who speak MAE from those who speak other dialects of English and at identifying some percent of NMAE dialect use. According to Conlin, although the screener is limited in its ability to identify the type of dialect use, the item selection and standardization process indicate that the test was "tacitly intended to identify children who speak AAE apart from MAE." A limitation to the DELV-S, however, is that it is intended for children between ages 4 to 12. The children in the present study were between ages 2.5 and 6 years old; therefore the test would not be suitable for some of the preschool-aged population.

For this study, I calculated dialect density using the total number of words rather than the number of utterances for several reasons. Although each child in this study produced at least 50 utterances, the MLU between participants varied considerably. Additionally, there were frequently multiple AAE features within a single utterance and even within a single word. By measuring dialect density using the total number of dialectal features divided by the total number of words in the sample, all productions of AAE features were accurately represented in each child's language sample. Morphosyntactic dialect density, phonological dialect density, and overall dialect density were each calculated separately.

Analysis of Dialect Features and Dialect Density. Two speakers of AAE were involved in coding of the samples. To code for AAE features, coders listened to the sample, one utterance at a time, and identified features typically associated with the use of AAE. Morphological and phonological AAE features were coded using the coding system developed by Craig et al. (2003) and adapted to the local dialect (see Tables 2 and 3). Inter-rater reliability was done by consensus (Shriberg et al., 1984). The two coders independently coded all of the language samples. Point-to-point comparisons examining morphological and phonological features were then made. For the first 12 language samples, when there were any disagreements in coding, the two coders met and discussed any discrepancies, and a consensus was made regarding if a feature was present, and if so, which feature it was. For the final 20 language samples, the first author identified disagreements in coding and made a decision about how to resolve the disagreement, based on the consensus decisions that had been made on the first 12 language samples. Dialect density was calculated as the number of dialect features divided by the total number of words in the sample. An overall dialect density, a morphological dialect density (based on morphological features only), and a phonological dialect density (based on phonological features only) were calculated for each child.

4AFC LWL Task. For each LWL trial, the time range analyzed was between 250ms (onset) and 1750 ms (end of analysis). 250 ms was chosen as the starting point because this was the time point at which eye movements began to move consistently toward the target when a plot of grand means (averages of eye gaze patterns across all participants) was examined. 1750 ms was chosen as the end point because 1500 ms is the typical period of analysis in many LWL studies (Fernald et al., 2006).

At each time point, the child's eye gaze was analyzed in terms of whether the child looked to one of four areas of interest (AOIs) (target, phonological foil, semantic foil, or unrelated foil), whether he/she was looking away from all four pictures, or whether the eye gaze was mistracked. The AOI's were defined by the location (in pixels) of each the four pictures. Missing data was imputed as follows: if there was a mistracking that was less than 100ms and then the child's eye gaze remained on the same AOI, the missing data was imputed to be a look toward that AOI. The mistracking was assumed to be due to a blink, because voluntary eye movements take at least 200 ms. *Accuracy* was defined as looking duration to the target relative to the total duration of interest (1500ms). *Latency* was defined as the time from word onset to the first look to the target picture (and was computed only for trials when the child was not looking at the target at word onset or in the first 50 ms after word onset). These two measures were used to represent lexical processing efficiency.

Statistical Analysis. I used regression analyses to examine the relationships among the different measures. The measures of interest were the following: age, dialect density (morphological, phonological, and combined), receptive and expressive vocabulary size (quantified as PPVT-4 GSV score and EVT-2 GSV score), age, and lexical processing efficiency (quantified as accuracy and latency during the LWL task).

Table 2: Morphosyntactic features of AAE used during language samples

Abbreviation	Full name	Explanation	Example from language sample
AIN [a]	Ain't	ain't used as a negative auxiliary in *have* + *not, do* + *not, are* + *not,* and + *not* constructions	"It ain't no fish in there" (415D)
ART [a]	Indefinite Article	article *a* used regardless of vowel context	"This is the house, not a elevator" (414D)
AUX [a]	Zero Auxiliary	modal auxiliary forms *will, can, do,* and *have* variably included	"I ____ have some more bread" (407D)
COP [a]	Zero copula	*is, are, am,* and other forms of the verb *to be* variably included in either copula	"He ___ stuck!" (091L)
DMK [a]	Double marked "s"	hypercorrection of irregular plural and possessive constructions	"Who eat mines?" (406D
EIT [a]	Existential *it*	*it* used in place of *there* to indicate the existence of a person, place, or thing without adding referential meaning	"…where it's animals at, the animal farm" (414D)
FSB [a]	Fitna/sposet a/bouta	Abbreviated forms coding imminent action	"They fitna go to bed" (067L)
GON [b]	Gon	Use of "gon" to indicate imminent action	"I gon do it" (083C)
IBE [a]	Invariant *be*	infinitival *be* coding habitual action with a variety of participants	"I be playing with different kinds of animals" (086C)
ING [a]	Zero *-ing*	present progressive *-ing* variably included	"This man eat___ in here" (421D)
NEG [a]	Multiple negation	two or more negative markers in one utterance	"It ain't no fish in there" (415D)
POS [a]	Zero possessive	possession coded by word order so that (a) possessive *-s* marker is deleted or (b) nominative or objective case of pro-nouns is used rather than possessive	"At grandma__ house" (036L)
PST [a]	Zero past tense	marker *-ed* not always used to denote regular past constructions or the present tense form used in place of the irregular past form	"Her scratch___ me" (046L)
SVA [a]	Subject–Verb Variation	the subject and verb in a (a) first, (b) second, or (c) third person plural or singular construction differing in either number or person	"He don't fly" (409D) "My brother do too" (404D)
UPC [a]	Undifferentiated pronoun case	nominative, objective, and demonstrative cases of pronouns used interchangeably	"Them fitna eat some flowers" (408D)

ZAR [a]	Zero article	the definite article "the" and indefinite articles "a" and "an" variably included	"I wanna look at ___ book" (035L)
ZPL [a]	Zero plural	the plural marker -*s* variably included	"Two frog___" (413D)
ZPR [a]	Zero preposition	prepositions *of, on,* and *at* variably included	"And we gon get this man out ___ this trunk" (421D)
ZTO [a]	Zero to	Infinitival to is variably included	"Yeah I'm gon ___ drive the truck" (402D)

Table 3: Phonological features of AAE used during language samples

Abbreviation	Full name	Explanation	Example from LS
PCR [a]	Postvocalic consonant reduction	Deletions of consonant singleton following vowels	"Wi" for "with" (406D) "Go" for "goat" (080C)
UH [b]	Postvocalic /r/ in words ending in "er" replaced by "uh"	Deletion of "er" replaced by "uh" ɚ replaced by /ə/	"Brotha" or "brothuh" for "brother" (404D) "Butta" for "butter" (013L)
CCR [a]	Consonant cluster reduction	Deletion of phonemes from consonant clusters	"Firs" for "first" (091L) "Frien" for "friend" (409D)
G [a]	"g" dropping	Substitutions of /n/ for /N/ in final word positions	"Goin" for "going" (438D) "Swimmin" for "Swimming" (025L)
SDL [a]	Syllable deletion	Reduction of an (unstressed) syllable in a multisyllabic word	"skuse" for "excuse" (035L)
STH [a]	Substitutions for /ð/ and /θ/	/t/ and /d/ substitute for /T/ and /D/ in prevocalic positions, /f, t/ and /v/ substitute for /T/ and /D/ in intervocalic positions, and in postvocalic positions	"Dey" for "they" (087C) "Bof" for "both" (438D)
VOW [a]	Monophthongization of diphthongs	Neutralization of diphthong	"our" /Ar/ for /Aɟr/ (438D)

[a] Morphological and phonological AAE features were coded using the coding system developed by Craig et al. (2003)

[b] Features marked with an asterisk were added by the coders to reflect features found in the local dialect

The first analysis examined the relationship among dialect density, age, and accuracy on the LWL task. Again, latency was not found to be a significant predictor of any variable; as a result, no analyses were run controlling for latency. Controlling for age, a U-shaped relationship was predicted: children with low and high amounts of dialect density were expected to have better accuracy than children with moderate amounts of dialect density. The second analysis examined the relationship among age, dialect density and vocabulary (expressive and receptive). Controlling for age, I predicted a similar U-shaped relationship; children with low and high amounts of dialect density were expected to have better larger expressive vocabularies than children with moderate amounts of dialect density. The third analysis examined the relation between vocabulary size and accuracy. Similar to previous research, I predicted a positive linear relationship between these two variables. Finally, I evaluated the relationship across all measures. The dependent variable was expressive vocabulary size. The independent variables were accuracy on the LWL task, age, and dialect density. The question of interest in this analysis was whether both lexical processing ability and dialect density independently predicted vocabulary size. All analyses involving vocabulary size used growth score values (GSV) on the EVT-2 and the PPVT-4. As stated previously, PPVT-4 GSV scores were only available for a subset of participants (n=26) Growth score values were used, because they are based on a linear scale (Williams, 2007).

CHAPTER 3

Results

Participant description. Family income was quantified on a 5-point scale and maternal education was quantified on a 6-point scale, as described in Table 1. The mean maternal education level was 2.84 (SD=1.24), which is equivalent to between a GED and a high school degree. The highest education was reported to be *some college* or *trade school*. The mean income level was 1.19 (SD=0.45), which is equivalent to between *below $20,000* and *$20,000 to $40,000* per year. The highest income reported was between *$41,000 and $60,000* per year. Based on these data, the participants from this study were all considered to be from low SES families. The average PPVT-4 standard score was 92 and the average EVT-2 standard score was 92. These scores are in the low-normal range and are similar to what has been observed in other studies of children in this age range from low SES families (Washington & Craig, 1999).

Dialect density. Average morphological, phonological, and overall dialect densities were calculated for each participant. The average morphological dialect density was 0.07 (SD= 0.04); the average phonological dialect density was 0.06 (SD = 0.04); and the average overall dialect density was 0.13 (SD= 0.08). These mean dialect density scores and standard deviations are similar to previous research examining dialect density in oral language samples of preschool-aged children (Craig and Washington, 2004; Edwards et al., 2014).

Further analysis was conducted to examine which AAE features were most prevalent within the sample. Of the features proposed by Craig et al., 2003, some features were not observed at all and other features that were used only a few times. These features are noted in Appendix B and include both morphological and phonological features. Overall, it was found that dialect density decreased with age. This is because the total number of words *increased* with age and the number of dialect features *decreased* with age. There was a significant negative correlation between age and both morphological dialect density and overall dialect density, but not between age and phonological dialect density (r = -.58, $p < .001$ for morphological dialect density, r = -.28, $p > .1$ for phonological dialect density, r = -.49, $p = .004$ for overall dialect density).

In order to further examine the relationship between dialect density and age, a median split was done by age. There were 17 participants in the younger group (46 months or younger), and 15 participants in the older group (47 months and older). Figure 2 shows histograms of feature counts for the most common features used by the younger and older groups. It can be observed in this figure and in Table 4 that use of some features increases with age, use of other features decreases with age, and use of still other features is not influenced by age.

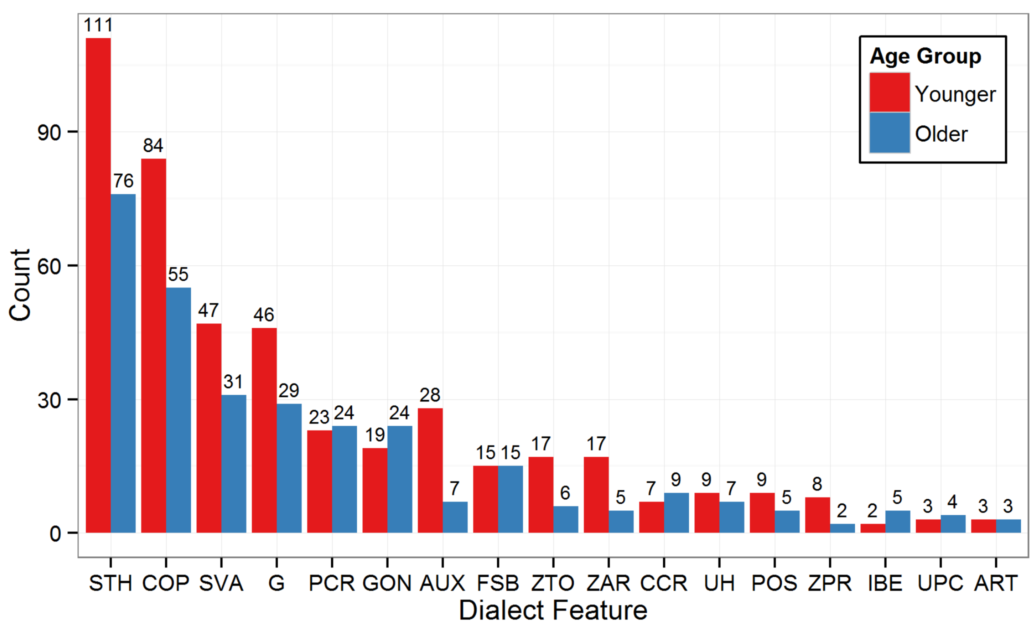

Figure 2. Histogram of dialect features by younger and older groups (see Tables 2 and 3 for a key to the abbreviations used in this figure caption).

I compared the count for each feature between the younger and older children to determine whether there was an increase, decrease, or no change as a function of age (see Table 4). Use of a number of dialect features decreased by more than 40% between the younger and older children. These included: omission of an auxiliary verb (AUX), lack of subject-verb agreement (SVA), omission of plural marking (ZPL), omission of possessive marking (POS), omission of an article (ZAR), omission of a preposition (ZPR), and omission of the infinitival *to* (ZTO).

Table 4. Most common dialect features[a] used by participants during language samples

Dialect features [a]	Younger (46 months or less) (n = 17)	Older (47 months or more) (n = 15)	% change in use as age increases
ART	3	3	0% change
AUX	28	7	75% decrease
COP	84	55	35% decrease
FSB	15	15	0% change
IBE	2	5	60% increase
POS	9	5	44% decrease
SVA	47	31	34% decrease
UPC	3	4	25% increase
ZAR	17	5	71% decrease
ZPR	8	2	75% decrease
ZTO	17	6	65% decrease
CCR	7	9	22% increase
G	46	29	37% decrease
PCR	23	24	4% increase
STH	111	76	32% decrease
GON	19	24	21% increase
UH	9	7	22% decrease

[a] See Table 2, 3 for an explanation of the dialect feature abbreviations

It is plausible that this decrease in use of these features for children over 46 months relative to children 46 months or younger is due to more mature language rather than to a decrease in dialect feature use. A revised dialect density measure was developed that accounted for maturation in language development. This revised dialect density was based on features that decreased by less than 40%, increased, or stayed the same, and was used as a non-developmentally/age sensitive measure of dialect density. Features that had a decrease of more than 40% between the younger and older group were not included in this measure, as it was impossible to determine whether the use of these features was due to dialect or to linguistic immaturity. The mean of this revised non-age sensitive measure of dialect density was 0.12 (SD=0.07). This measure of dialect density was also negatively correlated with age (r = -.36, p = .04), but the relationship was less strong, compared to the relationship between age and original overall measure of dialect density (r = -.49, p = .004).

Looking-while-listening task. As can be observed in Figure 3, at word onset, children looked about equally to all four picture types. After word onset, there was an increase in looks to the target and a decrease in looks to the three foils over time. The latency for each trial on which the child was looking to the distractor at word onset and the accuracy (looks to the target relative to looks to either target or files in the time period from 250 to 2750 ms was calculated for each trial for each child in each block. A weighted mean for latency and for accuracy were calculated for each child. See Appendix D for the raw data that were used to calculate these weighted means.

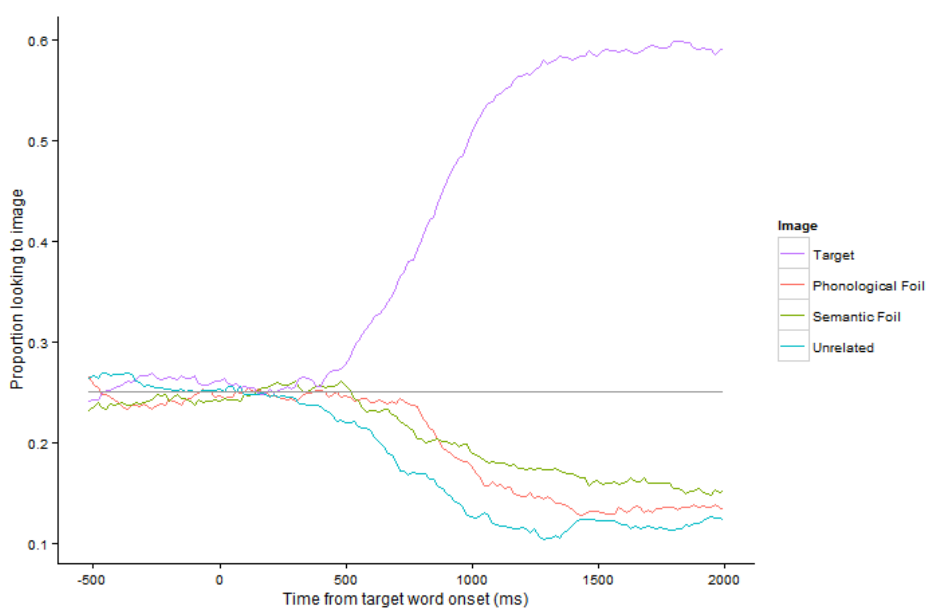

Figure 3. Average looks to target word and three foils over time.

Regression Analyses. The following measures were used in the regression analyses discussed below: Age in months, dialect density (morphological, phonological, overall, and non-age-sensitive), receptive and expressive vocabulary size (quantified as PPVT-4 GSV score and EVT-2 GSV scores), and lexical processing efficiency (quantified as accuracy weighted mean and latency weighted mean during the LWL task). Weighted mean latency was not found to have a significant effect on any measures of interests, so LWL weighted mean accuracy was used as the sole measure of lexical processing efficiency. All regression analyses were step-wise multiple linear regression.

The first analysis examined the relationship among dialect density, age, and accuracy on the LWL task. The dependent variable was accuracy on the LWL task; dialect density and age were the independent variables. A positive linear relationship was found between age and LWL accuracy (R^2=0.43, p < .001). Regardless of the dialect density measure used (morphological, phonological, overall, or non-age-sensitive), there was no significant relationship between dialect density and LWL accuracy. Figure 4 shows the relationship between age and LWL accuracy. It can be observed that accuracy increases as age increases.

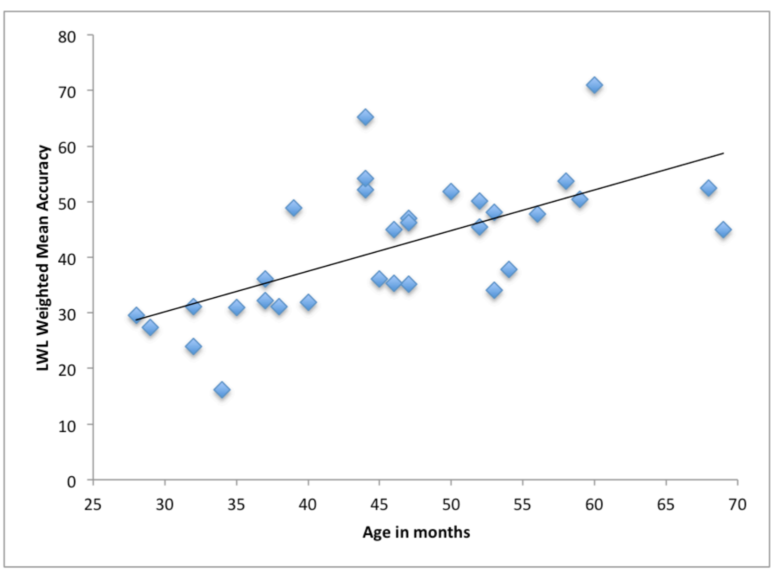

Figure 4. LWL mean accuracy plotted as a function of age in months.

The second analysis examined the relationship among age, dialect density and vocabulary size. The dependent variable was vocabulary size (either PPVT-4-GSV or EVT-2-GSV); dialect density and age were the independent variables. As expected, there was a positive linear relationship was found between age and vocabulary (R^2= 0.56, $p < .001$ for expressive vocabulary and R^2= 0.62, $p < .001$ for receptive vocabulary,). Regardless of the dialect density measure used (morphological, phonological, overall, or non-age-sensitive), there was no significant relationship between dialect density and either receptive or expressive vocabulary size.

The third analysis examined the relation between vocabulary size and accuracy during the LWL task. The dependent variable was accuracy on the LWL task; expressive and receptive vocabulary size, age, and dialect density were the independent variables. Similar to previous research (e.g., Fernald et al., 2006), a positive linear relationship was found between vocabulary size and accuracy on the LWL task. When both receptive and expressive vocabulary size were included in the analysis, the only significant predictor was receptive vocabulary size (R^2=0.75, $p < .001$). Neither expressive vocabulary size, age, nor any measure of dialect density were significant predictors. If receptive vocabulary size was excluded from the analysis, then the only significant predictor was expressive vocabulary size (R^2=0.74, $p < .001$). Neither age nor any measure of dialect density were significant predictors. Figures 5 and 6 show the relationship between vocabulary size and accuracy on the LWL task.

Finally, I evaluated the relationship across all measures. The dependent variable was vocabulary size (either receptive or expressive). The independent variables were accuracy on the LWL task, age, and dialect density. The question of interest in this analysis was whether both lexical processing ability and dialect density independently predicted vocabulary size. The only significant predictors of vocabulary were age and LWL accuracy. When the dependent variable was expressive vocabulary, both LWL accuracy and age were significant predictors (R^2=0.74, $p < .001$ for LWL accuracy alone; R^2=0.79,

$p < .001$ for both LWL accuracy and age). Similarly, when the dependent variable was receptive vocabulary, both LWL accuracy and age were significant predictor (R^2=0.75, $p < .001$ for LWL accuracy alone; R^2=0.85, $p < .001$ for both LWL accuracy and age). None of the measures of dialect density were significant predictors of either receptive or expressive vocabulary.

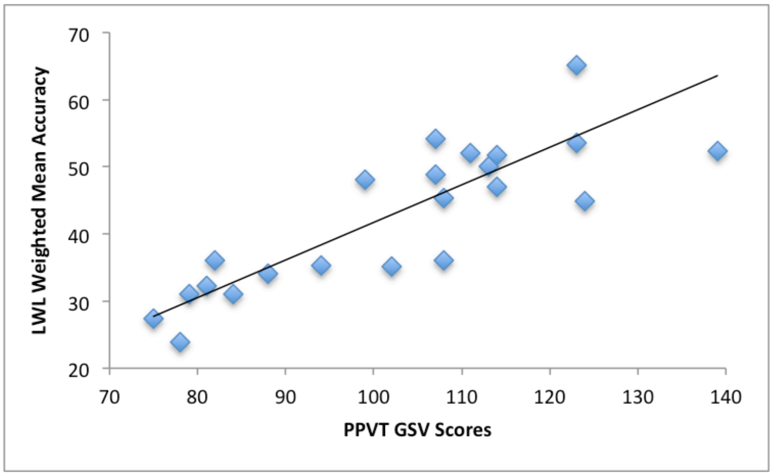

Figure 5: LWL accuracy plotted as a function of receptive vocabulary size.

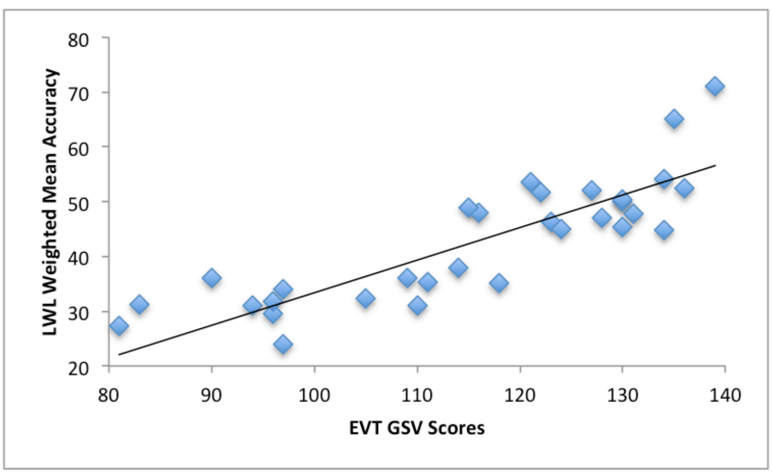

Figure 6: LWL accuracy plotted as a function of expressive vocabulary size.

CHAPTER 4

Discussion

This study examined the relationship among dialect density, vocabulary size, and lexical processing efficiency (quantified as accuracy on an LWL task) in African-American English-speaking preschool-aged children from low-SES households. It was found that age influenced all three measures; as age increased, dialect density decreased and both vocabulary size and lexical processing efficiency increased. There was also a relationship between vocabulary size (both receptive and expressive) and lexical processing efficiency. As in previous studies (e.g., Fernald et al., 2006), vocabulary size was positively correlated with lexical processing efficiency, as quantified by accuracy on the LWL task. Once age was taken into account, dialect density (morphological, phonological, overall, or non-age-dependent) was not a significant predictor for any of the variables of interest in this group of preschool-aged children. One has to wonder whether or not this was due to the language measures used. Would there have been a relationship between dialect density and a measure of syntax? This was not evaluated in this study, and would be something to examine in the future. Another possible reason for the lack of relationship between dialect density and measures of interest may be that dialect shifting was not measured. Studies with older children that have shown a relationship between dialect density and other language measures have collected language samples with MAE-speaking examiners in school settings where dialect-shifting to MAE is pragmatically appropriate. In these studies, the children with higher levels of dialect density are those children have not yet learned to dialect shift and this may be why dialect density is related to poor language performance in these studies. This was not an issue for the children in this study. As preschoolers, they have not yet been significantly exposed to MAE (for example, in a school setting); additionally, language samples were elicited in an informal play setting in their native dialect with an AAE speaking examiner.

One finding of interest in this study was the difference in dialect feature use as a function of age. It was observed that a number of dialect features decreased by 70% or more for the older children in the study relative to the younger children. Use of only seven dialect features either stayed the same or increased in use for the older group relative to the younger group. A limitation of this finding is that this study was not longitudinal; however it is still interesting to look at the differences between the two age groups. While previous studies (e.g., Craig & Washington, 2004) have chosen to measure only morphological dialect density in preschool-aged children because of a concern that it is difficult to differentiate between dialect feature use and language development in young children, this study found that morphological dialect density was more related to age than phonological dialect density. Perhaps there is simply no good way to differentiate between language development and dialect use in preschool-aged children.

Although dialect density was not a significant predictor for any of the variables of interest, vocabulary size was a significant predictor of lexical processing efficiency. Of the children in this sample, two were 1.3SD or more below the mean on the EVT, and four were 1.3SD or more below the mean on the PPVT. Most of the children were "within normal limits" when compared to their peers. However, the majority of children scored between 80 and 100 (n=23), placing them below average when compared to their peers. Although not considered "language-impaired," most of the children in this study would be considered "at risk" in terms of vocabulary. Because vocabulary size was related to lexical processing efficiency, this is a major concern; processing familiar words less accurately puts children with smaller vocabularies at a disadvantage, both for language acquisition and for general learning. This, in turn, could lead to later literacy problems and negative school outcomes. By acknowledging the fact that these later difficulties result from smaller vocabularies rather than dialect use in the classroom, early intervention for these children should focus on enhancing their vocabulary, thereby reducing the amount of misdiagnoses as having a language impairment, as well as diminishing the chance of negative outcomes in the classroom as they grow older.

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Appendix A: Age of acquisition word list on the LWL task

Objective AOA: 38.5	**Objective AOA: 44.5**	**Objective AOA: 50.5**	**Objective AOA: 56.5**
Bread	Bell	Bear	Bee
Dress	Cheese	Drum	Fly
Flag	Pan	Heart	Gift
Horse	Pear	Ring	Shirt
Kite	Pen	Swing	Swan
	Spoon	Sword	Vase
		Van	

Appendix B: Complete list of African-American English features (adapted from Craig et al., 2003)

Abbreviation	Full name	Explanation
AIN[a]	Ain't	ain't used as a negative auxiliary in *have* + *not, do* + *not, are* + *not,* and + *not* constructions
PRO[b]	Appositive Pronoun	both a pronoun and a noun or two pro- nouns used to reference the same person or object Zero past tense
DON[b]	Completive *done*	*done* is used for emphasis to make reference to an action completed in the recent past
DMK[a]	Double marked "s"	hypercorrection of irregular plural and possessive constructions
MOD	Double modal/double auxiliary	two modal auxiliary forms used in a single clause
EIT[a]	Existential *it*	*it* used in place of *there* to indicate the existence of a person, place, or thing without adding referential meaning
FSB	Fitna/sposeta/bouta	Abbreviated forms coding imminent action
HAD[b]	Had	preterite *had* before the verb in simple past constructions
ART	Indefinite Article	article *a* used regardless of vowel context
IBE	Invariant *be*	infinitival *be* coding habitual action with a variety of participants
NEG [a]	Multiple negation	two or more negative markers in one utterance
REF [b]	Reflexive Pronoun	reflexive pronouns "himself" and "themselves" expressed as "hisself" and "theyself" or "theirselves"
BEN [b]	Remote past *been*	"been" used to mark action in the remote past
SVA	Subject–Verb Variation	the subject and verb in a (a) first, (b) second, or (c) third person plural or singular construction differing in either number or person
UPC	Undifferentiated pronoun case	nominative, objective, and demonstrative cases of pronouns used interchangeably
ZAR	Zero article	the definite article "the" and indefinite articles "a" and "an" variably included
COP	Zero copula	*is, are, am,* and other forms of the verb *to be* variably included in either copula
ING[a]	Zero *-ing*	present progressive *-ing* variably included
AUX	Zero Auxiliary	modal auxiliary forms *will, can, do,* and *have* variably included
PST	Zero past tense	marker *-ed* not always used to denote regular past constructions or the present tense form used in place of the irregular past form
ZPL[a]	Zero plural	the plural marker *-s* variably included

POS	Zero possessive	possession coded by word order so that (a) possessive -*s* marker is deleted or (b) nominative or objective case of pronouns is used rather than possessive
ZPR	Zero preposition	prepositions *of, on,* and *at* variably included
ZTO	Zero to	Infinitival to is variably included
PCR	Postvocalic consonant reduction	Deletions of consonant singleton following vowels
G	"g" dropping	Substitutions of /n/ for /N/ in final word positions
STH	Substitutions for /ð/ and /θ/	/t/ and /d/ substitute for /T/ and /D/ in prevocalic positions, /f, t/ and /v/ substitute for /T/ and /D/ in intervocalic positions, and in postvocalic positions
CCR	Consonant cluster reduction	Deletion of phonemes from consonant clusters
CCM[b]	Consonant cluster movement	Reversal of phonemes within a cluster, with or without consonant reduplication
SDL[a]	Syllable deletion	Reduction of an (unstressed) syllable in a multisyllabic word
SAD[b]	Syllable addition	Addition of a syllable to a word, usually as a hypercorrection
VOW [c]	Monophthongization of diphthongs	Neutralization of diphthong
OTH		Other verb error
UH [c]	Postvocalic /r/ in words ending in "er" replaced by "uh"	Deletion of "er" replaced by "uh" ɚ replaced by /ə/
GON [c]	Gon	Use of "gon" to indicate imminent action

[a] Features that were used less than 5 times total, across all language samples
[b] Features that were not used in any language sample.
[c] Features that were added to reflect the local dialect

Appendix C: Standardized test scores, total number of words, and number of dialect features by subject

Participant ID	Gender	Age (in months)	EVT raw	EVT standard	EVT GSV	PPVT raw	PPVT standard	PPVT GSV	TNW	#Morph Dialect Features	#Phon Dialect Features	Total # Dialect Features	# Other Dialect Features
013L	M	32	9	82	83	18	84	73	166	14	10	24	7
017L	M	28	17	94	96	27	95	83	183	21	11	32	0
025L	F	37	25	95	105	25	82	81	179	11	10	21	0
035L	F	32	18	91	97	22	88	78	151	22	7	29	0
036L	F	29	8	81	81	20	88	75	148	25	11	36	4
046L	F	35	30	97	110	28	90	84	122	8	7	15	0
066L	F	38	16	84	94	23	80	79	140	20	22	42	0
067L	F	37	29	98	109	54	106	108	158	20	31	51	4
080C	F	45	13	73	90	26	74	82	144	6	5	11	0
081C	M	52	54	119	130	54	104	108	217	5	4	9	0

086C	F	58	43	83	121	73	96	123	223	7	16	23	0
087C	F	52	54	99	130	60	92	113	178	7	8	15	4
091L	F	34	10	82	85	NA	NA	NA	182	18	15	33	3
401D	M	59	54	93	130	NA	NA	NA	167	5	4	9	4
402D	M	44	42	98	135	73	108	123	178	16	3	19	4
404D	M	47	51	104	128	62	100	114	172	15	6	21	3
406D	F	40	17	83	96	NA	NA	NA	186	19	15	34	0
407D	F	47	40	94	118	47	89	102	137	6	13	19	3
408D	M	53	37	84	116	44	79	99	191	23	32	55	5
409D	M	54	35	80	114	NA	NA	NA	205	25	17	42	7
410D	M	47	45	98	123	NA	NA	NA	124	7	3	10	0
412D	F	39	36	101	115	53	103	107	147	4	8	12	0
413D	M	50	44	92	122	62	95	114	153	18	5	23	6
414D	M	68	61	91	136	96	102	139	248	6	10	16	0

415D	M	44	58	117	134	53	97	107	177	16	13	29	1
416D	M	46	46	99	124	NA	NA	NA	187	6	9	15	0
417D	F	56	55	97	131	NA	NA	NA	170	2	1	3	0
421D	F	46	32	87	111	38	78	94	173	20	11	31	5
435D	M	69	58	89	134	75	87	124	205	5	8	13	0
436D	F	53	18	67	97	32	70	88	153	7	8	15	0
438D	F	60	65	101	139	85	102	131	173	7	10	14	1

Appendix D: Raw data used to calculate weighted means by participant

Participant ID	Percent Missing Data RWL Block 1	RWL Accuracy Block 1	Number of Latencies RWL Block 1	RWL Latency Block 1	Percent Missing Data RWL Block 2	RWL Accuracy Block 2	Number of Latencies RWL Block 2	RWL Latency Block 2	Weighted Mean/Latency	Weighted Mean Accuracy
013L	35.09	32.46	1	266.47	48.93	29.55	4	820.24	709.49	31.18
017L	27.37	36.33	8	855.63	11.89	24.06	7	832.73	844.84	29.60
025L	11.24	31.91	8	986.79	9.9	32.67	7	1054	829.23	32.29
035L	68.5	16.6	1	916	16.21	26.66	9	819.78	829.402	23.91
036L	10.02	25.89	10	1179.15	23.81	29.08	3	1337.92	1215.79	27.35
046L	15.56	32.2	7	780.39	33.37	29.5	4	1111.69	900.86	31.01
066L	NA	NA	NA	NA	19.61	31.06	8	1082.55	1082.55	31.06
067L	5.96	36.35	6	1090.88	9.82	35.85	9	1012.23	1043.69	36.11
080C	11.62	38.27	8	1067.98	27.75	33.32	4	653.69	929.88	36.04
081C	18.1	39.41	12	943.76	9.95	50.85	15	739.46	830.26	45.40

083C	38.95	47.24	7	818.45	19.71	55.77	13	881.41	859.374	52.09
086C	3.5	54.6	13	690.53	20.32	52.48	9	653.23	675.27	53.64
087C	15.21	49.96	9	930.81	18.77	50.28	10	1057.57	997.53	50.12
091L	NA	NA	NA	NA	38.46	16.11	1	366.4	366.4	16.11
401D	10.05	47.41	9	773.51	13.42	53.42	11	797.91	786.93	50.36
402D	17.81	71.07	6	663.41	NA	NA	NA	NA	663.41	65.18
404D	20.07	51.28	15	765	11.85	43.26	12	950.7	847.53	47.07
406D	27.1	32.02	9	941.91	6.88	31.74	12	1121.41	1044.48	31.86
407D	17.39	36.31	9	1084.4	16.48	34.02	4	1086.71	1085.11	35.16
408D	2.45	47.87	14	927.9	8.26	48.22	12	956.25	940.98	48.04
409D	10.4	38.18	8	845.22	18.08	37.49	10	1017.6	940.99	37.85
410D	3.06	52.96	14	955.26	5.47	39.36	12	1340.7	1133.16	46.25
412D	3.9	46.14	15	935.99	15.79	51.99	9	980.77	952.78	48.87
413D	8.79	53.16	8	913.92	29.36	50.01	4	1074.22	967.35	51.79

414D	9.67	50.57	10	819.41	1.45	54.07	14	887.45	859.1	52.4
415D	2.26	53.04	14	831.54	2.41	55.24	13	876.29	853.09	54.14
416D	4.09	43.8	9	775.36	6.73	46.22	13	876.29	835	44.99
417D	3.59	53.7	10	907.68	5.73	41.59	13	1031.3	977.55	47.71
421D	18.92	30.88	5	872.7	40.67	41.37	5	519.62	696.16	35.31
435D	0.08	47.5	10	1187.47	8.98	42.07	8	976.38	1093.65	44.91
436D	NA	NA	NA	NA	10.97	34.03	13	1069.74	1069.74	34.03
438D	NA	NA	NA	NA	2.03	73.08	13	675.15	675.15	71.01