ABSTRACT

Title of Dissertation: UNDERSTANDING HOW AFRICAN AMERICAN ENGLISH-SPEAKING CHILDREN USE INFLECTIONAL VERB MORPHOLOGY IN SENTENCE PROCESSING AND WORD LEARNING

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This research examined how linguistic differences between African American English (AAE) and Mainstream American English (MAE) impact how children process sentences and learn new information. The central hypothesis of this dissertation is that these linguistic differences adversely impact how AAE-speaking children use contrastive inflectional verb morphology (e.g., *was*/*were*, third person singular -s) to process and comprehend MAE sentences, as well as to infer word meanings when they depend on dialect-specific parsing of sentence cues. To test this hypothesis, this dissertation conducted three experiments on how linguistic mismatch impacts spoken language comprehension and word learning in school-age MAE- and AAE-speaking children. The first study examined how children used the auxiliary verbs *was* or *were* to comprehend MAE sentences in an offline spoken language comprehension task. In contrast, the second study asked the same question in an online sentence processing task. The final study examined how children used inflectional verb morphology (i.e., third-person

singular -s, *was*/*were*) to infer information about novel verbs. Each study examined how participants' dialect, either MAE or AAE, predicted performance on listening tasks produced in MAE. Furthermore, each study examined how individual differences such as age, dialect density, and vocabulary size influenced children's performance.

Across all studies, results demonstrated that when there were redundant linguistic cues that were not impacted by dialect differences, AAE- and MAE-speaking children used available linguistic cues to process and comprehend spoken language and infer verb meanings in a similar manner. However, when linguistic redundancy was decreased due to perceptual ambiguity, there were group differences in how AAE- and MAE-speaking children used inflectional verb morphology on spoken language tasks. The second study showed that AAE-speaking children were sensitive to contrastive verb morphology in real-time processing, but they were less likely than their MAE-speaking peers to use it as an informative cue to revise initial parses when processing spoken language. The results of the final study indicated that individual characteristics such as age and dialect density influence how dialect impacts a learning process. These results demonstrate that linguistic mismatch can affect spoken language processes. Furthermore, the findings from this research highlight a complex relationship between the effects of linguistic mismatch and individual differences such as age and dialect density.

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by

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Dedication

This dissertation is dedicated to God. Completing this degree is a living testament to God's goodness in my life. This dissertation is also dedicated to James and Mattie Lucille Byrd, my grandparents, who saw me begin this degree but passed before I finished. Your prayers and reminders that I can do anything because "I am a Byrd" were sources of daily motivation. I love you and know you're proud.

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Chapter 1: Introduction

There is a long-standing academic performance gap between African American students and their European American peers (e.g., Bell, 2012; Hillard, 2003; Mark, 2013; National Center for Education Statistics, 2019). It is well-established that multiple factors contribute to this academic performance gap, including socioeconomic status (SES) and school funding/resources. One factor that has garnered significant interest from educators and language scientists is how the dialect many African American students use, African American English (AAE), interacts with academic performance. Research has documented a negative relationship between speaking AAE and performance on academic tasks (Brown et al., 2015; Dexter et al.; 2018; Gaitlin & Wanzek, 2015; Puranik et al., 2020; Washington et al., 2018) even when SES is considered, a result that has raised questions about how speaking AAE contributes to adverse academic outcomes.

To address those questions, researchers have provided hypotheses about what is causing this relationship between AAE and academic outcomes. The predominant explanation for why AAE is related to academic performance is that differences between the phonological and morphological features of AAE and Mainstream American English (MAE), the dialect of academic instruction, result in a linguistic mismatch between perceptual and mental representations, and it is this linguistic mismatch that adversely affects academic outcomes (Charity et al. 2004; Gatlin & Wanzek, 2015).

While the linguistic mismatch hypothesis is plausible, this hypothesis does not explain *how* dialect differences impact underlying cognitive processes related to academic performance. The existing framework primarily describes correlational relationships between the production of AAE and academic performance. It does not consider how a child's linguistic experiences as an

AAE speaker shape how they process MAE and how that influences their learning. Without understanding how linguistic mismatch impacts underlying cognitive processes that support learning explanation, it is difficult to understand *why* there is a relationship between the production of AAE features and academic performance. With a limited understanding of why this relationship exists, it is difficult to craft educational policies or curricula that support and improve the academic performance of AAE-speaking children. Thus, it is important to expand the current framework to understand how the linguistic experiences of AAE speakers impact underlying cognitive processes in real-time and explore how linguistic mismatch is related to learning.

One avenue to explore how linguistic mismatch impacts cognitive processes is examining how AAE-speaking children process and comprehend MAE sentences they hear. Spoken language is one of the primary mediums of instruction in the classroom, making efficiently and accurately comprehending what the teacher says crucial for learning (Linebarger, 2001; Swain et al., 2004; Tindall et al., 2008). Research has shown that speaker variation can impact how children comprehend and learn from their teachers (Barker, 2015; Bent, 2014; García, 2017; García et al., 2022; Harte et al., 2016). While most of this literature has focused on how children comprehend words and sentences when listening to speakers of different accents (e.g., Barker, 2015; Bent, 2014; Harte et al. 2016), a growing body of work has begun to demonstrate that listening to a speaker who speaks a dialect that differs from the listener's can impact how children comprehend spoken language (Beyer & Hudson-Kam, 2015; Byrd et al., 2023; Beyer & Hudson-Kam, 2015; De Villers & Johnson, 2007; Edwards et al., 2014).

For example, Edwards and colleagues (2014) showed that AAE-speaking children were less accurate at comprehending words spoken in MAE that contained contrastive phonological features. For example, the word *goal* is perceptually ambiguous to AAE-speaking children because final consonant clusters are optionally produced in AAE, which means *goal* could be interpreted as *gold* (/goʊld/) or *goal* (/goʊl/) in AAE, while it has only one meaning (*goal)* in MAE. Edwards and colleagues found that AAE-speaking children were less accurate than MAE-speaking children only at recognizing words that were perceptually ambiguous in AAE, but not in MAE. Similar results have been found in studies that examined how contrastive morphological features impact spoken language comprehension in AAE-speaking children. De Villers and Johnson (2007) examined how AAE- and MAE-speaking children used third-person singular -s to comprehend perceptually ambiguous sentences (e.g., *The cat swims/The cats swim*). De Villers and Johnson (2007) found that by age 7, MAE-speaking children reliably used third-person singular -s as a comprehension cue. However, AAE-speaking children did not. A similar finding was also found by Beyer and Hudson-Kam (2012), who examined other contrastive dialect features, such as contracted -‘ll and past tense -ed and found that AAE-speaking children did not reliably use these features as comprehension cues in MAE. These studies demonstrate that AAE-speaking children are less accurate at comprehending words and sentences spoken in MAE if they contain phonological and verb morphological features that differ between MAE and AAE.

However, it is unclear if the observed results in spoken language comprehension studies are due to dialect differences or to the phonetic saliency of the linguistic features used for testing. Inflectional verb morphology features are often realized with lower phonetic saliency. They are the final consonant in a consonant cluster, are often coarticulated with the following word in spontaneous speech and have durations that are more likely to be influenced by the position of the morpheme within the sentence (Bortolini et al., 2006, Leonard, et al., 1997, Leonard, 2014).

The dialect features examined in previous literature (Beyer & Hudson-Kam, 2012; De Villers & Johnson, 2007), such as third-person singular -s and past tense -ed, are exactly those inflectional morphemes that have low phonetic saliency. Thus, it is possible that AAE-speaking children would perform similarly to their MAE-speaking peers in a spoken language comprehension task that has linguistic features with increased phonetic saliency.

To disentangle whether the observed effects in spoken language comprehension are due to listeners' dialect or the phonetic saliency of the linguistic feature, researchers need to examine how AAE-speaking children process MAE sentences that contain whole syllable verb morphology cues with increased phonetic saliency, like *was* and *were.* The first study (Byrd et al. 2023) addresses this gap by evaluating how AAE- and MAE-speaking children use the auxiliary verbs *was* and *were* to comprehend MAE sentences. In this experiment, I predict that even when the phonetic saliency of the linguistic cue is increased, AAE-speaking children will be less accurate at comprehending MAE sentences. This prediction is based on previous literature that demonstrated AAE-speaking children are less likely to attend to contrastive verb morphology during sentence comprehension tasks (Beyer & Hudson-Kam, 2012; De Villers & Johnson, 2007). Alternatively, it is possible that AAE-speaking children will perform similarly to their MAE-speaking peers, which would suggest that results from previous studies are due to phonetic saliency. The results from this chapter help determine whether linguistic mismatch truly impacts spoken language comprehension. Furthermore, the results from the first study help establish if examining cognitive processes related to spoken language comprehension, like sentence processing, improves our understanding of how AAE is related to academic outcomes.

A limitation of the first study is that it examines offline responses rather than real-time sentence processing. As sentences unfold in real-time, adults and children recruit information from morphology, syntactic structures, and semantic meanings to interpret sentences (Huang et al., 2013; Huang et al., 2023; Martin et al., 2022). How children determine what cues are informative and reliable to aid sentences processing are based on the parsing algorithms they infer from the distributional input they receive from the adults around them (Bates et al. 1982; Chan et al., 2009; Huang et al. 2013; Huang et al. 2023; MacWhinney et al. 1984). This process inextricably links children's linguistic experiences and knowledge to how they process sentences (Díaz-Campos, 2001, 2005; Huang et al., 2013).

Two studies have provided preliminary evidence that AAE-speaking children are leveraging their linguistic and sociolinguistic knowledge of AAE to guide how they parse MAE sentences. Terry and colleagues (2022) found that AAE-speaking children do not use third-person singular -s to determine subject number in sentence-processing tasks. Third-person singular -s is zero-marked in adult AAE and AAE-speaking children also show evidence that they zero-mark third-person singular -s as young as 48 months (van Hofwegen & Wolfram, 2010). The lack of production of third-person singular -s in AAE-speaking children and adults has led researchers to argue the feature is not a part of the grammar of AAE (Newkirk-Turner & Green, 2016). Based on this information, Terry et al. (2022) hypothesized that AAE-speaking children interpreted third-person singular -s as an error which increased their cognitive load when processing MAE sentences. In another study of online sentence processing, Erskine (2023) examined how AAE-speaking children processed MAE sentences with contrastive phonological and morphological features in varying social and linguistic contexts and found that AAE-speaking children were slower to process MAE sentences in context with limited semantic and social cues. However, AAE- and MAE-speaking children performed similarly when provided additional social (e.g., speaker race) and semantic (e.g., a predictive verb) cues. This suggests that linguistic mismatch may be context-specific and occur in environments that lack other linguistic cues unaffected by dialect differences.

Studies by Erskine (2023) and Terry and colleagues (2022) provide preliminary evidence that linguistic mismatch impacts how AAE-speaking children process MAE sentences in real-time. However, the results of these two studies cannot explain what is causing the differences observed in AAE- and MAE-speaking children's parsing strategies. Thus far, researchers have considered two different explanations of why AAE-speaking children parse MAE sentences differently than their MAE-speaking peers. One hypothesis is that processing differences occur because AAE-speaking children are less sensitive to contrastive verb morphology features (Beyer & Hudson-Kam, 2012; Byrd et al., 2023; De Villers and Johnson, 2007). If a feature is optionally produced or absent in AAE, then AAE speakers may decide that it is not an informative cue to guide sentence processing (even in MAE), as compared to other linguistic cues, such as the subject noun phrase which consistently provide reliable information. Alternatively, it is possible that AAE speakers are sensitive to MAE verb morphology, but because it is different than AAE verb morphology, this difference increases cognitive load and leads to slower and less accurate processing (Erskine, 2023; Terry et al., 2010; Terry et al., 2022).

The second study in this dissertation is designed to evaluate how AAE-speaking children leverage linguistic cues in real time to parse MAE sentences. This study examines how AAE- and MAE-speaking children use inflectional verb morphology (i.e., *was* and *were*) to comprehend MAE sentences in an online processing task using the visual world paradigm. Eye movements are closely linked to how an unfolding speech signal is parsed (Farris-Trimble & McMurray, 2013; Spivey et al., 2002), which allows for the examination of what linguistic cues

AAE-speaking children are sensitive to, how they weigh different linguistic cues, and any potential revision strategies.

Based on results from the previous literature (Beyer & Hudson-Kam, 2015; Byrd et al., 2023, De Villers & Johnson, 2007, Edwards et al., 2014; Erskine, 2023; Terry et al., 2010), I predict that there will be group differences in how AAE- and MAE-speaking children use inflectional verb morphology to parse sentences. Specifically, I predict that AAE-speaking children will be less sensitive to the auxiliary verbs *was* and *were* and instead weigh the subject noun phrase more heavily as a reliable cue. This hypothesis is based on the results from Byrd and colleagues (2023), who found that AAE-speaking children were less likely than their MAE-speaking peers to use the number information contained in the auxiliary verbs *was* and *were* to comprehend MAE sentences.

By examining eye movement patterns for AAE-speaking and MAE-speaking children in three different time windows (subject noun phrase, verb phrase, end of sentence), I will examine whether AAE speakers are sensitive to MAE inflectional verb morphology, if they use it for sentence processing, and if they rely more heavily on the subject to parse sentences. If AAE-speaking children, relative to MAE-speaking children, rely more on the subject noun phrase, then group differences should be observed in the subject noun phrase time window analysis. If AAE-speaking children, relative to MAE-speaking children, are less sensitive to the number information contained in the verb inflectional morphology, then group differences should be observed in the verb phrase time window analysis. Finally, if AAE-speaking children, relative to MAE-speaking children, are less likely to use the number information contained in the auxiliary verb for revision, then we would expect to see group differences in the end of sentence time window analysis.

The studies to date suggest that linguistic mismatch impacts how AAE-speaking children comprehend MAE sentences with contrastive verb morphology (Beyer & Hudson-Kam, 2015; Byrd et al., 2023, De Villers & Johnson, 2007, Edwards et al., 2014; Terry et al., 2010), and provides preliminary evidence that it also impacts sentence processing (Erskine, 2023; Terry et al., 2022). However, there is no research to date on whether linguistic mismatch directly impacts learning in the classroom. It is possible that linguistic mismatch does affect learning since learning in the classroom relies on the efficient parsing and accurate comprehension of MAE sentences. For instance, if AAE-speaking children are less likely to attend to verb morphology, then it is possible they could miss redundant information to infer or confirm the meaning of novel words. Research has shown that linguistic cue redundancy helps facilitate comprehension and learning in young children (Gerken, Wilson, & Lewis, 2005; Morgan, Meier, & Newport, 1987; Tal & Arnon, 2022; Witt & Gillete, 1999); therefore, linguistic mismatch could impact learning by restricting access to redundant and informative linguistic cues. Alternatively, it is possible linguistic mismatch has minimal impacts on learning. Erskine (2023) found that linguistic mismatch primarily impacted children when there was an absence of social and semantic cues. Therefore, the effects on learning could be marginal since children often integrate linguistic and non-linguistic cues to support understanding (Berman et al., 2013; Domanski, 2024; Erskine, 2023; King, 2019; Knowlton & Gomes, 2022; Nadig & Sedivy, 2002; Roy et al., 2015; Weatherhead et al., 2021; Yu & Ballard, 2007).

The final study in this dissertation directly examines whether linguistic mismatch impacts a learning process, in this case, word learning. When learning words, children integrate morphological and syntactic cues to infer word meanings (Apfelbaum & McMurrary, 2016; Fisher, 1996; Gertner & Fisher, 2012; Gleitman, 1990; Gleitman et al., 2019; Lidz, 2020;

Naigles, 1996). Linguistic cues allow children to make inferences about the grammatical properties and constraints of new vocabulary, and rely on children's prior linguistic knowledge, such as word order in their language, to help determine what linguistic cues are informative for word learning (Fisher, 1996; Gertner & Fisher, 2012; Gleitman, 1990; Gleitman, et al., 2019; Kline et al, 2017; Huang et al. 2019; Lidz, 2020; Naigles, 1996; Pozzan, et al., 2016; Snedeker & Trueswell, 2004; Yu & Smith; 2007). The interaction between children's linguistic knowledge and word learning provides an opportunity to examine how AAE-speaking children leverage their linguistic knowledge to learn information about new words that are embedded in MAE sentences.

To test the relationship between linguistic mismatch and learning, the final study examines how linguistic mismatch impacts children's inferences about the number of participants required for a novel verb. Research has shown that the number of verbs a child knows positively predicts how they process and produce sentences that contain complex syntax (Ambridge, Pine, Rowland & Young, 2008; Kueser et al., 2023; Lapata, Keller, & Walde, 2001; Van Horne, Curran, & Hall, 2017). Furthermore, as children progress through school, understanding and producing sentences with complex syntax in oral and written formats predicts academic success (Hoff, 2013; Scott & Balthazar, 2010). Focusing on verb learning allows for an examination of how linguistic mismatch impacts a learning process and provides an opportunity to hypothesize about cascading effects that could provide an explanation for why children who speak AAE have poorer academic outcomes than their MAE-speaking counterparts.

This final study modifies a verb learning task (see Arunachalam & Waxman, 2010; Messenger et al., 2015; Pozzan et al., 2016; Yuan & Fisher, 2009), to examine how AAE- and MAE-speaking children use contrastive verb morphology to infer the meaning of novel verbs embedded in intransitive sentences. In intransitive sentences (e.g., "*Anna blicked* or *Julianne Rose was blicking*), children can use their knowledge of word order and verb morphology to infer if novel verbs are one- or two-participant events. In AAE, *was* is produced with both singular and plural subjects. This means that in linguistic contexts where AAE-speaking children must rely on inflectional verb morphology to infer verb meaning (i.e., if subject information is obscured), AAE-speaking children may be at chance on the number of participants a verb requires. Whereas in MAE, *was* is only produced with singular subjects providing a reliable cue to infer subject number and eventually the number of participants completing a novel verb.

Based on results from spoken language processing and comprehension studies, I predict there will be group differences in how AAE- and MAE-speaking children use inflectional verb morphology to infer if a verb is a 1- or 2-participant event. If this prediction is true, it would provide evidence that linguistic mismatch does impact word learning and causes cascading effects that adversely impact learning via a spoken medium. Alternatively, it is plausible that there will be no group differences in performance on the word learning task, which would suggest that linguistic mismatch has minimal effects on verb learning. If this prediction is true, it would suggest AAE-speaking children can rely on other linguistic cues not impacted by linguistic mismatch (e.g., word order) to support word learning. Whether the null or alternative hypothesis is true, this experiment is one of the first to test how linguistic mismatch impacts a learning process.

Implications of the Dissertation

Overall, the primary objective of this dissertation is to examine the impact of linguistic mismatch on sentence processing and word learning in AAE-speaking children. To provide an account of how linguistic mismatch impacts cognitive processes and learning, this dissertation implements three experiments to: 1) examine whether linguistic mismatch affects spoken language comprehension in a phonetically salient context in an offline task (Chapter 2, [Byrd et al, 2023]); 2) examine how linguistic mismatch impacts spoken language comprehension in an online sentence task (Chapter 3, [Byrd, 2024a]); and 3) examine whether linguistic mismatch impacts word learning (Chapter 4, [Byrd, 2024b]). Each experiment includes AAE- and MAE-speaking children, and the ages of participants in each study range from 5;0 to 11;0. This age range allows for the examination of linguistic mismatch in elementary school-age children, the age at which children are learning and beginning to refine their literacy skills. Furthermore, each experiment evaluates how linguistic mismatch impacts children in two linguistic contexts: one that has increased access to redundant cues and one that has decreased access to redundant cues. This approach provides more information on when linguistic mismatch may be the most impactful on spoken language comprehension and word learning.

The studies in this dissertation address two primary research questions: 1) Are there group differences in how AAE- and MAE-speaking children use verb morphology on spoken language tasks, and 2) Do individual differences, such as age and dialect density, impact how children use verb morphology in spoken language tasks? Based on previous literature, I predict that there will be group differences in how AAE- and MAE-speaking children perform on spoken language tasks in MAE because research has shown that dialect difference decreases how accurately (Beyer & Hudson-Kam, 2012; Byrd et al., 2023; De Villers & Johnson, 2007) and efficiently (Erskine, 2023; Terry et al., 2022) AAE-speaking children process and comprehend MAE sentences. Furthermore, I predict individual differences, such as dialect density, will predict how sensitive African American children are to verb morphology as cues from spoken language comprehension, processing, and learning. Dialect density, defined as the proportion of

AAE features in a particular speech sample, is an individual characteristic of interest because it is a continuous measurement of non-mainstream dialect use that focuses on the amount of AAE features a child produces (Craig et al., 2014; Terry, 2006; Thompson et al., 2003; Puranik et al, 2020; Washington & Craig, 1994).

While many studies, including this one, classify speakers categorically as either MAE or AAE speakers, there are many problems with a categorical classification (Oetting & McDonald, 2002). Some speakers produce more dialect features in their speech and others produce fewer features – it is not really a binary choice. Therefore, researchers have proposed using a continuous measure of dialect, such as dialect density, as a more sensitive measure of linguistic experience with a particular dialect (Craig et al., 2014; Terry, 2006; Puranik et al, 2020; Oetting & McDonald, 2002; Thompson et al., 2003; Washington & Craig, 1994). Furthermore, studies have shown differences between children with high and low dialect densities. AAE-speaking children with higher dialect density than peers with lower dialect density have poorer outcomes on literacy measures (NP Terry et al., 2010). Similarly, dialect density predicted how children with higher dialect densities are more likely to use their knowledge of AAE to comprehend MAE phrases and sentences (Byrd et al., 2023; Edwards et al., 2014).

Collectively, the results from these studies will provide information about how linguistic mismatch impacts a cognitive process that supports learning. Specifically, we will know how children's linguistic knowledge influences how they use cues that are not within their dialect to process sentences, which will help provide an explanation for why AAE-speaking children are less accurate at comprehending MAE sentences. Additionally, we will know *if* linguistic mismatch impacts how AAE-speaking use dialect features that differ between AAE and MAE to learn new information, allowing for additional hypotheses about the relationship between linguistic mismatch and academic achievement. The findings from this study will help the field move beyond using correlational methods to examine the effects of linguistic mismatch and toward mechanistic explanations of how linguistic mismatch impacts cognitive processes that support learning and academic success. Moving beyond correlational methods will help the field develop effective educational strategies to improve the academic outcomes of AAE-speaking children.

Chapter 2: The Impact of Dialect Differences on Spoken Language Comprehension

Dialects of a language are typically defined as mutually intelligible, which allows speakers of different dialects to communicate (Gooskens et al., 2018; Robin, 2017). However, a small body of research suggests that both adults and children may have difficulty using dialect features that are present in one dialect but not the other as cues in spoken language comprehension (Bühler et al., 2017; Beyer, Edwards, & Fuller, 2015; De Villers & Johnson, 2007; Edwards et al., 2014; Jones, Kalbfeld, Hancock, & Clark, 2019). For instance, Bühler et al. (2017) found that adult Swiss German speakers show processing differences (as measured by ERP's) in a word comprehension task with words that have dialect-specific pronunciations that result in different pronunciations in Swiss German and High German.

Difficulty using dialect-specific features as cues for spoken language comprehension has also been observed in dialects of American English with speakers of African American English (AAE), a non-mainstream dialect, and Mainstream American English (MAE), a dialect that is considered "standard". Research has shown that both AAE and MAE speakers can have difficulty using phonological and morphological features that are not within the respective dialects as spoken language comprehension cues (Beyer et al., 2015; De Villers & Johnson, 2007; Edwards et al., 2014; Jones et al., 2019). The differences in how AAE and MAE speakers use features present in one dialect but not the other are of interest, particularly for AAE-speaking children. This is because the primary medium of instruction within the classroom is spoken language and the dialect of instruction is almost always MAE (Brown et al., 2015; Byrd & Brown, 2021; Connor & Craig, 2006; Edwards et al., 2014; Gatlin & Wanzek, 2015; Labov & Baker, 2015). Since MAE is the predominant dialect used within the classroom for instruction, academic success depends in part on the accurate and efficient comprehension of MAE to understand new concepts. Therefore, if AAE-speaking children have difficulty understanding their MAE-speaking teachers, this could lead to academic consequences based on how students use MAE features as comprehension cues and not their academic abilities. While there have been efforts to move away from MAE as the “standard” dialect for academic instruction and performance, they have been slowed by political and societal barriers (Barton & Coley, 2010; Paris, 2012; Sleeter, 2012; Young, 2010; Young, et al., 2014). As advocacy continues to promote linguistic diversity within the classroom, there remains a need to understand how dialect differences impact the academic experiences of AAE-speaking children, specifically in spoken language comprehension.

There has been limited research examining how listening to a *contrastive feature*, which is a feature present in one dialect but not the other, impacts spoken language comprehension. The existing evidence suggests that both adult MAE speakers and child AAE speakers have difficulty using contrastive features as comprehension cues. This type of linguistic mismatch can occur when speakers of one dialect hear a different dialect that contains contrastive features. For instance, MAE-speaking courtroom stenographers, who are trained to be 95% to 98% accurate in transcribing a verbatim record of proceedings, on average transcribed only 60 % of AAE-speakers’ sentences accurately (Jones, et al., 2019). MAE-speaking stenographers were particularly inaccurate in transcribing the speech of AAE speakers when it included common and frequently used AAE features. These findings are further supported by work that has examined how adult MAE speakers used stressed /bɪˈn/ (hereafter ‘stressed BIN’), a feature of AAE, to comprehend AAE sentences in a spoken language comprehension task (Beyer et al., 2015). Stressed BIN refers to an event in the remote past or an event that has occurred for a long undisclosed period of time (Beyer et al., 2015; Green, 1998; Labov, 1972, Rickford, 1975).

Beyer et al. (2015) presented adult AAE and MAE speakers with pre-recorded sentences that included both stressed BIN (e.g., S*he been on the phone*), regular *been* (e.g., *She has been on the phone for a long time),* and fillers. They found that while AAE speakers accurately used stressed BIN to infer an event that occurred a long time ago, MAE speakers incorrectly assumed that it referred to an event that occurred in the recent past. Beyer et al. (2015) described the MAE speakers' interpretations of stressed BIN as pseudo-comprehensions, where the listener felt confident in their understanding of what they heard but ultimately failed to use the cue appropriately.

The small number of studies that evaluate how linguistic mismatch impacts children's listening comprehension has focused on how AAE-speaking children use contrastive features that are present in MAE but not AAE to comprehend MAE words or sentences they hear. Edwards et al. (2014) investigated how 4- to 8-year-old children who spoke AAE interpreted MAE words that are ambiguous in AAE but not MAE because of phonological and morphological differences between the dialects. For example, consonant clusters can be optionally produced in AAE (e.g., *gold* can be produced as /goʊld/ or /goʊl/) but only as /goʊld/ in MAE (Green, 2002). Edwards and colleagues found that AAE-speaking children were less accurate at comprehending words that were ambiguous in AAE due to phonological and morphological differences between the dialects (e.g., plural marker -*s*, final consonant clusters) in comparison to words that did not have dialect-sensitive features. Furthermore, dialect density (quantified as the number of features of AAE that children used in a language sample relative to the total number of sentences in the language sample) predicted performance independently of language experience (quantified as vocabulary size).

Other studies have examined the impact of linguistic mismatch on children's comprehension of verbal morphology in sentences. De Villiers and Johnson (2007) examined how AAE and MAE-speaking children, ages 4-7, used third-person singular -*s* in spoken language comprehension tasks. Overt third-person singular marking is obligatory in MAE, while zero marking is obligatory in AAE (e.g., *The cat eat**s** the mouse* in MAE vs. *The cat eat***_** *the mouse* in AAE; Green, 2002, 2010; Newkirk-Turner & Green, 2016, 2021). De Villiers and Johnson found that MAE-speaking children produced third-person singular -*s* by age 4 but did not reliably use it as a comprehension cue in sentences where the plural morpheme on the noun is co-articulated with the beginning of the verb (e.g., *The cat sleeps on the bed*) until ages 6 to 7. By contrast, AAE-speaking children did not reliably produce third-person singular -*s* in production or use it as a comprehension cue at ages 6 or 7 (De Villiers & Johnson, 2007; Newkirk-Turner & Green, 2016, 2021). Beyer and Hudson Kam (2012) used a picture-choice task to examine how AAE- and MAE- speaking children in 1st and 2nd grade used a wider variety of morphological forms that are contrastive between AAE and MAE (e.g., past tense -ed, third-person singular -s, future contracted -ll; *she'll or he'll*). In the task, participants listened to sentences that were produced in MAE and were instructed to select the picture that best matched what they heard. In the test sentences, participants had to rely on the verb morphology as cues to comprehend the tense of the sentence (e.g., *"She walk**ed** from the library")*. Beyer and colleagues found that both AAE- and MAE-speaking children correctly comprehended sentences with shared morphological forms (e.g., plural -s); however, only the MAE-speaking children successfully used contrastive features that are produced in MAE to comprehend tense in MAE sentences. There was no age or grade-related change in how contrastive dialect features were used as comprehension cues to understand MAE sentences. These results suggest that although

AAE-speaking children are consistently exposed to MAE in the classroom, they are more likely to use their grammatical knowledge of AAE when comprehending MAE sentences they hear.

However, the studies that have evaluated how AAE-speaking children use contrastive dialect features to comprehend MAE sentences have focused on features that typically have lower phonetic saliency (e.g., past tense -ed, verbal -s). The term "phonetic saliency" was brought into the acquisition literature by Leonard (1997, 2014) and has been used to refer to morphological features that are usually realized as final consonant clusters that are coarticulated with the following word in spontaneous speech, and whose duration is influenced by the position of the morpheme within the sentence. Inflectional morphemes with low phonetic saliency are generally produced later with full-syllable morphemes that have greater phonetic saliency (e.g., contractible copula and auxiliary vs. uncontactable copula and auxiliary) (Bortolini, et al., 2006; Leonard 1996, 2014). While the comprehension of low-phonetic-saliency morphemes has been less well studied, as compared to production, there is some evidence that phonetic saliency also affects comprehension. For example, 5-year-old MAE-speaking children are not reliable at using verbal -s as a comprehension cue, although they consistently use it in production at earlier ages (De Villers & Johnson, 2007; Kouider et al., 2006; Lukyanenko & Fisher, 2016; Wood et al., 2009). This raises the possibility that prior findings with AAE-speaking children confounded linguistic mismatch and the phonetic saliency of the features used for testing. To address this limitation, the current study examines a feature that is produced as a whole syllable which has increased phonetic saliency. This allowed us to determine the extent to which linguistic mismatch impacts how AAE-speaking children broadly use MAE morphology for sentence comprehension.

The purpose of this study was to examine if a contrastive morphological feature with greater phonetic saliency (a whole syllable), *was* vs. *were,* also leads to differences between AAE- and MAE-speaking children's performance in spoken language comprehension tasks. In AAE, the same verb form (*was*) is used for both plural and singular subjects, while MAE differentiates between single and plural verb forms (*She was walking*/*They was walking* in AAE and *She was walking/They were walking* in MAE; Green, 2002; Newkirk-Turner, Oetting, & Stockman, 2014).[1] The use of *was* with both singular and plural subjects is a highly consistent feature of AAE and shows a minimal decrease in use with age in elementary school (Craig & Washington, 2004). In addition, both *was* and *were* are produced as whole non-contracted syllables in both AAE and MAE, and thus they have more phonetic saliency than previously tested features (e.g., past tense and third-person singular -s), which can have shorter duration times and become less distinct when coarticulated. Furthermore, the use of auxiliaries such as *was* and *were* are used consistently as comprehension cues in young MAE-speaking children (Kouider et al., 2006; Lukyanenko & Fisher, 2016; Wood et al., 2009).

This study will also examine if a participant's dialect density is predictive of how *was* and *were* is used as a comprehension cue. There is conflicting evidence on how dialect density, a measure of dialect use in production, predicts how MAE features are used in spoken language comprehension. Edwards et al. (2014) found that dialect density was predictive of how AAE speakers comprehended words and phrases that contained contrastive dialect features. Other studies (De Villiers & Johnson, 2007; Beyer & Hudson Kam, 2012) did not directly examine the

[1] In some instances, *were* may be used by adolescent or adult AAE speakers with plural subjects, but that depends on the linguistic environment and if this feature is within the speaker’s linguistic repertoire (Green, 2002; Green, 2010).

relationship between dialect density and comprehension; however, they did not observe age or grade-related changes in comprehension of MAE. Since, previous research has shown that as age and grade increase, AAE-speaking students' dialect density decreases (Brown, et al., 2015; Gatlin & Wanzek, 2015), this suggests that a decrease in the production of AAE features may not equate to increased use of MAE verb morphology as a comprehension cue. This study will evaluate if dialect density is predictive of how AAE-speaking participants perform in a spoken language comprehension task with a more phonetically salient cue, *was* and *were.*

This study addresses two questions: 1) Are there differences in how AAE- and MAE-speaking children use *was* and *were* to comprehend spoken language? and 2) Does dialect density predict how *was* and *were* are used to comprehend spoken language for AAE speakers? One possibility is that children who speak AAE will perform similarly to their peers who speak MAE because of the greater phonetic saliency of *was* and *were*, relative to the previously tested features (i.e., -ll, -ed, verbal -s). This would suggest that previous results are due to the lower phonetic saliency of the features, and children who speak AAE use information about MAE grammar to interpret MAE sentences if the feature is phonetically salient. Alternatively, it is also possible that children who speak AAE will have difficulty using *was* and *were* to differentiate between singular and plural subject despite their increased phonetic saliency because the differences between how inflectional verb morphology is used in AAE and MAE will influence how AAE-speaking children attend to the feature as a comprehension cue. The latter result would support the claim presented in the previous studies that children who speak AAE, and potentially other non-mainstream dialects, use the morphological rules of their predominant dialect to interpret sentences spoken in another dialect such as MAE. Lastly, it is possible that changes in dialect density will be predictive of how participants use *was* and *were* as comprehension cues and that as dialect density, or the number of AAE features produced, increases participants will be less sensitive to the auxiliary verb as a cue. Alternatively, it is possible that changes in dialect density will not be predictive of how participants use *was* and *were*, which would mean that familiarity or production of an MAE feature may be unrelated to how an MAE feature is used as a comprehension cue by a child who speaks a non-mainstream dialect. The results from this study will broaden our theoretical understanding of how children who speak different varieties of American English attend to contrastive features to process sentences in dialects that differ from their own.

Methods

Authors' Positionality Statement. As in all research, it is helpful to understand our positionality and, therefore, our lens on the data. The first author is an African American woman who speaks multiple dialects of American English, including Southern American English, AAE, and MAE. The second author is an Asian American woman who is a bilingual speaker of English and Mandarin. The third author is a monolingual speaker of MAE who lives in a bilingual household where both English and Greek are spoken. The authors' linguistic experiences shape their beliefs that all languages and dialects are valid methods of communication in academic spaces. Furthermore, these authors' research has been centered on understanding the relationship between linguistic variation, cognitive processes, and academic outcomes. All three authors are committed to supporting linguistic diversity in academic spaces.

Participants. Sixty-nine participants, ages 6;5-10;0 years old, were recruited from across the US, with most recruited from the Maryland/DC and Georgia areas. Due to the COVID-19 pandemic, participants were tested virtually, and their race was used as a proxy to increase the likelihood of recruiting participants from communities who were more likely to speak AAE and MAE.

However, a standardized assessment was used to determine the dialect variation a participant spoke once they consented to participate. Parents of participants provided informed consent, and families received compensation (i.e., $20) for their participation in the study. See Table 1 for participant demographics.

Table 1. Participant Demographics

Group	n	Gender	Race	PVT (SS)[2]	Age in Months	Dialect Density[3]
MAE Speakers	44	Female *n=23* Male *n=21*	Asian *n=3* Black *n=21* White n= 20	M[4]=111, SD=13; Range=83-142	M=8;5, SD=1;0; Range=6;5-10;0	M=0.11, SD=0.45, Range=0.00-0.36
AAE Speakers	25	Female *n=10* Male *n=15*	Black *n*=20 White *n=5*	M=100, SD=13; Range= 77-128	M=8;3, SD=0;7; Range=7;0-9;11	M=0.45, SD=0.34, Range=0.08-0.93

Standardized Assessment Measures

Participants were administered part 1 of the *Diagnostic Evaluation of Language Variation-Screener* (DELV-ST) (Seymour et al., 2003) and the *Picture Vocabulary Test-remote administration* from the National Institute of Health cognitive toolbox (PVT) (Weintraub et al., 2013). Both assessments were administered virtually over zoom.

Part 1 of the DELV-ST is a screening test that is designed to distinguish dialectal variation from MAE by evaluating the production of contrastive features between MAE and AAE. Five items focus on phonological features that differ between the two dialects, and the remaining 10 items focus on dialect differences in subject-verb agreement. The DELV-ST

[2] PVT (SS) = PVT standard score (normalized mean = 100 and SD = 15)
[3] Dialect Density was calculated by taking the number of non-mainstream features produced on the DELV-ST and dividing by the total number of scorable items
[4] M and SD stand for mean and standard deviation, respectively

provides an age-referenced criterion score that identifies if a participant is a: (a) *MAE speaker*; (b) *has some variation from MAE;* or (c) *strong variation from MAE.* For this study, criterion scores of *some variation from MAE* or *strong variation from MAE* were collapsed into the category of AAE speakers since these criterion scores indicated they used AAE features in production. In addition, a dialect density score was calculated based on how many AAE features a speaker uses on the DELV-ST and was used as a continuous measure of dialect. This score has been used by other researchers (e.g., Terry et al., 2010; Terry & Connor, 2012; Terry et al., 2012) and was calculated by taking the number of non-mainstream features produced and dividing by the total number of scorable items. For example, a student who used only MAE features would score a 0, and a participant that used only AAE features would score a 1.

The PVT is a standardized measure of receptive vocabulary skills that is designed for remote computer administration. Participants were presented with four images and were instructed to tell the examiner the number of the picture that best matched the definition of the word they heard. The PVT automatically adjusts the number of items and what items are presented based on the participant's age and performance. For most participants, the measure lasted approximately 5 minutes and contained about 25 items.

Sentence Processing Task

Stimuli

The sentence-processing task was implemented on a web-based application for a tablet. The web-based application was designed using JavaScript, which was adapted from Frank et al. (2016). This web-based application presented visual and auditory stimuli on a tablet and recorded the corresponding data using a secure data server.

Auditory Stimuli Norming. Initially, auditory norming was conducted to find an ambiguous name that could be perceived as one or two people. An ambiguous name that could be perceived as one or two people was necessary to ensure that participants had to rely on the auxiliary verb to disambiguate the sentence. A set of ambiguous and unambiguous names were presented to adult listeners in past tense sentences (e.g., *Carolyn May/Carol 'n May baked cookies; Janice, Don, Carol, and John baked cookies; Alexander baked cookies)*. Past tense verbs were used so the listeners would have to rely on the proper noun(s) rather than the verb to decide how many subjects were in the sentence. After each sentence was played, adult listeners were asked to identify how many people (one, two, three, or four) completed the action described in the sentence. Unambiguous subject names were included to ensure that participants were accurately completing the task and to make sure the novelty of the ambiguous names were preserved. Through initial auditory norming, the name Julianne Rose from "Julianne *Rose baked cookies*" was selected because it was perceived as one person 50% of the time and as two people 50% of the time. However, when piloting with children, we observed a 2-person bias; MAE-speaking children interpreted most ambiguous sentences as two people regardless of the auxiliary verb. Therefore, to counteract this 2-person bias while preserving some of the perceptual ambiguity of the subject name, a token of *Carolyn May* in the sentence "*Carolyn May baked cookies"* was selected. In piloting, 67% of adult participants interpreted this name to be one person, and 33% interpreted it as two people. When this name was piloted again with MAE-speaking children, the plural bias decreased and participants used both *was* and *were* to determine subject number even though they were not from regions where this conjoined first name is typically used. See Appendix B for a detailed breakdown of the norming results.

Auditory. All auditory stimuli used in both stimuli norming and testing were recorded by the same MAE speaker from the Northeastern U.S. The auditory stimuli are sentences of the form <*person's name*> *was* <*VP-ing*>< *NP*>. Two items were manipulated in the auditory stimuli: 1) whether the name was ambiguous or unambiguous, 2) whether the sentence contained the auxiliary verb *were* or *was*. All sentences were presented with three names: *Jeremiah* (singular noun phrase, male), *Carter and Joe* (conjoined noun phrase, male), and *Carolyn May* or *Carol 'n May* (ambiguous between singular or conjoined noun phrase, female). The plural auxiliary verb *were* was used with conjoined noun phrases, and the singular auxiliary verb *was* was used with singular noun phrases. In this task, sentences with unambiguous names were used as control trials and sentences with ambiguous names were used as critical trials since both groups would have to attend to the auxiliary verb to decide if the subject is one or two people. The unambiguous and ambiguous names were matched by the number of syllables. The unambiguous names *Jeremiah* and *Carter and Joe* were both .93 seconds in duration, and the ambiguous name *Carolyn May* was .86 seconds in duration. The remainder of the verb phrase in the sentence contained verbs and direct objects that were controlled for age of acquisition; the age of acquisition was age 6;0 or younger for all verbs and nouns. Each participant heard 28 sentences that contained 7 tokens of each condition (i.e., unambiguous singular noun phrase, unambiguous conjoined noun phrase, ambiguous singular conjoined noun phrase, ambiguous plural conjoined noun phrase). This ensured that each participant was exposed to every condition while still preserving the novelty of the ambiguous names paired with a single display. (See Appendix A for a list of sentences and age of acquisition information for the verbs and direct objects.) Items were counterbalanced using a Latin Square design to prevent order effects, and pseudo-randomization was used to change the order of each list each time it was presented to a participant. Examples of auditory stimuli can be found here (ttps://osf.io/w7jhs/?view_only=5750411992e4450081a95d147da731ec).

Visual. The visual stimuli consisted of layered clip art images that corresponded to the experimental and control sentences. There were four images of the named children: *Carolyn May* (one girl), *Carol 'n May* (two girls), *Jeremiah* (one boy), and *Carter and Joe* (two boys). The images of these children were consistent throughout the pictures. Each sentence type depicts a single action that is completed by one or two people. The presentation of the images in the 2 x 2 array were fixed to reduce task demands (see Figure 1). Insofar as possible, the images were identical except for the identity of the people completing the action.

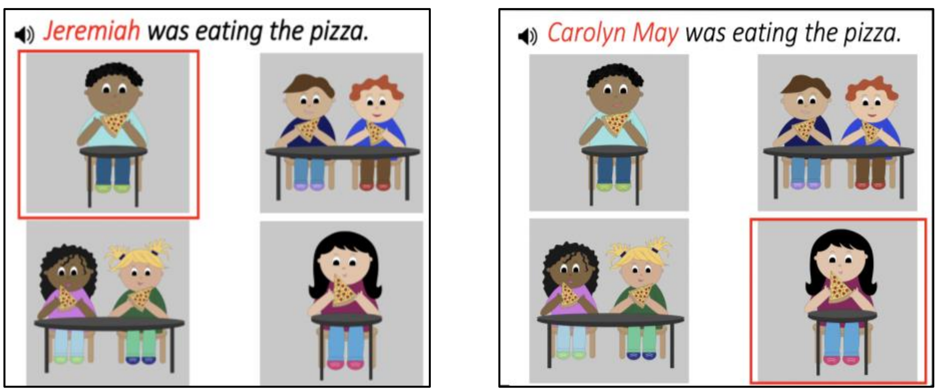

Figure 1. An example of the visual and auditory stimuli. The auditory stimuli were not presented on the screen but are presented here for illustration purposes. The image outlined in red was the target response for the auditory stimuli provided.

Procedure

All participants were administered the assessments virtually via Zoom on devices that were capable of sharing screens or had touchscreen capabilities. Shared screen functions were used to administer the DELV-ST and PVT, and a web link was sent to participants to open the web application on the participant's personal touch-screen device (i.e., iPad or other tablets, touchscreen computer, touchscreen phone). Participants' parents were asked to find a quiet room and use headphones during the administration of all tasks.

Before beginning the sentence comprehension task, participants were given a story introducing them to six characters: *Jeremiah*, *Carter and Joe*, *Carolyn May,* and *Carol n' May*. As the story was told, the picture of each character(s) moved to help participants associate the name they heard in the story with what the characters looked like visually. To evaluate whether participants knew the names of the characters, the first set of practice trials had four trials that asked participants to touch the picture that was associated with the character's name presented auditorily. The second set of practice trials had four trials that asked participants to touch the image that best matched the sentence they heard in order to train participants on the task itself. The sentences in the second set of practice trials used the auxiliary verbs *is* and *are* and contained a corresponding reflexive pronoun at the end (e.g., Carter *and Joe are cutting the paper themselves*) to encourage participants to attend to other cues outside of the subject name, particularly for the ambiguous name *Carolyn May*. Participants had to answer all of the practice trials in both sets of practice trials correctly before they could begin experimental trials. In the experimental trials, participants heard a sentence and selected an image. All experimental trials were time-locked so that the participant could not select an image until the sentence ended. The PVT and the DELV-ST were administered after the sentence processing task. Some study materials cannot be publicly shared (PVT and DELV-ST) because these materials are copyrighted by the publisher.

Results

The analyses were designed to answer the two experimental questions: (1) are there differences in the use of auxiliary verb (*was* vs. *were*) for the critical sentences, and (2) does dialect density predict the use of the auxiliary verb for ambiguous sentences? Both logistic mixed-effects and logistic linear regression models were used to test the predictive value of each independent variable (Fitzmaurice et al., 2011). Logistic mixed effects models were built using the buildmer package (Version 2.8; Voeten, 2021). Buildmer uses stepwise elimination to find the largest possible regression model that will converge. Final predictor variables were selected based on the result of the buildmer model and previous literature that has shown that variables like vocabulary or dialect are predictive of sentence processing outcomes in AAE-speaking children (Beyer & Hudson-Kam, 2012; De Villers & Johnson, 2007; Edwards, et al., 2014). Each model was tested to ensure it did not violate parametric assumptions. Both dialect density, a continuous variable, and vocabulary scores were centered because the distributions were skewed. Models were fit using the lme4 package (Version 1.1-21; Bates et al., 2015) in R (Version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses. Standardized parameter estimates are provided. The data and analysis code can be found here.

Understanding plurality in the unambiguous condition. First, a logistic mixed-effects model was used to analyze if AAE and MAE speakers could determine how many subjects were completing an activity in the unambiguous sentences. In this model, Plural Responses were regressed on Participant Dialect (AAE vs MAE) and Verb Type (*was vs were*). Plural Responses is a dichotomous variable where "0" represented a participant selecting a 1-person image and "1" indicated the selection of a 2-person image. A positive coefficient indicates an increase in the log odds of plural responses relative to the reference levels, which were AAE speakers and *were* Verb Type. A negative coefficient indicates a decrease in the log odds of plural responses relative to the reference levels. Vocabulary scores were included as a covariate within the model.

Figure 2 illustrates that both AAE and MAE speakers were more likely to select a 2-person image after hearing *were* than *was*. There was no effect of vocabulary, suggesting that overall language development did not impact an AAE speaker's likelihood to select 2-person image after hearing *were*. There was an effect of Verb Type (p<0.01, d=-3.19), which indicates that AAE speakers were less likely to select a 2-person image after hearing the Verb Type *was* than *were.* However, there was also no effect of Participant Dialect, meaning there was no statistically significant difference between AAE and MAE speakers' likelihood to select a 2-person image after hearing sentences with *were.* There is also a significant Participant Dialect by Verb Type interaction indicating that there was less of an effect of Verb Type on the number of plural responses AAE speakers chose than MAE speakers (p<0.01, d=-0.35).

Interestingly, it appears that errors in the Unambiguous condition were unrelated to subject-verb agreement. When we examined the error types produced by both groups to understand why there were more errors for the *was* Verb Type for AAE speakers relative to the MAE speakers. Figure 3 illustrates that for AAE speakers, the primary error type was selecting the incorrect gender, suggesting that they understood that Jeremiah was a singular noun but thought that it could be female rather than male (this is despite the fact that they had correctly responded in all training trials). Nevertheless, both groups had a significant and relatively large difference between the number of plural responses for the two verb types, indicating that they understood the task. See Table 2 for model coefficients.

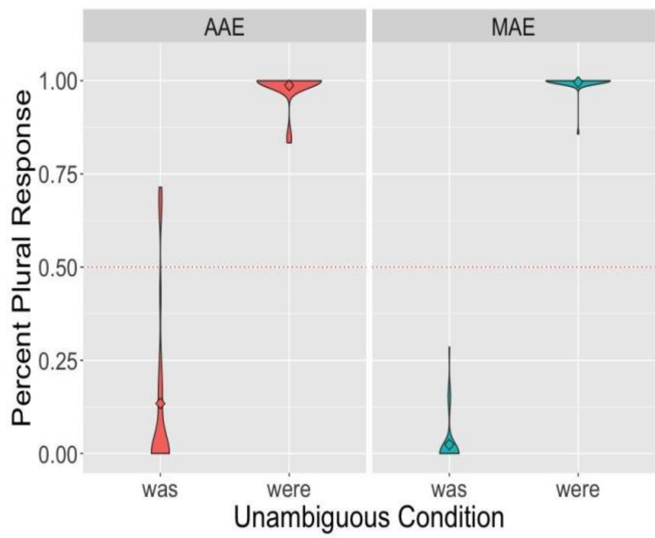

Figure 2. Percent of Plural Responses by Dialect Group and Verb Type for unambiguous sentences. Group means are shown by the black diamond. The violin plot demonstrates where the distribution of responses occurs within the group.

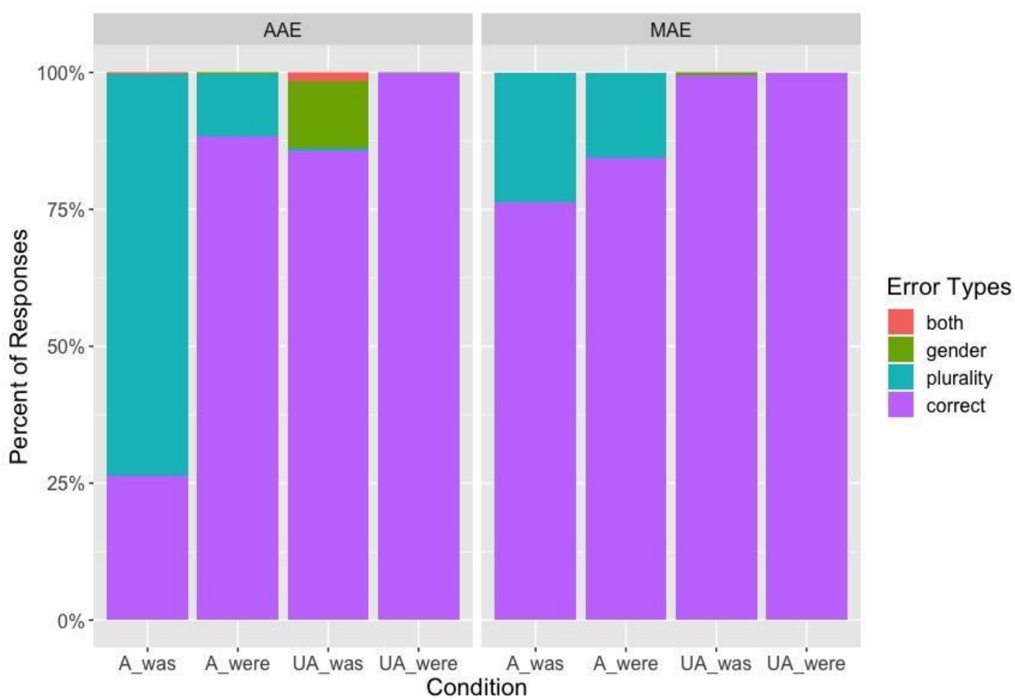

Figure 3. Types of errors in ambiguous and unambiguous conditions for AAE and MAE speakers. Condition names with "A" before them are ambiguous Verb Types, and condition names with "UA" before them are unambiguous Verb Types.

Table 2. Fixed effects (Speaker Group x Verb Type) from the logistic mixed-effects for the unambiguous sentences

		CI[5]		
	OR[6]	LL[7]	UL[8]	*p*
(Intercept)	157.66	1.29	19288.13	<0.01*
Vocabulary Standard Scores	1.00	0.96	1.05	0.95
Speaker Group MAE	3.31	0.25	43.60	0.36
Verb Type was	0.00	0.00	0.00	<0.01*
Speaker Group MAE x Verb Type was	0.04	0.00	0.67	<0.05*

Note. The reference groups for the model are AAE speakers for Speaker Group and *were* for Verb Type.

Group differences in auxiliary use: Likelihood to select a 2-person image. To analyze if there were group differences in how AAE and MAE speakers used inflectional verb morphology for comprehension, a logistic mixed-effects model was used to evaluate if Participant Dialect (AAE vs MAE) and Verb Type (*was* vs. *were*) were predictive of how likely a participant was to select a 2- person image. Participants' race and vocabulary were included as covariates within the model. The likelihood of selecting a 2-person image is a dichotomous variable where “0” represented a participant selecting a 1-person image and “1” indicated the selection of a 2-person image. Speaker Group was leveled so that AAE participants were the reference group, and Verb Type was leveled so that singular (*was*) was the reference group. The covariate Race was leveled so that Black participants were the reference group. Participant were modeled as random slopes to account for individual differences. In this model, a positive coefficient indicates an increase in the log odds of plural responses relative to the reference levels, which were AAE speakers and *was*. A negative coefficient indicates a decrease in the log odds of plural responses relative to the

[5] *CI*=Confidence Interval
[6] *OR*= Odds Ratio
[7] *LL*=Lower Limit,
[8] *UL*=Upper Limit

reference levels. Only responses to ambiguous sentences were included in this model. The R code for this model can be found in Appendix C.

Figure 4 illustrates that MAE-speakers were more likely to select 2-person images after hearing *was* than *were*, indicating sensitivity to the Verb Type. However, AAE-speaking participants selected 2-person images after both *was* and *were*. The logistic mixed-effects model demonstrated there was no effect of participant Race, meaning there was no statistically significant difference between the likelihood that Asian/White and Black participants would select a 2-person image after hearing the Verb Type *was*. Furthermore, there was no effect of Vocabulary, meaning that vocabulary scores were not predictive of AAE speakers' likelihood to select a 2-person image after hearing the Verb Type *was.* There was an effect of Participant Dialect for MAE speakers ($p < 0.05$, $d=-0.75$), which indicated that MAE speakers, as compared to AAE speakers, were less likely to select a 2-person image after hearing the Verb Type *was*. In addition, there was an effect of the Verb Type *were* ($p < 0.05$, $d=0.17$), meaning that AAE speakers were more likely to select a 2-person image with the Verb Type *were* than *was.* There was a significant interaction between Participant Dialect and Verb Type ($p <0.01$, $d=0.38$), which suggests there was more of an effect of Verb Type on the likelihood of selecting a 2-person image for MAE speakers relative to AAE speakers. MAE speakers were more likely to select a 2-person image for *were* and not *was* verbs, whereas AAE speakers were more likely to select a 2-person image for both *was* and *were* verbs. See table 3 for model coefficients.

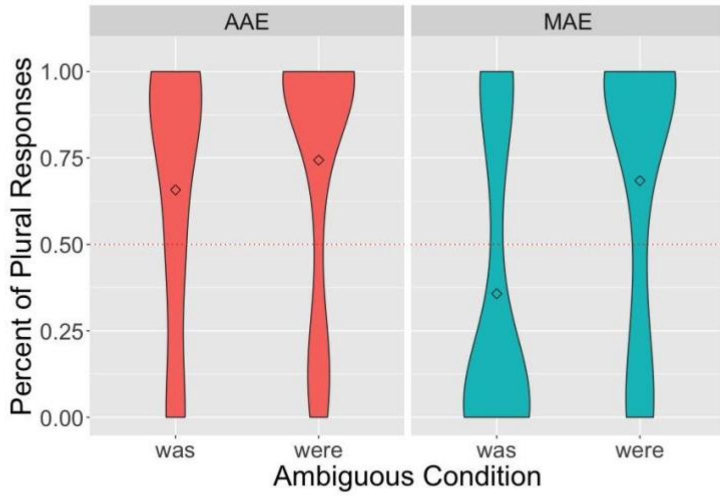

Figure 4. Percent of Plural Responses by Dialect Group and Verb Type for ambiguous sentences. Group means are shown by the black diamond. The violin plot demonstrates where the distribution of responses occurs within the group.

Table 3. Fixed effects (Speaker Group x Verb Type) from the logistic mixed-effects models for the ambiguous sentences.

		CI		
	OR	*LL*	*UL*	*p*
(Intercept)	3.50	0.54	22.46	0.19
Race Asian/White	3.23	0.38	27.83	0.29
Vocabulary Standard Scores	0.87	0.30	2.52	0.79
Speaker Group MAE	0.04	0.00	0.44	<0.05*
Verb Type were	2.90	1.32	6.38	<0.05*
AAE speaker x Verb Type were	9.95	3.50	28.31	<0.01*

Effect of Dialect Density on auxiliary verb use. A logistic linear regression was performed to evaluate if dialect density (as a continuous measure) predicted how Black participants used the Verb Type (*was* or *were*) to comprehend ambiguous sentences. This analysis was performed only with Black participants because there was little variation in dialect density for the Asian/White participants (dialect density range .08 to .93 for Black relative to 0 to .36 for Asian/White participants). Dialect density was calculated by taking the number of non-mainstream features produced on the DELV-ST and dividing by the total number of scorable items. For example, a student who used only MAE features would score a 0, and a participant that used only AAE features would score a 1. Vocabulary was included in the model as a covariate to control for differences in language knowledge, and Age was included as a covariate to control for developmental differences in performance. A positive coefficient indicates an increase in the log odds of plural responses relative to the reference levels, which were ambiguous *was*, and a negative coefficient indicates a decrease in the log odds of plural responses relative to the reference level. The R code for this model can be found in Appendix C.

Figure 5 illustrates that lower dialect density for Black participants was associated with greater sensitivity to the auxiliary verb, whereas higher dialect density was associated with less sensitivity to the auxiliary verb. There was an effect of Dialect Density ($p < 0.01$, d=0.08), which indicates that as dialect density increased so did the likelihood of plural responses for ambiguous *was.* In addition, there was an effect of Verb Type *were* (p<0.01, d=0.13) meaning there were more plural responses in ambiguous *were* than *was*. There were no effects of Vocabulary or Age. Lastly, there was an interaction between Dialect Density and Verb Type ($p <$ 0.01, d=-0.07), indicating that Black participants with lower dialect density had a greater difference between the number of plural responses they selected for *was* and *were,* while Black participants with higher dialect differences had smaller differences between plural responses they selected for *was* and *were.* The results demonstrated that dialect density is predictive of how the auxiliary verb is used to comprehend MAE sentences. See Table 4 for model coefficients.

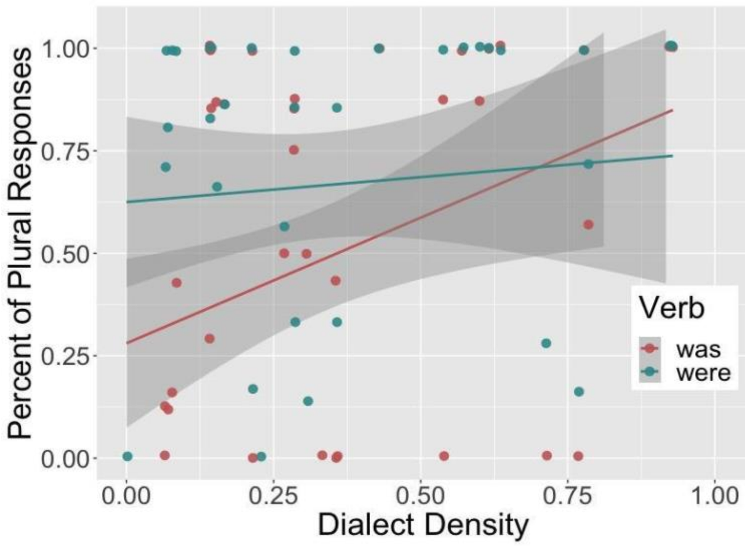

Figure 5. Percent of plural responses as a function of Dialect Density for the two verb conditions in Black participants.

Table 4. Logistic Linear Regression for Dialect Density and Verb Type in Black participants.

	β	SE	*z*	*p*
(Intercept)	0.44	0.21	2.13	<0.05*
Dialect Density	0.15	0.03	5.44	<0.01*
Verb Type were	0.23	0.04	5.27	<0.01*
Vocabulary Standard Scores	0.03	0.02	1.34	0.18
Age	0.00	0.00	-0.02	0.98
Dialect Density x Verb Type were	-0.12	0.04	-3.15	<0.01*

Discussion

The purpose of this study was to evaluate if there were differences in how AAE- and MAE-speaking children used a more phonetically salient contrastive feature to comprehend MAE sentences. The results revealed that even when the contrastive feature had greater phonetic saliency relative to morphological cues used in past studies, AAE speakers did not use it as a comprehension cue to differentiate between singular and plural nouns. This supports previous inferences that AAE-speaking children are not reliably sensitive to MAE morphology that are zero or optionally marked within their dialect (Beyer et al., 2015; De Villers & Johnson, 2007; Edwards et al., 2014), and suggest that the linguistic mismatch between features of MAE and AAE may impact spoken language comprehension, regardless of the phonetic saliency of the feature.

In AAE, subject-verb agreement is variably produced and *was* is used with both plural and singular subjects. Thus, plurality must be derived from the subject, not the verb which explains why Black AAE speakers may be less sensitive to the auxiliary verb in the ambiguous sentences (Green, 2002; Newkirk-Turner et al., 2014). The results from this study suggest that children who use AAE features in production, which is how participants were classified as MAE or AAE speakers, are also likely to also use these same dialect features in comprehension (e.g., optionally marked subject-verb agreement). On average, AAE speakers chose the 2-person image about 75% of the time for the verb *was* and about 95% of the time for the verb *were* in the ambiguous sentences. These results suggest that AAE speakers were not sensitive to verb number as a cue and instead relied on a general preference to interpret *Carolyn May* as a conjoined noun phrase in the ambiguous sentence. The pattern of selecting a 2-person image regardless of the verb aligns with how *was* is used in production for AAE speakers.

Moreover, differences in dialect density did predict how Black participants used the auxiliary verb to determine subject number. The results from the current study are in line with the results from Edwards et al. (2014), which found that dialect density predicted how AAE-speaking children used contrastive features as comprehension cues to interpret MAE words and phrases beyond vocabulary size (language experience). Despite there being a general decline in the production of AAE features as AAE-speaking children progress through school, it appears that how a contrastive feature is used for comprehension is influenced by the predominant dialect the speaker produces. Black participants who had a higher dialect density (i.e., AAE speakers) consistently used AAE in their productions on the DELV-ST *and* used their grammatical knowledge of AAE to interpret the MAE sentences. By contrast, the Black participants who had a lower dialect density (i.e., MAE speakers) primarily used MAE in their productions on the DELV-ST and used their grammatical knowledge of MAE to interpret the MAE sentences. Overall, changes in dialect density suggests that participants' linguistic experiences, as measured by the dialect features they produce, may shape what cues are used for comprehension.

This study suggests that even with increased phonetic saliency, there are difference in how AAE- and MAE-speaking children use the auxiliary verb to comprehend MAE sentences and that dialect density is predictive of sensitivity to the auxiliary verb. Furthermore, this study suggests that participants' linguistic experiences are influential in how children comprehend dialects that differ from the dialect they predominantly speak or are exposed to at home, which was demonstrated with the AAE speakers. These results suggest that researchers should take into consideration how children's linguistic experiences influence how they process sentences in MAE **(**Childs & Mallinson 2004, Cukor-Avila, 2001; Grieser, 2015; Wolfram & Beckett, 2000; Wolfram & Kohn, 2015). Furthermore, these findings raise additional questions as to how observed differences between AAE- and MAE-speaking children's performance in spoken language comprehension tasks may impact academic performance. It is possible that linguistic mismatch in spoken language 1) is resolved in naturalistic contexts where there are additional prosodic, visual, and repetition cues that improve comprehension (DeDe, 2010; Spivey et al., 2002) or 2) adversely affects AAE speakers by causing perceptual processing costs that impact other cognitive processes such as working memory (Arnold et al., 2012; Montgomery, 2000; Terry et al., 2010, 2022). However, additional work is needed to examine if these observed differences lead to fine-grained differences in how students parse MAE sentences and how that connects to academic performance.

Limitations and Suggestions

There were several limitations to this study. One limitation was the virtual recruitment and administration of the study. Although the virtual administration of this study allowed for a diverse sample, it limited the experimenter's ability to evenly match the number of AAE and MAE speakers because linguistic variation was established after participants consented to participate in the study. Likewise, the virtual administration allowed for more accessibility for participants to complete the study but limited the experimenters control over the testing environment. Although participants were encouraged to find a quiet room and use headphones during the study, distractions (e.g., noise, internet connections, etc.) could not be controlled. In addition, despite stimuli norming, there was a two-person bias for the ambiguous name *Carolyn May*, even for the MAE speakers in the *was* condition in ambiguous sentences (though not in unambiguous sentences).

Conclusions

To date, there has been limited research on how AAE-speaking children use features that are marked in MAE but not in AAE to understand MAE sentences. This study added to this body of work by demonstrating that regardless of phonetic saliency AAE-speaking children are less sensitive to MAE morphological features that are zero or optionally marked within their dialect. This work improves our knowledge about how linguistic variation can influence what cues children find relevant and reliable to comprehend sentences within another dialect. Furthermore, the results from this study demonstrate that linguistic mismatch, which has been primarily studied in reading and writing, also impacts what auxiliary verbs AAE-speaking children are sensitive to during spoken language comprehension. These findings help us better understand how linguistic mismatch may shape listening comprehension experiences, which will allow for the development of strategies to mitigate these effects as advocacy continues for linguistic inclusivity within the classroom.

Chapter 3: Evaluating how AAE- and MAE-speaking children use inflectional verb morphology to comprehend MAE sentences in a real-time spoken language comprehension task

There has been substantial research on how to close the persistent academic performance gap between African American and European American students for at least the past 20 years (e.g., Bell, 2012; Hillard, 2003; Mark, 2013; National Center for Education Statistics, 2019). Much of this research has focused on documenting societal (e.g., racism, school funding) and individual (e.g., parent support, poverty) factors that contribute to the gap, as well as exploring a variety of methods to improve the academic outcomes of African American students (e.g., Bell, 2012; Baugh, 1999; Brown et al., 2015; Cowan Pitre, 2014; Labov, 1972; Ladson-Billings, 2006; Mark, 2013; McCardle et al., 2001; NP Terry et al., 2010; Washington et al., 2013).

One focus of research on how to close the academic performance gap has focused on the interaction between African American English (AAE), the dialect many African American students speak, and academic performance. There is a well-documented negative relationship between the production of AAE features and academic outcomes, even when controlling for socioeconomic status (Brown et al., 2015; Dexter et al.; 2018; Gaitlin & Wanzek, 2015; Puranik et al., 2020; Washington et al., 2018). While there have been several hypotheses for why this relationship exists, the most prominent is the linguistic mismatch hypothesis. Linguistic mismatch can occur when a listener encounters a linguistic feature that is produced differently in their dialect (Bühler et al., 2018; Craig, 2016; Charity et al., 2004; Feitelson et al., 1993; Pearson et al., 2013; Saiegh-Haddad, 2005; NP Terry et al., 2018) relative to another dialect. For instance, AAE and Mainstream American English (MAE) are American English dialects that have similar surface structures, including shared lexical items and basic sentence structure (Beyer & Hudson, 2015; Green, 2002; Green & Sistrunk, 2015; Martin & Wolfram,1998);

however, they systematically differ in some phonological and morphosyntactic features (Green, 2002; Lanehart, 2015; Rickford, 1999). It is hypothesized that the differences between AAE and MAE cause a linguistic mismatch, which makes learning more difficult for AAE-speaking children. That is, there is a mismatch between spoken and written representation of words because the prominent dialect for academic instruction is MAE, and children are taught to read in MAE (Brown et al., 2015; Byrd & Brown, 2021; Connor & Craig, 2006; Craig, 2016; Charity et al., 2004; Edwards et al.,2014; Gatlin & Wanzek, 2015; Labov & Baker, 2015). The effects of linguistic mismatch are purported to impact literacy acquisition (Charity et al., 2004; Washington et al., 2018) and spelling (Ivy & Masterson, 2011; Kohler et al., 2007; Terry et al., 2010), resulting in poorer literacy scores and academic performance observed in some African American students.

Thus far, the impacts of linguistic mismatch have been primarily assessed in written language tasks such as reading and writing. There has been far less work on how linguistic mismatch impacts cognitive mechanisms, such as spoken language comprehension. Listening and, more importantly, understanding what the teacher is saying is crucial to developing other language skills, such as reading and writing, that are necessary for academic success (Linebarger, 2001; Swain et al., 2004; Tindall et al., 2008). How well students comprehend and learn from their teacher can depend on classroom noise, internal distractions, or speaker characteristics of the teacher, such as accent and dialect (Barker, 2015; Bent, 2014; García, 2017; García et al., 2022; Harte et al., 2016). Since a teacher’s accent and dialect can impact spoken language comprehension in the classroom, it is crucial to investigate how AAE-speaking children process contrastive features when listening to MAE sentences since the primary medium of instruction in the classroom is through spoken language.

The remainder of this chapter examines previous literature on how children and adults who speak AAE or MAE comprehend sentences in dialects that are similar or different than their own. Then, this chapter examines the limited studies that have explored how linguistic mismatch impacts online sentence processing in adults and children who speak AAE and MAE. Lastly, this chapter presents evidence that linguistic mismatch can impact how AAE-speaking children process MAE sentences in real-time and explores the implications of these findings.

Linguistic Mismatch and Spoken Language Comprehension

The small body of research investigating linguistic mismatch in spoken language comprehension has evaluated how adult speakers understand AAE or MAE and how child AAE speakers understand MAE. In adults, Beyer and Hudson-Kam (2015) and Beyer, Edwards, and Fuller (2015) found that MAE-speaking adults inappropriately interpreted sentences that contain stressed *BIN* (*been*), a morphosyntactic feature of AAE that indicates an action or event that occurred in the remote past (e.g., *She been cooking)*; but appropriately interpreted sentences that contained shared linguistic information such as temporal adverbs (e.g., *yesterday*). In the comprehension task, both AAE- and MAE-speaking adults were presented with test sentences that contained stressed BIN (e.g., *He been at the park)*, unstressed *been* (e.g., *She has been at the park),* or temporal adverbials (e.g., *They went to the park yesterday),* and filler sentences that corresponded to the present or future tense. They were then asked to rate if the action in the sentence occurred in the remote past, recent past, near future, or distant future. Compared to AAE-speaking adults, MAE-speaking adults interpreted every form of *been* as an action that occurred in the recent past, leading them to experience pseudo-comprehensions (a situation where the listeners believe that they understand the sentence but do not correctly understand it). It was hypothesized that pseudo-comprehensions were caused by MAE-speaking adults using the linguistic knowledge of their dialect to interpret stressed *BIN* (Beyer et al., 2015; Roy, 1987). These findings are further supported by evidence that MAE-speaking court stenographers experienced pseudo-comprehensions when transcribing testimony containing AAE features. Jones et al. (2019) found that MAE-speaking court recorders who were trained to be 95% to 98% accurate in their transcripts of court proceedings were only 60% accurate at transcribing testimony that contained common and frequently used features of AAE.

In children, linguistic mismatch in spoken comprehension has been examined at the word, phrase, and sentence level in offline comprehension tasks. Edwards et al. (2014) explored how AAE- and MAE-speaking children, ages 4 to 8, interpreted words and phrases that could be perceptually ambiguous due to a phonological (i.e., final consonant clusters) or morphological (i.e., plural morpheme -s) contrast between AAE and MAE. In AAE, final consonant clusters can be optionally produced if the two consonants agree in voicing (e.g., *cold* could be pronounced as col'), and the plural morpheme can be optionally marked if there is a quantifier proceeding the noun (e.g., *twenty cent*) (Bailey & Thomas, 2013; Green, 2002; Keare, 2009). Participants heard a word that could be perceptually ambiguous due to dialect differences or a dialect-neutral word that did not contain contrastive phonological or morphological features. Then, they were asked to select a picture that best matched what they heard. Edwards and colleagues found that AAE-speaking children were less accurate at comprehending perceptually ambiguous words than dialect-neutral words spoken in MAE. Furthermore, children's vocabulary size and dialect density (a measure of how many AAE dialect features children used in their spoken language) predicted their performance.

Several studies have explored how AAE-speaking children interpret a variety of contrastive verb morphology features, including third-person singular -s (De Villers & Johnson, 2007; Johnson, 2005), past tense -ed, contracted -ll (Beyer & Hudson-Kam, 2012), and subject-verb agreement (i.e., *was/were*) (Byrd et al., 2023). These studies used similar methods, which involved presenting children a sentence that contained contrastive verb morphology (e.g., third-person singular -s) and control sentences with shared verb morphology (e.g., plural -s) or other dialect-neutral cues. In each study, children were asked to select an image that best matched what they heard. De Villers and Johnson (2007) found that neither MAE- nor AAE-speaking children, ages 4 to 6 years, used third-person singular -s as a comprehension cue. However, by age 7, MAE speakers began to use third-person singular -s as a reliable cue, but AAE-speaking children did not. Beyer and Hudson-Kam (2015) found that MAE- and AAE-speaking children in first and second grade used shared verb morphology to comprehend MAE sentences. However, AAE-speaking children did not use contrastive verb morphology to interpret tense in MAE sentences, and there were no age-related changes in their performance (Beyer & Hudson-Kam, 2015). Furthermore, Byrd and colleagues also found that AAE-speaking children ages 6 to 10 did not use verb morphology (*was/were*) optionally marked in AAE but not MAE to interpret subject number in ambiguous MAE sentences. Dialect density, or the number of dialect features produced in spoken language on a standardized test, predicted African American children's performance on the task (Byrd et al., 2023).

Effects of Linguistic Mismatch on Real-time Processing Tasks

Thus far, limited studies have investigated the impacts of linguistic mismatch in online sentence processing tasks in children and adults who speak AAE and MAE. García and colleagues (2022) and Weissler and Brennan (2020) used online processing tasks to measure how linguistic mismatch impacted adults' sentence processing. García et al., 2022 used electroencephalography (EEG) and an offline grammatical judgment task to explore how adults who only speak MAE and adults who are bidialectal and speak MAE and AAE processed sentences that contained features of MAE, AAE, or were ungrammatical. Results demonstrated MAE speakers demonstrated a P600 response following the presentation of an AAE morphosyntax feature, which indicated error detection; this response was not seen in the bidialectal group, implying that bidialectal speakers leveraged information about AAE to process the sentences. The results of the grammaticality judgment task showed that bidialectal speakers were more likely to judge ungrammatical sentences as grammatical than monodialectal MAE speakers. Weissler and Brennan (2020) found similar results in a study in which adults who spoke different varieties of American English altered their grammatical expectations based on how "standard" they perceived the dialect of the speaker they were listening to, which led to more ratings of non-mainstream dialects as ungrammatical; however, that was not reflected in a P600, which indicates the perception of an error when measured by EEG.

Terry et al. (2022) used online processing methods, such as EEG, to examine how linguistic mismatch impacts sentence processing in MAE- and AAE-speaking children. Specifically, Terry et al. (2022) examined how AAE-speaking children used third-person singular -*s* to process MAE sentences and oral math problems. In the sentence processing tasks, children heard paired sentences that did or did not contain third-person singular -s and were asked to state if the sentences matched. Results showed that when AAE-speaking children encountered third-person singular -s in sentences, they experienced a morphosyntactic structure-building problem indicated by a bilateral early anterior-central negativity in the EEG. The morphosyntactic structure-building problem is hypothesized to be caused by third-person singular -*s* being outside of the participant's grammar. In the oral math problem task, AAE-speaking children demonstrated lower accuracy on math problems that contained third-person singular -*s*.

Erskine (2023) examined how AAE- and MAE-speaking children processed MAE sentences using eye-tracking during an online sentence processing task. The study found that linguistic mismatch had differing effects on how AAE- and MAE-speaking children processed MAE sentences depending on the context. For instance, in sentences with limited semantic information (i.e., sentences without a predictive verb as in *Find the book*), AAE-speaking children were less accurate at interpreting MAE sentences with contrastive phonological and morphological cues and demonstrated patterns of late processing with peak looks to the target occurring later than their MAE-speaking peers. However, when sentences contained additional semantic information (sentences with a predictive verb as in *Read the book*), AAE- and MAE-speaking children performed similarly. Furthermore, Erskine (2023) found that social context, such as speaker race, impacted performance on sentence processing tasks. For example, African American and European American children prioritized race-related cues over dialect in tasks that paired spoken dialect variation with visual cues (pictures of a European American or African American face).

The Current Study

The previous research provides evidence that a listener's dialect can impact what cues they use when comprehending or processing sentences in another dialect (Beyer & Hudson-Kam, 2015; Beyer et al., 2015; Byrd et al., 2023; Beyer & Hudson-Kam, 2015; De Villers & Johnson, 2007; Edwards et al., 2014; Erskine, 2023; García et al., 2022; Jones et al., 2019; Johnson, 2005; Terry et al. 2022; Weissler & Brennan, 2020). In children, studies have shown that AAE speakers are less likely to be sensitive to verb morphology that contrasts between AAE and

MAE, which decreases AAE speakers' accuracy on listening comprehension tasks in MAE sentences (Beyer & Hudson-Kam, 2015; Beyer et al., 2015; Byrd et al., 2023; Beyer & Hudson-Kam, 2015; De Villers & Johnson, 2007; Edwards et al., 2014). These results have led to concerns on how decreased accuracy on auditory sentence comprehension tasks may cause difficulty on academic tasks. However, before research can explore how AAE-speakers' offline responses connect to academic performance, it is important to understand why there are observed differences in how AAE- and MAE-speaking children interpret MAE sentences, especially since AAE-speaking children are exposed to MAE in school, which provides some measure of familiarity with the dialect. Observing how AAE- and MAE-speaking children process MAE verb morphology in real-time sentence processing tasks will build an understanding of what linguistic cues are guiding the interpretation of MAE sentences.

The results of the limited studies that have examined how AAE- and MAE-speaking children process MAE sentences have led researchers to hypothesize That observed differences could be due to slower or delayed processing (Erskine, 2023) or that contrastive verb morphology features are misinterpreted, leading to an increased cognitive load (Terry et al. 2022). While both hypotheses are plausible, there are potentially other reasons for *why* AAE-speaking children are less accurate at interpreting MAE sentences. For instance, it is possible that AAE-speaking children are less sensitive than their MAE-speaking peers to contrastive verb morphology, meaning that they are less likely to attend to cues that are not within AAE. This hypothesis would be supported by online sentence processing patterns showing AAE-speaking children systematically rely on other linguistic cues or do not revise their interpretations when encountering contrastive verb morphology. Conversely, it is possible that AAE speakers *are* sensitive to contrastive verb morphology but have difficulty using it as an informative cue to revise interpretations, or auxiliary verbs are weighed differently than other linguistic cues, which decreases their informativeness. This hypothesis would be supported by online sentence processing patterns that show AAE-speaking children reacting to contrastive verb morphology in real time. Previous studies have either focused on the cognitive processing costs of contrastive verb morphology (Terry et al., 2022) or have focused on how children integrate semantic and social cues when processing sentences with contrastive verb morphology (Erskine, 2023). Thus, there is a gap in knowledge on how AAE-speaking children leverage or weigh contrastive verb morphology when processing sentences. Understanding how contrastive features impact sentence processing in real time may improve our theories about how linguistic variation influences sentence processing.

This study aims to address this gap, by exploring how AAE- and MAE-speaking children use inflectional verb morphology to comprehend MAE sentences in an online processing task using the visual world paradigm. Since eye movements are closely linked to how an unfolding speech signal is parsed, an online sentence processing task provides a fine-grained approach to observing how the dialect a participant speaks interacts with how they process the linguistic information they hear (Farris-Trimble & McMurray, 2013; Spivey et al., 2002). This study specifically focuses on the inflectional verbs, *was* and *were,* that differ between AAE and MAE. In MAE, *was* is always paired with a singular subject (e.g., *she was*), whereas *were* is always paired with a plural subject (e.g., *they were*). In AAE, subject-verb agreement is variably produced, meaning that *was* can be produced with both singular subjects (e.g., *she was, they was)* (Green, 2002, 2012; Green & Sistrunk, 2015; Newkirk-Turner et al., 2014). This means *was* may not be a reliable cue for AAE speakers to interpret MAE sentences (Byrd et al., 2023). The inflectional verbs, *was* and *were,* were chosen because they are phonetically salient whole-syllable inflectional verb morphology features reliably used as comprehension cues by younger MAE-speaking children (Kouider et al., 2006; Lukyanenko & Fisher, 2016; Wood et al., 2009), which reduces the chances of our results being confounded by age-related or perceptual saliency issues (Bortolini et al., 2006; Leonard et al., 1997; Leonard, 2014). The focus on the interpretation of MAE speech explores what AAE-speaking students may be experiencing in real time in the classroom.

This study poses two research questions: 1) Are there group differences in how AAE- and MAE-speaking students use *was* and *were* to process MAE sentences in an online processing task, and 2) Does dialect density predict how AAE speakers use *was* and *were* to process MAE sentences in an online task? Based on the results of Byrd et al. (2023), it is predicted that there will be group differences in the accuracy of how AAE- and MAE-speaking children use *was* and *were* to process MAE sentences. Furthermore, based on the results of Byrd et al. (2023) and Edwards et al. (2014), it is also predicted that dialect density will predict accuracy in this task. The results of this study build on previous work and will provide additional knowledge on how linguistic experience and knowledge guide sentence processing in real time. Additionally, this study continues to help define the contexts in which linguistic mismatch adversely impacts sentence processing. Overall, the results from this study will improve our models of how children process sentences and take a step toward understanding how linguistic mismatch impacts the cognitive processes that support learning.

Methods

Participants. This study recruited 59 participants, ages 7;8-11;0 years old, from the Maryland/DC and Virginia areas. Recruitment methods included a university database, partnerships with two private schools and one public school in Maryland, and distribution of fliers in local communities. Most African American participants were recruited through school partnerships. Four participants were excluded because their parents reported they had a developmental delay, language delay, or Individualized Education Plan (IEP). Based on parent reports, all other participants had typical speech and language development. All participants passed a hearing screening at the beginning of testing. Parents of participants provided informed consent. Families received compensation for their participation, and children received a small gift. Table 1 provides demographic information and test scores for all participants.

To answer the research questions, this study used two samples derived from the recruitment pool: 1) a sample of all participants was used to address the first research question (n=55) and 2) a sample of all African American participants which was used to address the second research question (n=29). To highlight the diversity of each sample, Figures 1 and 2 provide additional visual descriptions for the relationship between participants' age and dialect density score, parent income and dialect density score, and race and dialect density score. Calculation of dialect density scores is described below in the section on Standardized Language Measures. In all figures, most participants are skewed towards having lower dialect density scores (scores between 0.00-0.20), which aligns with Table 1 which shows that most participants were identified as being MAE speakers.

Figure 1 shows the relationship between demographic variables and dialect density for all participants. Figure 1a shows that most participants recruited have dialect density scores less than 0.20, and that there does not appear to be a relationship between age and dialect density (r=-0.03, p=0.78) in this sample. Figure 1b. indicates that most of the racial diversity is concentrated within dialect density scores that range from 0.00-0.20. A one-way ANOVA indicated a significant difference between participants' race and their dialect score (F (3, 55) =

4.40, p <0.01). Post-hoc analyses revealed a statistical difference between the dialect density scores of African American and European American participants (p<0.01). Figure 1c. demonstrates that participant's parent income does not appear to be strongly related to dialect density scores (F (5, 51) = 1.16, p = 0.34), which is likely due to this sample being collected primarily from affluent suburbs of Washington D.C.

Figure 2 shows the relationship between demographic variables and dialect density for only the African American participants. Figure 2a. demonstrates that although most African American participants have dialect density scores less than 0.20, all age groups were represented in the full ranges of dialect density scores. In this sample, there does not appear to be a relationship between age and dialect density, which aligns with what was observed in all participants (r = -0.32, p = 0.09). Similarly to Figure 1c., Figure 2b. demonstrates that, for this sample of participants, parent income does not appear to be strongly related to dialect density scores (F (4, 24) = 1.78, p = 0.18).

Parent Survey

Parents of child participants completed a two-part survey. Part 1 evaluated parents' experiences with different dialects of American English, and part 2 collected demographic information such as race, parent education level, and total family income. The survey was 15 to 20 minutes long and administered asynchronously and virtually to parents. The survey was optional; parents could skip questions they did not want to answer or decline to complete. Approximately 92% of parents completed the parent survey. Responses from part 1 of the survey were not included in the analysis for this study.

Standardized Language Measures

Participants were administered two standardized assessments: the *Diagnostic Evaluation of Language Variation-Screener Test: Part 1* (DELV-ST) (Seymour et al., 2003) and the *Peabody Picture Vocabulary Test, 5th edition* (PPVT-5) (Weintraub et al., 2013).

The PPVT-5 is a standardized measure of receptive vocabulary skills. Participants were presented with four images and instructed to point to or tell the examiner the number of pictures that best matched the word they heard.

Part 1 of the DELV-ST is a screening test designed to describe dialectal variation from MAE by evaluating the production of contrastive features between MAE and AAE. The DELV-ST Part 1 provides an age-referenced criterion score that identifies if a participant is a: (a) MAE speaker, (b) has some variation from MAE, or (c) strong variation from MAE. This criterion score was used to identify if a student spoke a non-mainstream or mainstream dialect and assign participants to groups. For this study, criterion scores of some variation from MAE or strong variation from MAE were collapsed together into the category of non-mainstream dialect speakers (i.e., AAE) since these criterion scores indicated they used some non-mainstream features in production.

In addition, a dialect density score was calculated based on how many AAE features a speaker uses on the DELV-ST, which was used as a continuous measure of dialect. This score was calculated by dividing the number of non-mainstream features produced by the number of scorable items (Terry et al., 2010; Terry & Connor, 2012; Terry et al., 2012). Therefore, a student who used only MAE features would score a 0, and a participant who used only AAE features would score a 1.

Table 1. Participant Demographics

	AAE Listeners	MAE Listeners
n	17	42

Female	11	20
Mean Age	9;4	9;4
range	7;8-11;0	7;8-10;11
PPVT-5th Edition		
Mean SS[9] (SD[10])	108 (17)	119 (17)
Range	91-153	92-160
Dialect Density[11]		
Mean SS (SD)	0.35 (0.23)	0.04 (0.06)
Range	0.00-0.92	0.00-0.20
Race		
Asian	2	3
Black	14	16
Hispanic	1	2
White	0	21
Family Income		
$20,000-40,000	0	1
$41,000-60,000	0	2
$61,000-100,000	3	5
$100,000-200,000	10	13
More than $200,000	1	17
Declined to report	5	6

[9] SS stands for Standard Score
[10] SD stands for Standard Deviation
[11] Dialect Density was calculated by taking the number of non-mainstream features produced on the DELV-ST and dividing by the total number of scorable items.

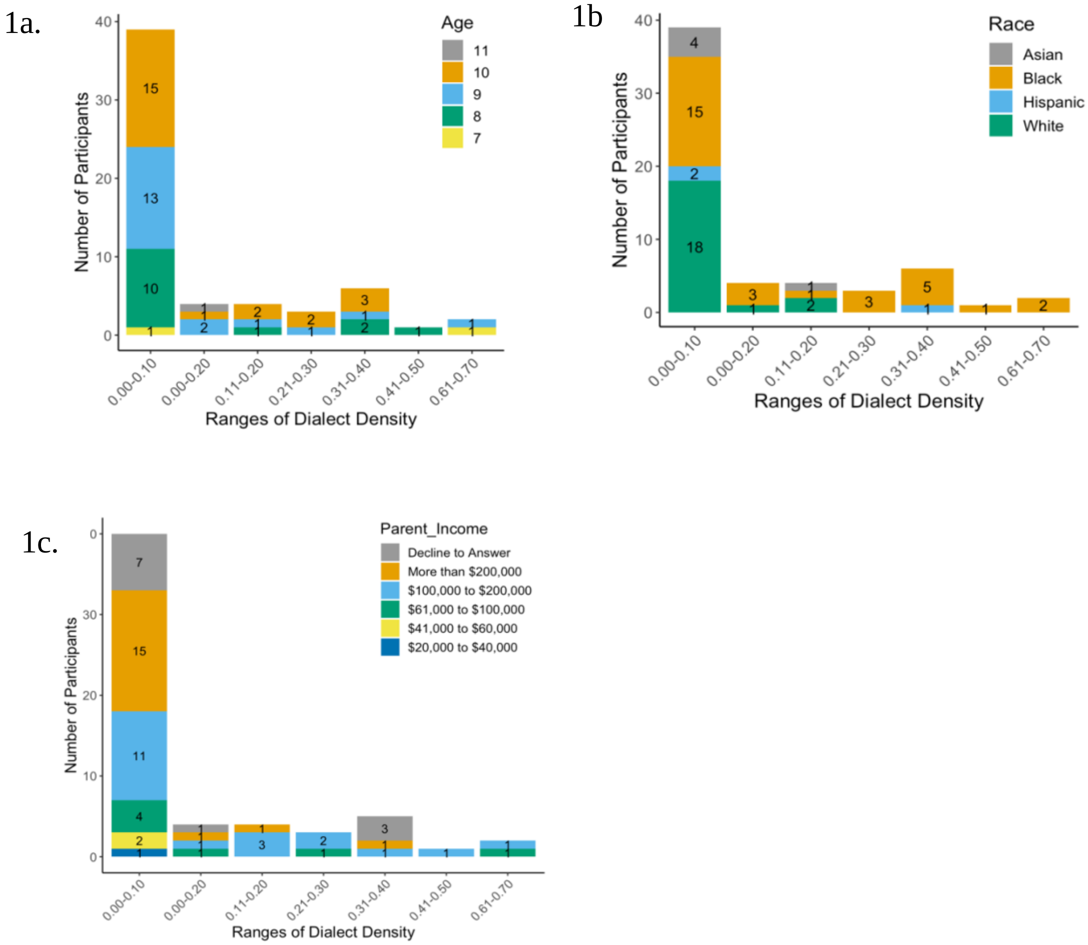

Figure 1. Histograms of the number of participants as a function of age, dialect density, race, and total family income for all participants (n=55). Figure 1a shows the number of participants as a function of dialect density and age. Figure 1b shows the number of participants as a function of dialect density and race. Figure 1c shows the number of participants as a function of dialect density and parent income.

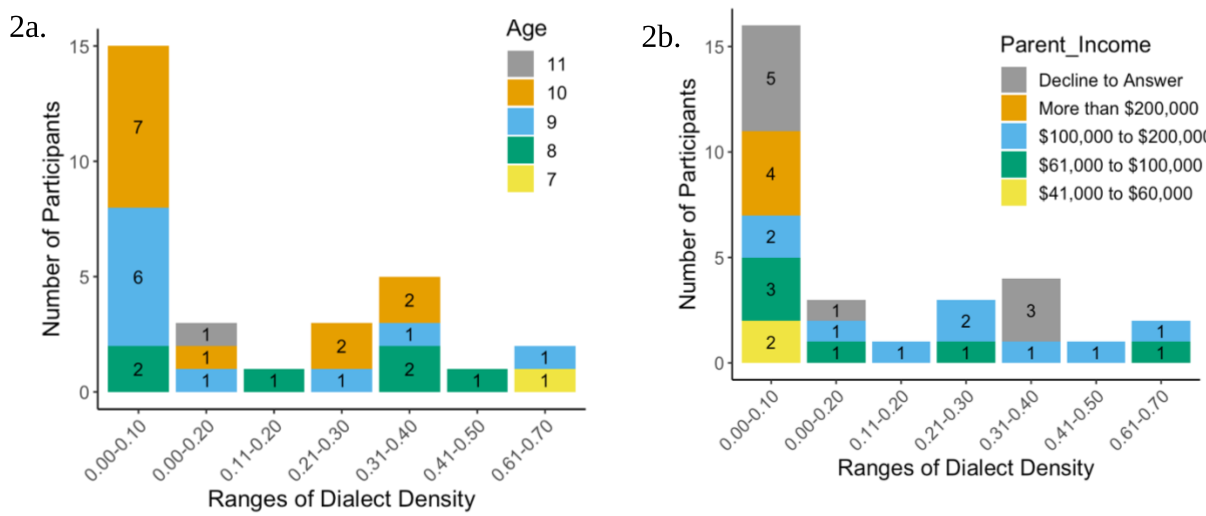

Figure 2. Histograms of the number of participants as a function of age, dialect density, race, and total family income for all participants (n=29). Figure 2a shows the number of participants as a function of dialect density and age. Figure 2b shows the number of participants as a function of dialect density and parent income.

Sentence Processing Task

Auditory Stimuli Norming. This study used the same auditory stimuli as an offline sentence processing task by Byrd et al. (2023). In that study, auditory norming was conducted on Amazon Mechanical Turk to find an ambiguous name that could be perceived as one or two people. A set of ambiguous and unambiguous names were presented to adult listeners in past tense sentences (e.g., *Julianne Rose [Julie 'n Rose] baked cookies; Janice, Don, Carol, and John baked cookies*; *Alexander baked cookies*). Past tense verbs were used, so the listeners needed to rely on the proper noun(s) rather than the verb to decide how many subjects were in the sentence. After each sentence was played, adult listeners were asked to identify how many people (one, two, three, or four) completed the action described in the sentence. Unambiguous subject names were included to ensure that participants accurately completed the task, and that the novelty of the ambiguous names was preserved.

In piloting, Byrd et al. (2023) observed a 2-person bias when using conjoined first names like "*Julianne Rose"* with MAE-speaking children, meaning the sentence was more likely to be interpreted as having a conjoined subject, regardless of the auxiliary verb. Therefore, Byrd and colleagues selected a token of *Carolyn May* (in the sentence "*Carolyn May baked cookies*") that was more likely to be perceived as singular more than plural in the norming study. The selected token of *Carolyn May* was perceived as a singular noun by 67% of the adult participants in the norming study, so Byrd and colleagues thought that this would help to counteract the observed 2-person bias. See Appendix A for norming results from Byrd et al. (2023).

Auditory Stimuli. An MAE speaker from the Northeastern U.S recorded auditory stimuli. The auditory stimuli are sentences of the form *<person's name> was <VP-ing>< NP>*. In each sentence, two items were manipulated: 1) whether the name was ambiguous or unambiguous, and 2) whether the sentence contained the auxiliary verb *were* or *was.* All sentences were presented with three names: *Jeremiah* (singular noun phrase, male), *Carter and Joe* (conjoined noun phrase, male), and *Carolyn May* or *Carol 'n May* (ambiguous between singular or conjoined noun phrase, female). All names were matched for syllable length and duration. The plural auxiliary verb *were* was used with conjoined noun phrases, and the singular auxiliary verb *was* was used with singular noun phrases. Sentences with unambiguous names were used as control trials, and sentences with ambiguous names were critical trials since both groups had to attend to the auxiliary verb to determine the subject number.

The remainder of the verb phrase in the sentence contained verbs and direct objects controlled for age of acquisition; the age of acquisition was age 6;0 or younger for all verbs and nouns. See Appendix B for a list of sentences and age of acquisition information for the verbs and direct objects from Byrd et al. (2023).

Visual stimuli. The visual stimuli consisted of layered clip art images corresponding to the experimental and control sentences. Each image showed the same action being completed by one girl (*Carolyn May*), two girls (*Carol n' May*), one boy (*Jeremiah*), and two boys (*Carter and Joe*). The presentation of the images in the visual world paradigm was fixed to reduce task demands (see Figure 4). The images were identical except for the identity of the character completing the action.

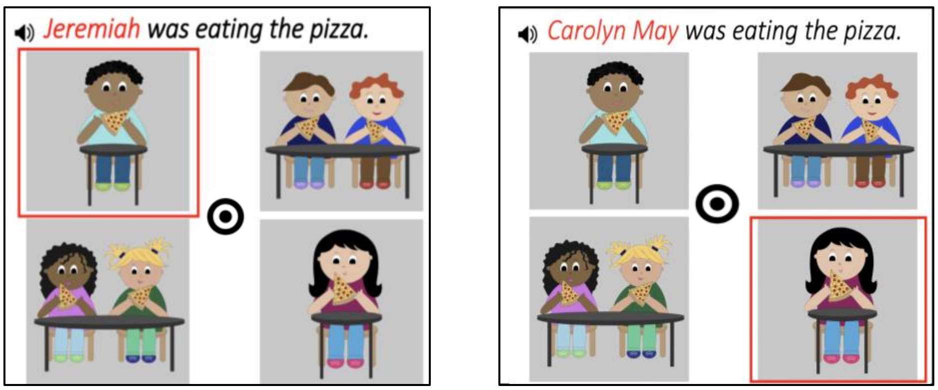

Figure 3. An example of the visual and auditory stimuli. The written version of the auditory stimuli was not presented on the screen but is presented here for purposes of illustration. The image outlined in red was the target response for the auditory stimuli provided.

Sentence task procedure.

The sentence processing task was designed in Experiment Builder version 2.3.38 and administered on an automatic EyeLink 1000 Plus or an EyeLink Portable Duo eye tracker at a sampling rate of 60Hz. Participants were introduced to the task under the pretense of playing an animal rescue game. Before beginning the sentence processing task, participants were given a story introducing them to six characters: *Jeremiah, Carter and Joe, Carolyn May,* and *Carol n' May*. Participants were asked to repeat the names of each character and complete practice trials before beginning the task.

There were two sets of practice trials. In the first set, participants heard a character's name embedded in a sentence. They were instructed to point to the image that showed the character (e.g., "Point to *Jeremiah is playing the piano*."). These practice trials trained participants to associate the characters' names with an image that represented the character. The second set of practice trials had four trials that asked participants to touch the image that best matched the sentence they heard to train participants on the task. The sentences in the second set of practice trials used the auxiliary verbs *is* and *are* and contained a corresponding reflexive pronoun at the end (e.g., *Carter and Joe are cutting the paper themselves*) to encourage participants to attend to other cues outside of the subject name, particularly for the ambiguous name *Carolyn May*. Participants had to answer all eight practice trials correctly before beginning the experiment.

In the experimental trials, participants were first presented with a visual world paradigm containing four layered clip art images. Then, participants had to focus on an eye gaze trigger in the middle of the screen to play the sentence. Each participant heard 56 sentences that contained 14 tokens of each condition (i.e., unambiguous singular noun phrase, unambiguous conjoined noun phrase, ambiguous singular conjoined noun phrase, ambiguous plural conjoined noun phrase), which ensured that each participant was exposed to every condition while preserving the novelty of the ambiguous names. Items were counterbalanced using a Latin Square design to prevent order effects, and pseudo-randomization was used to produce four lists that differed in the order in which each item was presented and so that names were not heard more than two times in a row. All trials were time-locked, so the participant could not select an image until the sentence ended. This prevented participants from selecting an image before they heard the auxiliary verb.

Data cleaning and preparation

The data was cleaned using r-package VWP Preprocessing for SR Eyelink Data (Poretta, 2017). This package has two primary functions. First, it formats the data by selecting necessary columns, defining interest areas, adjusting the sampling rate, aligning data to specific messages, and binning the data based on the data sampling rate. The time series data was aligned to the start time of the sentence audio. Based on the data sampling rate of 500 Hz, a bin size of 50ms was used, which resulted in 25 observations per bin. Areas of interest (AOI), the quadrant in which one of the four images appeared, were pre-defined in Experiment Builder by the boundaries of the four images on the display screen (450 by 450-pixel squares).

Track loss. All samples were evaluated for excessive amounts of track loss. In this analysis, looks off-screen were treated as track loss. Overall, only 2.77% of trials were looks off the screen, which resulted in track loss. Trials were removed if there was more than 50% track loss within the time window of analysis. This cleaning resulted in 1.5% (46/3077) of trials being dropped from analyses. Participants were evaluated individually for track loss in more than 25% of trials. All participants had track loss less than 25%, so no participants were removed from analyses. After cleaning, the average track loss per participant in the remaining trials was less than 6%, which did not differ by Dialect Group ($p = 0.15$).

Results

Offline Response Accuracy. Response accuracy on experimental trials (based on children's pointing responses to the touch screen) were investigated to examine the effects of dialect and condition on offline responses, similar to Byrd et al. (2023). Two logistic mixed-effects models were fitted to trial-level data, one for unambiguous and one for ambiguous sentences. Models were built using a forward stepwise elimination process to find the best-fitting model with the lowest AIC value. The initial variables selected to be included in the model-building process were informed by previous literature showing that age and vocabulary size can predict performance on sentence-processing tasks (Byrd et al., 2023; De Villers & Johnson, 2007; Edwards et al., 2014). Models were built to evaluate the research questions of interest and did not include all possible interactions.

Each model was tested to ensure it did not violate parametric assumptions. Age and vocabulary scores were centered because the distributions were skewed. Models were fit using the lme4 package (version 1.1-21; Bates et al., 2015) in R (version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses. In both models, target accuracy was regressed on Dialect Group (AAE and MAE), Verb Type (was and were), and Age (centered). Target accuracy is a dichotomous variable where "0" indicates an image that was not the target was selected and "1" indicates that a target image was selected. The model included a by-participant random intercept, and the fixed effects were leveled so that Dialect Group AAE and Verb Type were the reference group and condition. Model summaries can be found in Table 2.

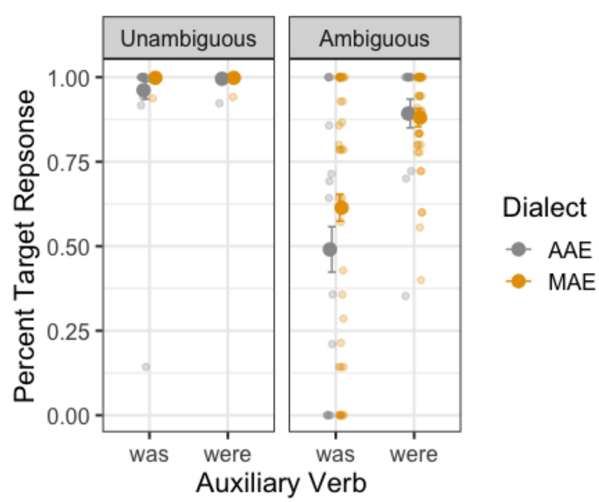

Figure 4. Percent of accurate target responses for each condition by Dialect Group and Verb Type. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Response Accuracy in the Unambiguous Sentences. Figure 4 (left panel) shows high levels of accuracy for both verbs, with somewhat higher levels of accuracy for *were* than *was*. There was a main effect of Verb Type ($p < 0.01$), indicating that the reference group, AAE speakers, were more accurate in selecting the target image in unambiguous sentences that contained the auxiliary verb *were* than *was*. There was also a statistically significant interaction between Dialect Group and Verb Type ($p < 0.05$), which indicates there was there was less of an effect of Verb Type on the target accuracy responses of AAE speakers than MAE speakers. Despite the interaction, Figure 4 (left panel) demonstrates that both AAE- and MAE-speaking children's responses in the unambiguous condition was above chance, which demonstrated they understood the task.

Response Accuracy in the Ambiguous Sentences. Figure 4 (right panel) shows lower levels of accuracy in the ambiguous sentences, especially in the *was* condition. There was a main effect of Verb Type ($p < 0.01$), which indicates that the reference group, AAE speakers, were more likely to select the correct target image after hearing *were* than *was*. There was also a main effect of Age ($p < 0.001$), which indicates that as age increased, AAE-speaking children had more looks to the target in sentences that contained *was*. Lastly, there was a statistically significant Dialect Group by Verb Type interaction ($p < 0.01$), which indicates there was a greater effect of the auxiliary verb on the target accuracy responses of MAE speakers than AAE speakers. That is, MAE speakers were more likely to select the correct target image after hearing *was* and *were* than their AAE-speaking peers.

Table 2. Fixed effects (Dialect Group x Auxiliary Verb) from the logistic mixed effects model for unambiguous sentences (top of table) and ambiguous sentences (bottom of table).

	β	***SE***	***z***
Unambiguous sentences			
Intercept	6.80	3.21	2.12
Age	1.17	1.04	1.12
Dialect Group: MAE	3.54	2.49	1.42
Verb Type: Were	4.34	1.56	2.79**
Dialect Group x Verb Type	-4.30	2.12	-2.03*
Ambiguous sentences			
(Intercept)	0.10	0.52	0.19
Age	0.72	0.26	2.75**
Dialect Group: MAE	0.91	0.61	1.50
Verb Type: were	3.17	0.35	8.97***
Dialect Group x Verb Type	-1.17	0.40	-2.94**

p <.001***, p < .01 **, p < .05*

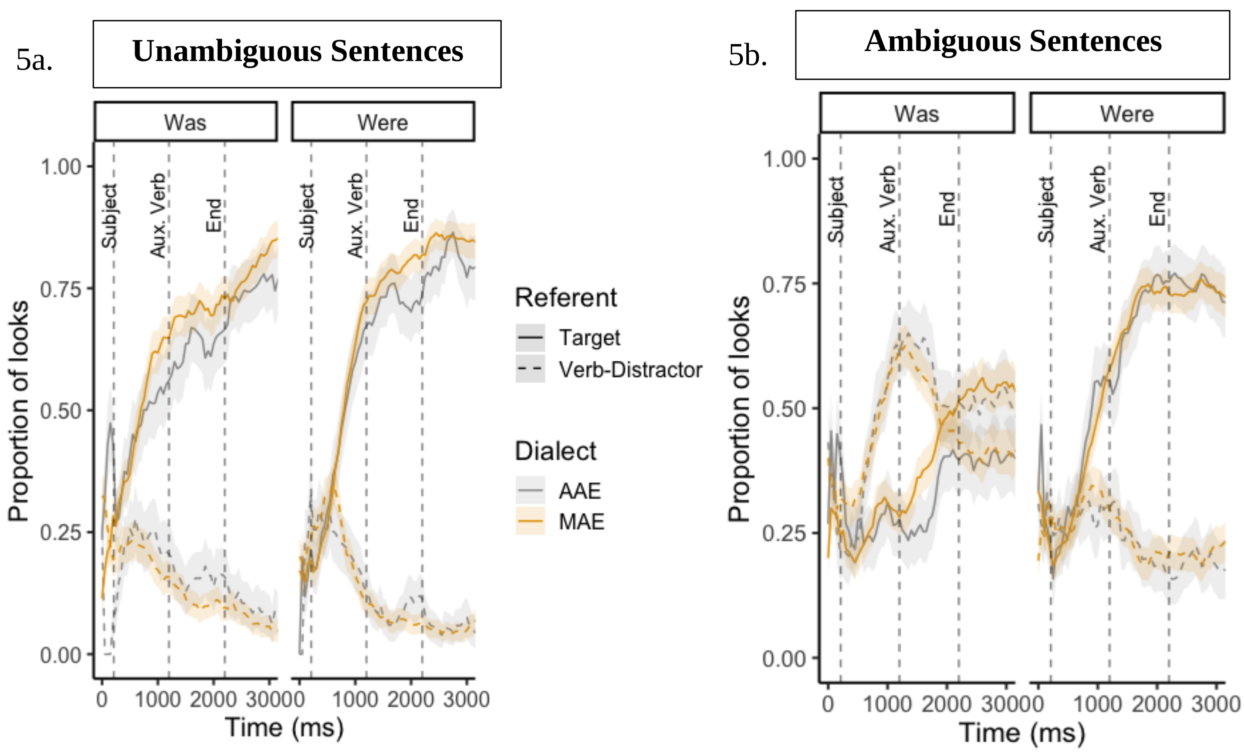

Figure 5. Proportion of looks to target versus proportion of looks to the verb-distractor for AAE and MAE speakers in unambiguous sentences and ambiguous sentences.

Analyses of Eye-Tracking Data

Three separate analyses were conducted on the eye-tracking data over three separate time windows. The first time window analysis was conducted over the subject noun phrase, which was defined as beginning 200ms after the onset of the subject noun phrase (to account for the time required for participants' eyes to initiate a saccade) and ending at the onset of the auxiliary verb (i.e., *was* or *were)*. This time window was examined to determine whether AAE- and MAE-speaking children weighed the subject noun phrase as a cue to parse unambiguous and ambiguous sentences. This analysis was motivated by the results of Byrd et al. (2023), which suggested that children who speak AAE attend less to the number of the auxiliary verb than children who speak MAE.

The second time window analysis was conducted over the verb phrase, defined as beginning at 200ms after the onset of the auxiliary verb (*was* or *were*) (to account for the time required for participants' eyes to initiate a saccade) and ending at the offset of the direct object (e.g., *pizza* in the sentence *Carolyn May was eating the pizza*). Since the verb phrase was equalized for duration across all stimuli, this window provides the opportunity to examine group differences in how the auxiliary verb is used as a cue to process MAE sentences, particularly in the ambiguous condition.

The final time window analysis was conducted on eye gaze fixations that occurred after the sentence ended. Evaluating fixations at the end of the sentence allowed for the examination of any revision processes that may have occurred once the entire sentence had been processed. The end-of-sentence time window spans from 2200-3500ms: it was defined as beginning after the offset of the last word in the sentence and ending after 1300ms of silence. Since all sentences are time-locked, each sentence ends within this time frame, ensuring that eye-gaze patterns and statistical analyses capture processing after the sentence has been played.

Time Window Analysis: Subject Noun Phrase

Two generalized mixed effects models for unambiguous and ambiguous sentences were conducted to evaluate looks to the target in the subject noun phrase region. Both models were built using a forward stepwise elimination process to find the best-fitting model with the lowest AIC value. The initial variables selected to be included in the model-building process were informed by previous literature showing that age and vocabulary size can predict performance on sentence-processing tasks (Byrd et al., 2023; De Villers & Johnson, 2007; Edwards et al., 2014). Models were leveled so that Dialect Group *AAE* and Verb Type *was* were the reference groups. Models were built to evaluate the research questions of interest and did not include all possible interactions.

In both models, the fixed effects of age, vocabulary, dialect group (AAE and MAE), and verb type (was and were) predicted the proportion of looks to target. The model included a by-participant random intercept. Age and vocabulary scores were centered because the distributions were skewed. The model included a by-participant random intercept, and the fixed effects were leveled so that Dialect Group AAE and Verb Type were the reference group and condition. Models were fit using the lme4 package (version 1.1-21; Bates et al., 2015) in R (version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses.

Fixations in unambiguous and ambiguous sentences. Figure 6 illustrates fixations to target within that time window. In the unambiguous sentences, there were no significant main effects or interactions. In the ambiguous sentences, there was a significant main effect of Verb

Type ($p < 0.05$), meaning that AAE speakers, the reference group, had more looks to the target when the Verb Type was plural (*were)* than singular (*was*). Of note, there were no other significant main effects of Dialect group interactions. See Table 3 for parameter estimates for the unambiguous sentences and Table 4 for the parameter estimates for the ambiguous sentences.

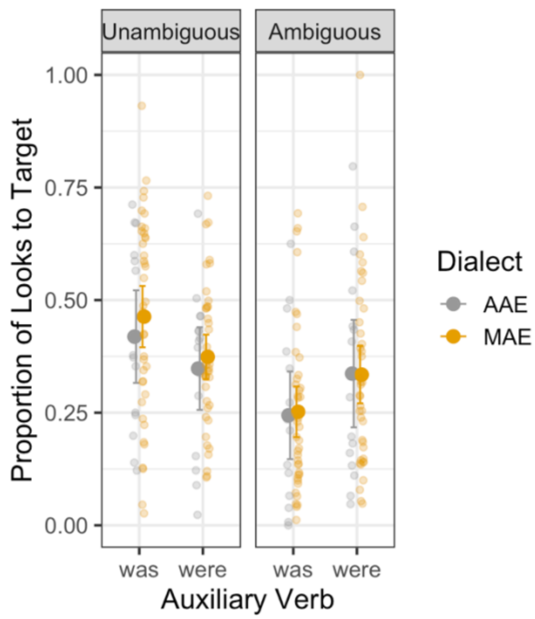

Figure 6. Time window analysis of looks of proportion of looks to target in the subject phrase. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Table 3. Summary of parameter estimates for the mixed-effects model fit to the gaze data in unambiguous sentences for the subject phrase time window.

Fixed Effects

	β	*SE*	*t*
Intercept	0.44	0.04	10.79***
Vocabulary	0.03	0.02	1.74
Age	0.03	0.02	1.65
Dialect Group: MAE	0.01	0.05	0.11
Verb Type: Were	-0.06	0.04	-1.35
Dialect Group x Verb Type	-0.02	0.05	-0.48

Random Effects

Parameter	Variance	SD
Subject (Intercept)	0.01	0.09
Residual	37.78	6.15

p <.001***, p < .01 **, p < .05*

Table 4. Summary of parameter estimates for the mixed-effects model fit to the gaze data in ambiguous sentences for the subject phrase time window.

Fixed Effects

	β	***SE***	***t***
Intercept	0.23	0.04	6.22***
Vocabulary	-0.01	0.02	-0.62
Age	0.01	0.02	0.69
Dialect Group: MAE	0.01	0.04	0.31
Verb Type: Were	0.09	0.04	2.35*
Dialect Group x Verb Type	-0.03	0.05	-0.65

Random Effects

Parameter	Variance	SD
Subject (Intercept)	0.01	0.09
Residual	32.56	5.71

p <.001***, p < .01 **, p < .05*

Time Window Analysis: Verb Phrase

The analysis of the verb phrase time window directly addressed the question of whether there were online processing differences in the use of *was* and *were* between AAE and MAE speakers. As in the previous time window analyses, all models were built using a forward stepwise elimination process to find the best-fitting model with the lowest AIC. Models were built to evaluate the research questions of interest and did not include all possible interactions. Two generalized mixed-effects models were fitted to trial-level data, one for unambiguous sentences and one for ambiguous sentences. In both models, the fixed effects of Age predicted the proportion of looks to target. Vocabulary, Dialect Group (AAE and MAE) and Verb Type (*was* and *were*). Age and vocabulary scores were centered because the distributions were skewed. Models were fit using the lme4 package (version 1.1-21; Bates et al., 2015) in R (version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses.

Fixations in the Unambiguous Sentences. In the unambiguous sentences, fixations in the verb phrase were examined to ensure both AAE and MAE listeners understood the task, which was to listen to the sentence and select the target image. The unambiguous sentences allowed listeners to use both the subject (i.e., *Jeremiah* or *Carter and Joe*), gender of the subject (i.e., male) and the auxiliary verb to interpret the sentence; therefore, both speaker groups should have a greater proportion of looks to the target than the verb distractor. The verb distractor is the image of the same gender, but the incorrect plurality (e.g., *Carter and Joe* for *Jeremiah* and *Jeremiah* for *Carter and Joe*). In the statistical model, the dependent variable was the proportion of looks to the target and the predictor variables included fixed effects of Age (continuous variable centered), Vocabulary (continuous variable centered), Dialect Group (AAE/MAE) and Verb Type (*was*/*were*). The model included a by-participant random intercept, and the fixed effects were leveled so that Dialect Group AAE and Verb Type were the reference group and condition. A summary of model parameters can be found in Table 5.

Figure 5a demonstrates the looks to target versus looks to the verb distractor in the unambiguous sentences. In the singular (i.e., *was*) condition, both AAE and MAE speakers demonstrated more looks to the target as early as 200 to 300ms after the onset of the subject noun phrase. Both groups appear to use the name *Jeremiah* to look more at the image of one boy completing an action than two boys completing an action, as evidenced by their being a greater proportion of looks to target before the onset of the auxiliary verb. In the plural (i.e., *were*) condition, AAE and MAE speakers demonstrated more looks to the target than the verb distractor, albeit later than they did in the singular condition. Around 500 to 600ms after the onset of the subject noun phrase, both groups had a greater proportion of looks to the image of two boys completing a task than one boy. The eye gaze pattern demonstrates that both groups appear to use the names *Carter and Joe* to look more at the image of two boys completing an action, as evidenced by both groups having a greater proportion of looks to the target before the auxiliary verb is played. In both conditions, the proportions of looks to the target continued to increase after the onset of the auxiliary verb.

Figure 7 (left panel) shows mean looks to target during the verb phrase. There is a statistically significant main effect Verb Type ($p < 0.01$): AAE speakers had a greater proportion of looks to the target when they heard *were* in the plural condition than *was* in the singular condition. There were no main effects of Age, Vocabulary, or Dialect Group, and there was no statistically significant interaction between Dialect Group and Verb type. The absence of a main effect of Dialect Group or a significant interaction between Dialect Group and Verb Type indicates that both groups performed similarly on the unambiguous sentences.

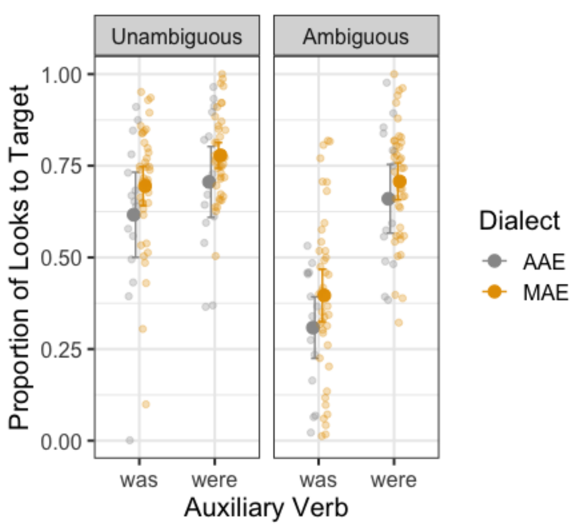

Figure 7. Time window analysis in the unambiguous and ambiguous sentences for the verb phrase. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Table 5. Summary of parameter estimates for the mixed-effects model fit to the gaze data in unambiguous sentences for the verb phrase time window.

Fixed Effects

	β	***SE***	***t***
Intercept	0.64	0.03	17.64***
Vocabulary	0.03	0.02	1.88
Age	0.00	0.02	0.14
Dialect Group: MAE	0.05	0.04	1.27
Verb Type: Were	0.09	0.03	2.80**
Dialect Group x Verb Type	-0.02	0.04	-0.45

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.01	0.09
Residual	45.78	6.77

p <.001***, p < .01 **, p < .05*

Fixations in the Ambiguous Sentences. Fixations in the verb phrase in the ambiguous sentences were examined to investigate how AAE- and MAE-speaking children used the auxiliary verbs *was* or *were* to process MAE sentences with perceptual ambiguities. The subject phrase (i.e., *Carolyn May, Carol n' May*) is perceptually ambiguous. Therefore, the auxiliary verb is the only cue listeners can use to determine the subject number, and this cue is available in MAE but not in AAE. In the statistical model, the dependent variable was the proportion of looks to the target, and the predictor variables included fixed effects of Age (continuous variable centered), Vocabulary (centered), Dialect Group (AAE/MAE), and Verb Type (*was*/*were*). The model included a by-participant random intercept and was leveled to Dialect Group AAE and Verb Type *was* as the reference group and condition. A summary of model parameters can be found in Table 6.

Figure 5b shows the looks to target versus looks to the verb distractor in the ambiguous sentence. In the singular (i.e., *was*) condition, AAE and MAE speakers exhibit more looks to the verb distractor beginning at the onset of the subject noun phrase. However, looks to the verb distractor decreased for *both* groups after the onset of the auxiliary verb *was*. By the end of the verb phrase, MAE speakers' looks to the target increase above chance, and their looks to the verb distractor decrease below chance. Although AAE speakers' looks to the verb distractor also decreased at the onset of the auxiliary verb, their looks to the verb distractor never decreased below chance during the verb phrase. Conversely, in the plural (i.e., *were*) condition, both groups had a greater proportion of looks to the target in the subject phase and sustained those looks to the target as those sentences progressed.

Figure 7 (right panel) illustrates the proportion of looks to target for AAE- and MAE-speaking children in the verb phrase of ambiguous sentences. There was a statistically significant main effect of Verb Type ($p < 0.001$): AAE speakers had a greater proportion of looks to the target for the plural auxiliary verb relative to the singular. There were no significant main effects of Age, Vocabulary, or Dialect Group, and there was no interaction between Dialect Group and Verb Type.

Table 6. Summary of parameter estimates for the mixed-effects model fit to the gaze data for ambiguous sentences in the verb phrase time window.

Fixed Effects

	β	***SE***	***t***
Intercept	0.31	0.04	8.91***
Vocabulary	0.02	0.02	1.61
Age	0.03	0.02	1.59
Dialect Group: MAE	0.08	0.04	1.80
Verb Type: Were	0.37	0.04	10.37***
Dialect Group x Verb Type	-0.07	0.04	-1.59

Random Effects

Parameter	Variance	SD
Subject (Intercept)	0.01	0.08
Residual	53.15	7.30

p <.001***, p < .01 **, p < .05*

Time Window Analysis: End of Sentence

As in the previous analyses, two generalized mixed-effects models were fitted to trial-level data, one for unambiguous sentences and one for ambiguous sentences, to examine eye gaze patterns at the end of the sentence. Both models were built using a forward stepwise to find the best-fitting model with the lowest AIC. Models were built to evaluate the research questions of interest and did not include all possible interactions. In both models, the fixed effects of Age predicted the proportion of looks to target. Vocabulary, Dialect Group (AAE and MAE), and Verb Type (*was* and *were*). Age and vocabulary scores were centered because the distributions were skewed. Models were fit using the lme4 package (version 1.1-21; Bates et al., 2015) in R (version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses.

Fixations in the Unambiguous Sentences. Figure 5a demonstrates the looks to target versus looks to the verb distractor in the unambiguous sentences. In both the singular (i.e., *was*) and plural (i.e., *were*) conditions, AAE- and MAE-speaking children have more looks to the target than the verb distractor by the end of the sentence. A generalized mixed effect model was performed to evaluate if there were any statistically significant differences in looks to target. The dependent variable was the proportion of looks to the target, and the predictor variables included fixed effects of Age (continuous variable centered), Vocabulary (continuous variable centered), Dialect Group (AAE/MAE), and Verb Type (*was/were*). The model included a by-participant random intercept, and the fixed effects were leveled so that Dialect Group AAE and Verb Type were the reference group and condition. A summary of model parameters can be found in Table 7.

Figure 8 (left panel) shows that AAE- and MAE-speaking children used available cues to parse the sentence similarly. There is a main effect of Verb Type ($p < 0.05$), meaning that AAE speakers had more looks to the target in sentences that had Verb Type *were* than *was*. Furthermore, there was a main effect of Vocabulary ($p < 0.05$), which indicates that as vocabulary size increased, there were more looks to the target for the singular (was) Verb Type for AAE speakers. However, there were no statistically significant main effects of Dialect Group or Age and no statistically significant interaction between Dialect Group and Verb Type.

Table 7. Summary of parameter estimates for the mixed-effects model fit to the gaze data in unambiguous sentences for the end-of-sentence time window.

Fixed Effects

	β	***SE***	***t***
Intercept	0.77	0.03	22.22***
Vocabulary	0.04	0.02	2.08*
Age	0.00	0.02	0.27
Dialect Group: MAE	0.02	0.04	0.49
Verb Type: Were	0.06	0.03	2.04*
Dialect Group x Verb Type	0.00	0.03	-0.12

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.01	0.09
Residual	38.32	6.19

p <.001***, p < .01 **, p < .05*

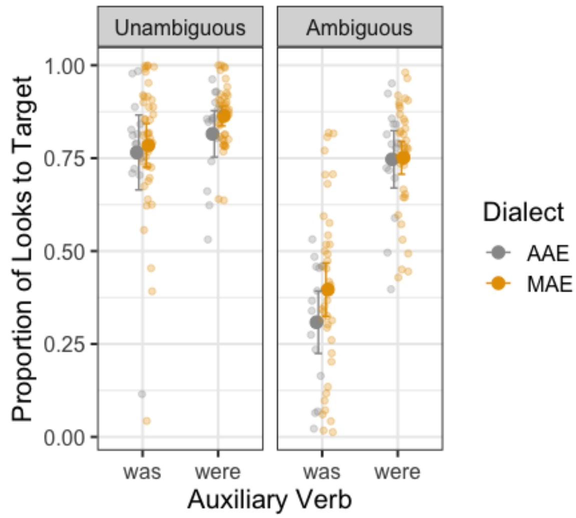

Figure 8. Time window analysis in the unambiguous and ambiguous sentences for the end of sentence time window. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error and dots show individual data points.

Fixations in the Ambiguous Sentences. Figure 5b demonstrates the looks to target versus looks to the verb distractor in the ambiguous sentences. In the singular (i.e., *was*) condition, MAE speakers' looks to the target increased and remained above chance after the sentence ended, while their looks to the verb distractor decreased and remained below chance. Conversely, AAE-speaking children continue to have a greater proportion of looks to the verb distractor than the target, although their looks to the verb distractor remained at chance. In addition, AAE-speaking children's proportion of looks to the target did not increase beyond 0.30-0.40. In the plural (i.e., *were*) condition, AAE- and MAE-speaking children had a greater proportion of looks to the target in the end of the sentence region.

A generalized mixed effect model was used to evaluate if there were any statistically significant differences in looks to target after the sentence ended. The dependent variable was proportion of looks to the target and the predictor variables included fixed effects of Age (continuous variable centered), Vocabulary (continuous variable centered), Dialect Group

(AAE/MAE) and Verb Type (was/were). The model included a by-participant random intercept and the fixed effects were leveled so that Dialect Group *AAE* and Verb Type *was* were the reference group and condition. A summary of model parameters can be found in Table 8.

Figure 8 (right panel) shows that MAE-speaking children were more likely to use the auxiliary verb *was* to revise sentence interpretations than AAE-speaking children. There was a main effect of Verb Type ($p < 0.001$): there were more looks to the target in ambiguous sentences that had Verb Type *were* than *was* for the reference group, AAE speakers. Furthermore, there was a statistically significant interaction between Verb Type and Dialect group ($p < 0.05$). There was a greater effect of Verb Type for MAE-speaking children than their AAE-speaking peers.

Table 8. Summary of parameter estimates for the mixed-effects model fit to the gaze data in ambiguous sentences for the end-of-sentence time window.

Fixed Effects

	β	***SE***	***t***
Intercept	0.31	0.04	7.93***
Vocabulary	0.02	0.02	1.34
Age	0.03	0.02	1.53
Dialect Group: MAE	0.08	0.05	1.68
Verb Type: Were	0.43	0.04	12.35***
Dialect Group x Verb Type	-0.09	0.04	-2.28*

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.01	0.09
Residual	38.32	6.19

p <.001***, p < .01 **, p < .05*

Dialect Density and Auxiliary Verb Use

To answer the second research question, "Does dialect density predict how AAE speakers use was and were to process MAE sentences in an online task?" this study examined whether dialect density in the speech of African American participants predicted eye gaze fixations in the verb phrase of ambiguous sentences. Dialect density is a continuous measure of the number of AAE dialect features a speaker produces. The relationship between eye gaze patterns and dialect density was examined only in African American participants (*n*=29) because there was a larger range of features produced (0.00-0.92) in comparison to their European American peers (0.0-0.20). A generalized mixed effects model examined if the proportion of looks to target in the verb phrase was predicted by the fixed effects of Dialect Density (continuous variable centered), Vocabulary (continuous variable centered), and Verb Type (*was* vs. *were*). The model included a by-participant random intercept and fixed effects were leveled so that Verb Type *was* was the reference group.

The model was built using a forward stepwise to find the best-fitting model with the lowest AIC. Variables included in building the model were based on previous studies that demonstrated these variables could predict performance in sentence comprehension and processing tasks. Models were built to evaluate the research questions of interest and did not include all possible interactions. The model was fit using the lme4 package (version 1.1-21; Bates et al., 2015) in R (version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses. A summary of model parameters can be found in Table 9.

Figure 9 illustrates mean looks to target during the verb phrase as a function of dialect density for the singular and plural verb conditions in the ambiguous sentences. There was a significant main effect of Verb Type ($p < 0.05$): there were fewer looks in the singular (*was*) verb condition in the ambiguous sentences as dialect density increased. There was also a significant interaction between Verb Type and Dialect density ($p < 0.05$). That is, as dialect density increased, Verb Type had less effect on looks to the target. African American participants with higher dialect densities were less sensitive to the auxiliary verb than those with lower dialect densities. There was no statistically significant effect of Vocabulary, and all other interactions were non-significant.

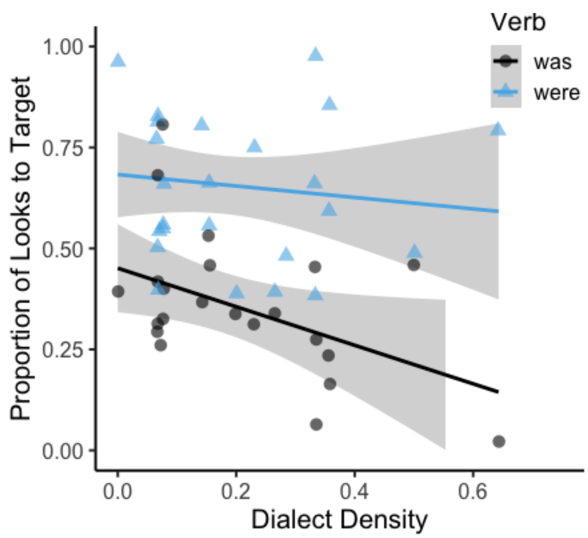

Figure 9. Proportion of looks to target for AAE and MAE speakers in the Singular (was) and Plural (were) conditions for the ambiguous sentences.

Table 9. Summary of parameter estimates for the mixed-effects model fit to Dialect Density to gaze data in verb phrase time window in ambiguous sentences.

Fixed Effects

	β	***SE***	***t***
Intercept	0.65	0.02	27.79*
Vocabulary	0.03	0.02	1.67
Dialect Density	0.00	0.02	0.14
Verb Type: Were	-0.22	0.03	-7.96*
Dialect Group x Verb Type	-0.07	0.02	-3.16*

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.00	0.06
Residual	55.83	7.47

p <.001***, p < .01 **, p < .05*

Discussion

The purpose of this study was to examine how linguistic mismatch impacted real-time sentence processing in children who spoke either AAE or MAE. Before exploring real-time sentence processing, this study sought to replicate findings that show that AAE speakers are less accurate at comprehending MAE sentences with contrastive verb morphology (e.g., was/were, third-person singular -s) (Beyer & Hudson-Kam, 2015; Beyer et al., 2015; Byrd et al., 2023; Beyer & Hudson-Kam, 2015; De Villers & Johnson, 2007; Edwards et al., 2014). Our results replicated these findings, and specifically replicated the findings of Byrd and colleagues (2023), which found that AAE-speaking children were less likely to use the auxiliary verbs *was* and *were* to determine subject number in MAE sentences that are ambiguous in an offline task. This replication affirms that linguistic mismatch can impact sentence comprehension, particularly in contexts where other linguistic information is ambiguous. This finding sets the foundation for exploring *why* this result is persistent regardless of the saliency of the verb morphology cue or the consistency of the feature in AAE (i.e., whether the feature is zero or optionally marked). Different hypotheses are considered below.

Do AAE-speaking children prioritize subject-noun phrase cues more than their MAE-speaking peers?

Previous studies suggested that AAE speakers had decreased accuracy in comprehending MAE sentences due to decreased sensitivity to the auxiliary verb. Byrd et al. (2023) hypothesized that AAE-speaking children, relative to MAE-speaking children, were more likely to rely on the subject as a comprehension cue since verb morphology is variably produced in AAE. Participants' eye fixations were examined within the subject noun phrase window to test that hypothesis. If AAE-speaking children, relative to their MAE-speaking peers, weigh the subject noun phrase more strongly as an informative and reliable cue, then there should be a greater proportion of looks to the target during the subject noun phrase time window in both unambiguous and ambiguous sentences for AAE-speaking children relative to their MAE-speaking peers. The results of this study did not support this hypothesis. Both dialect groups had a similar proportion of looks to the target during the subject noun phrase time window.

Do AAE-speaking children ignore auxiliary verb cues in sentence processing?

Given the results of offline studies, it has been suggested that AAE-speaking children do not attend to number cues in the auxiliary verb because this cue is not informative in AAE. This hypothesis was tested in the verb phrase window analysis in ambiguous sentences. It was observed that, in ambiguous sentences that contained plural (*were*) verb morphology, AAE- and MAE-speaking children had more looks to the target (i.e., two girls) after hearing the auxiliary verb and the looks to the target persisted throughout the verb phrase. W*ere* is exclusively produced with plural subjects in AAE and MAE (Green, 2002, 2012; Green & Sistrunk, 2015;

Newkirk-Turner et al., 2014). Thus, in both dialects, "*were"* served as a reliable cue that *Carolyn May* represented two people. Although the subject was ambiguous, both groups used the redundant information provided by the auxiliary verb to determine the subject number, which demonstrates that when AAE- and MAE-speaking children have access to redundant and informative cues for subject number they will process sentences similarly.

The crucial test of whether AAE-speaking children attend to verb morphology was in ambiguous sentences with singular (*was*) verb morphology, as *was* is used with both singular and plural nouns in AAE. It was observed that *both* AAE- and MAE-speaking children decreased their looks to the verb distractor (i.e., an image of two girls) after the onset of *was*. There was no significant effect of Group and no significant Group by Verb Type interaction for the ambiguous sentences in the verb phrase time window. This result argues against the hypothesis that AAE-speaking children are less accurate at comprehending MAE sentences because they are not sensitive to contrastive verb morphology (see Beyer & Hudson Kam, 2012; Byrd et al., 2023; De Villers and Johnson, 2007). Instead, this result suggests that AAE-speaking children, like their MAE-speaking peers, at least by the later grades of elementary school, are sensitive to number information in verb morphology. It should be noted that the children in this study were older (7 to 11 years) than children in many of the previous studies. Perhaps this result is not surprising because by age 7, AAE-speaking children have been exposed to MAE from their teachers for at least 2 to 3 years. Despite both groups being sensitive to the auxiliary verb *was*, there were observed group differences in how the cue was used to revise sentence interpretations.

For MAE-speaking children, their looks to target increased above chance once the sentence ended. Conversely, AAE-speaking children's looks to the verb distractor remained at chance after the sentence ended, and their looks to the target never increased above chance. A significant Dialect Group by Verb Type interaction revealed that MAE-speaking children were more sensitive to the number information in the verb relative to their AAE-speaking peers. MAE-speaking children leveraged their linguistic knowledge that *was* is a cue to a singular subject to slowly revise their initial parsing of this sentence. This slow pattern of revision suggests that MAE-speaking children were engaging in post-diction. Post-diction relies on linguistic context and prior knowledge to manipulate previous information in working memory (Ronnberg, 2003; Ronnberg, et al., 2019). The recruitment of working memory to manipulate initial parsing causes post-diction to be a slow process that unfolds over seconds (Ronnberg et al., 2019; Stenfelt & Ronnberg, 2009; Ronnberg, 2022), which may explain why it takes MAE-speakers to the end of the sentence to revise their initial parsing of the sentence. This revision was not observed for AAE-speaking children.

The question arises then of why MAE-speaking children, but not AAE-speaking children, were able to use *was* to infer a singular subject, given that both groups were sensitive to *was* in the verb phrase. There are several possible explanations. One possibility is that distributional input from AAE-speaking parents has shaped how AAE-speaking children weigh the singular verb morphology as a cue. Research has shown that children build algorithms of different grammatical properties to aid sentence interpretation (Huang, 2013; Huang et al., 2023; Huang & Snedeker, 2017; MacWhinney et al., 1984). Since AAE-speaking children are consistently exposed to spoken input where auxiliary verbs are optionally produced, they may have learned to weigh it less than other linguistic information that is more reliable, such as semantic or contextual cues. This hypothesis is supported by work from Erskine (2023) that demonstrated that AAE-speaking children leveraged semantic and contextual information to process sentences with contrastive verb morphology. In this study, AAE-speaking children could have been waiting for additional semantic or contextual information, which would explain why looks to the verb distractor remained at chance throughout the verb phrase despite sensitivity to the auxiliary verb.

Another possibility is that *was* provides probabilistic information that must be confirmed by other linguistic cues in the sentences (e.g., subject or semantic information), which decreases the informativeness. Research studies have shown adults have difficulty interpreting phrases that contain probabilistic linguistic cues, or cues that can predict several other elements, then phrases that contain deterministic linguistic cues (Isbilen & Christiansen, 2022; Van de Bos et al., 2012). Since probabilistic linguistic cues provide partial information, they depend on the integration of other knowledge or linguistic cues to be informative (Redington & Chater, 1997). For AAE-speaking children *was* may provide probabilistic information that the subject is one or two people because it is produced with both singular and plural subjects; thus, they must integrate other linguistic cues to determine subject number. This could also explain why AAE-speaking children looks to the verb distractor remain at chance throughout the verb phrase. For MAE-speaking children, "*was"* a deterministic cue that informs listeners the subject is one person, which allowed MAE-speaking children to begin increase their looks to the target towards the end of the verb phrase.

While AAE-speaking children were sensitive to singular verb morphology, *was* was not a reliable nor informative cue to aid in sentence processing. While it is not possible to disentangle why *was* is not informative based on the data provided from this study, the hypotheses discussed above outline potential rationales. Overall, the results from the verb window analysis reveal that decreased accuracy in comprehending MAE sentences may not be due to a lack of sensitivity to contrastive verb morphology but instead to the informativeness of other linguistic cues that can help mitigate the impact of processing contrastive dialect features.

Does dialect density predict sensitivity to the number information in auxiliary verbs in an online task?

To address this question, this study evaluated the proportion of looks to target in the verb phrase region of ambiguous sentences in African American children. The results indicated that as children produced more features of AAE, they relied less on the auxiliary verb to look toward the target. For children with higher dialect densities (i.e., use more AAE-like features, scores closer to 1), the auxiliary verb was not an informative cue to help parse the sentence, particularly in sentences with *was* since it can be optionally produced with singular or plural subjects. Whereas for children with lower dialect densities (i.e., more MAE-like features, scores closer to 0), the auxiliary verb serves as an informative cue to determine the subject number.

This finding is aligned with studies by Edwards et al (2014) and Byrd et al (2023) that found dialect density was predictive of performance on sentence comprehension task that contained MAE sentences. The more dialect features a child speaks, the more likely they may be to rely on previous linguistic knowledge to guide what cues are reliable and informative to parse sentences (Byrd et al., 2023; Beyer et al., 2015; Roy, 1987). These results affirm that the amount and frequency of AAE features produced can be predictive of what linguistic knowledge AAE-speaking children are likely to rely on for sentence processing, demonstrating a symmetry between production rates of dialect features and how they are used as comprehension cues.

Conclusions and Future Implications

The results of this study demonstrate that in a context with similar redundant and informative linguistic cues, both AAE and MAE speakers use the available cues to parse sentences in similar ways. However, differences between AAE and MAE speakers were observed in a context where redundancy or informativeness was decreased. Crucially, these differences were not because AAE-speaking children were not sensitive to the auxiliary verb. Instead, linguistic mismatch appeared to cause *was* to be a less informative cue to determine subject number in AAE (which is consistent with its use in AAE). The lack of other informative linguistic cues (e.g., semantic, contextual, etc.) results in chance performance for AAE-speaking children in this context.

These results provide additional evidence that linguistic mismatch can impact sentence processing. The current expectation in American classrooms is that all students have quick and efficient processing of MAE sentences to facilitate learning. The impact of linguistic mismatch on sentence processing raises the question of how inefficient parsing due to linguistic mismatch impacts learning in the classroom. Several studies have shown that ambiguity in real time processing can impact what information children learn about words and can impact word mapping down the road (Huang & Arnold, 2016; Omaki et al., 2015); thus, making it possible that linguistic mismatch can interfere with aspects of word learning.

However, learning in classrooms doesn't rely only on the comprehension of linguistic cues. There are visual, social, and gestural cues that listeners integrate during spoken language to aid spoken language comprehension and word learning (Berman et al., 2013; Domanski, 2024; Erskine, 2023; King, 2019; Knowlton & Gomes, 2022; Nadig & Sedivy, 2002; Roy et al., 2015; Weatherhead et al., 2021; Yu & Ballard, 2007). Therefore, it is plausible that in a naturalistic context where AAE-speaking children have access to these additional non-linguistic cues, the impacts of linguistic mismatch will be decreased or resolved, and there may be limited impacts on learning. Further work is needed to explore both possibilities to help increase understanding of how linguistic mismatch is related to academic outcomes and what additional cues exist that can help mitigate the impacts of linguistic mismatch on educational outcomes.

Chapter 4: Evaluating how AAE- and MAE-speaking children use inflectional verb morphology to infer novel verb meanings in a word learning task.

Research has shown that the phonological and morphological differences between African American English (AAE) and Mainstream American English (MAE), the dialect of academic instruction, can lead to linguistic mismatch (Bühler et al., 2018; Craig, 2016; Charity et al., 2004; Edwards et al., 2014; Feitelson et al., 1993; Pearson et al., 2013; Saiegh-Haddad, 2005; NP Terry et al., 2018; Washington et al., 2018) because of phonological and morphological differences between the two dialects. A large body of research has found that linguistic mismatch results in poorer academic outcomes, especially on written tasks (Asadi & Kawar, 2023; Brown et al., 2015; Bühler, 2017; Craig, 2016; Charity et al., 2004; Dexter et al.; 2018; Gaitlin & Wanzek, 2015; Makhoul et al., 2015; Pearson et al., 2013; Saiegh-Haddad et al., 2022NP Terry et al., 2018; Washington et al., 2018). While a correlation between speaking AAE and poor performance on literacy tasks is well-established, there is much less work explaining *why* and *how* linguistic mismatch impacts academic performance.

One prominent explanation of the relationship between speaking AAE and poor literacy outcomes is that linguistic mismatch results in increased processing costs, which has cascading effects on academic performance (Karasinsk et al., 2015; Johnson, 2012; Terry et al., 2010; Terry et al., 2022). Research has shown that children and adults have more difficulty processing speech from people whose accents or dialects differ from their own (Barker & Meyer, 2015; Bent, 2014; Durrant et al., 2012; Harte et al., 2016; Kartushina & Mayor, 2018; Major et al., 2005; O'Connor & Gibson, 2011; Schmale et al., 2010). Thus, it is plausible to posit that linguistic mismatch increases processing costs, but it is unclear how these increased processing costs have a negative impact on academic performance. For example, none of the previous research has directly examined the relationship between linguistic mismatch and learning. This study is designed to test whether linguistic mismatch impacts learning, specifically word learning. Since efficient and accurate speech processing is directly related to word learning (Fernald et al., 2006; Weisleder & Fernald, 2013), it makes sense that linguistic mismatch may negatively impact word learning. Furthermore, learning new words is an essential aspect of academic learning. Thus, examining the relationship between linguistic mismatch and word learning provides an opportunity to explore how linguistic mismatch negatively impacts academic outcomes.

The remainder of Chapter 4 discusses previous research on how speaker variability, such as accents and dialects, impacts listeners' word recognition and sentence comprehension. Chapter 4 will also discuss previous research on how individual factors such as age and linguistic experience interact to mitigate accent and dialect effects on word learning. Lastly, this chapter explores whether linguistic differences between AAE and MAE impact word learning.

Accents and Word Recognition

Research has demonstrated that speaker variability, such as accent and dialect, can impact spoken language comprehension and word learning. However, the majority of research has focused on how listening to a speaker with a different accent adversely impacts word intelligibility (Clopper & Bradlow, 2008; Major et al., 2005), word recognition (Adnak et al., 2009; Bent, 2014; Floccia et al., 2006; Holt & Bent, 2017; Nathan & Wells, 2001; Nathan et al., 1998; Ryall & Pisonni, 2007), and sentence comprehension (Major et al., 2005; O'Connor & Gibbon, 2011) in children and adults. Although accents and dialects are different forms of speaker variation, exploring how accents impact word recognition and word learning provides an opportunity to hypothesize how dialect variation impacts word recognition and word learning.

For adults, listening to a non-native accent has been found to impact processing time (Adnak et al., 2009). For example, Adnak et al. (2009) examined how British adults interpreted British-accented English, a familiar and more standard accent, versus Glaswegian English, a less familiar accent, in noisy and quiet environments. Although participants accurately comprehended each sentence, processing speeds were slower in the condition with unfamiliar accents and noise. Furthermore, familiarity with the accent was found to moderate processing speeds on the task. Other studies found similar results in intelligibility, comprehension, and word recognition tasks where adults accurately understood what was being said in unfamiliar accents, but their processing times were longer (Floccia et al., 2009; Munro & Derwing, 2005; Rogers et al., 2004).

In children, developmental aspects (i.e., age and vocabulary size) and exposure to variation moderate understanding of words and sentences in unfamiliar accents. Best et al. (2009) and Mulak et al. (2013) found that infants 9 months through 18 months could recognize familiar words in native but not non-native accents. Van Heugten et al. (2015) also found a similar result in children 20 to 25 months old who did poorer on word recognition trials in Jamaican-accented speech than trials in their native Canadian English. Trials that included additional exposure to Jamaican-accented speech did not improve toddlers' performance on the task. The adverse impact of accented speech on word recognition in children has been found up to age 3 (Barker & Meyer, 2015). It is hypothesized that limited phonological inventories and processing resources in younger children cause poorer performance on word recognition tasks in accented speech (Adank et al., 2009; Nathan et al., 1998).

By age 5, children begin to leverage context cues, vocabulary, and their phonological inventory to help facilitate word recognition and sentence comprehension in accented speech (Bent, 2014; Holt & Bent, 2017; Nathan & Wells, 2001; Nathan et al., 1998; Ryall & Pisoni, 2007). Holt and Bent (2017) found that when children ages 5-7 performed better at predicting words in high-probability contexts (e.g., *"Elephants are big animals"*) versus low-probability contexts (e.g., *"Find the big animals"*), regardless of the accent of the speaker. The number of errors also decreased as children got older, and older children leveraged their linguistic experience (i.e., larger vocabulary and experience with variation) to increase their accuracy in high-probability contexts.

The results from the literature on word recognition and comprehension demonstrate that young children have difficulty in word recognition and comprehension tasks with unfamiliar accented speech. However, once children reach age 5, they can leverage linguistic context and accent familiarity to adapt to variation (Adnak et al., 2009; Barker & Meyer, 2015; Bent, 2014; Holt & Bent, 2017; Mulak et al., 2013; Nathan & Wells, 2001; Nathan et al., 1998; Ryall & Pisoni, 2007; Van Heugten et al., 2015). This raises questions about how children learn from speakers who speak different accents than their own and whether age predicts their performance in learning environments with speaker variation.

Accents and Word Learning

Accent variation affects word learning as well as word recognition. Research has shown that toddlers can successfully learn words in accented speech (Newman et al., 2018; Potter & Saffran, 2017; Schmale et al., 2011; Schmale et al., 2012; Schmale et al., 2015). For example, Schmale et al. (2011) examined how toddlers, ages 2;0-2;6 years old, learned words from an adult who spoke their native accent versus an adult who spoke Spanish-accented speech.

Toddlers were randomly assigned to a Native-to-Accent or an Accent-to-Native condition. In the Native-to-Accent condition, toddlers learned a novel word in their native accent and were tested if they could identify the novel verb when presented in Spanish-accented speech. In the Accent-to-Native trials, the learning phase occurred in Spanish-accented speech and the test phase in the native accent. Results demonstrated that toddlers aged 2;0 failed to generalize words learned in the native accent learning phase to the Spanish-accented test phase; however, toddlers aged 2;6 generalized words learned in the Spanish-accented learning phase to the native-accent test phase. These findings were replicated by Schmale et al. (2012; 2015), Potter and Saffran (2017), and Newman and colleagues (2018), who found that toddlers accommodated unfamiliar accents in rapid word learning.

Older children are not as successful when asked to learn words spoken in different accents. Buac (2019) examined how monolingual early elementary school-age American English-speaking children, ages 4-5, learned words from Mainstream American English, Spanish-accented, and Korean-accented speech. Children were asked to learn three lists of words and a corresponding novel object, one list per accent. In the test phase, children heard a word in one of the accents and were asked to select the novel object corresponding to the word they heard. Results demonstrated that children had difficulty learning words in Spanish- and Korean-accented speech. However, to test how long-term exposure to different accents impacted word learning, Buac (2019) tested how bilingual Spanish-English-speaking children performed on this task. She found that bilingual Spanish-English-speaking children learned novel words in American English- and Spanish-accented speech but not Korean-accented speech. The results from this study demonstrate that unfamiliar accents can impact word learning. However, that impact can be mitigated by familiarity with the accent, as demonstrated in the bilingual Spanish-English-speaking children.

To summarize, in younger children, studies suggest that age (Schmale et al., 2011), attention (Potter & Saffran, 2017), and phonological context (Newman et al., 2018) may determine how well toddlers learn from accented speech. However, in older children, it appears that familiarity with the accent may be more predictive of how children learn words from accented speech (Buac, 2019). These studies suggest that younger children have more flexibility to learn from speakers of different accents. However, as children get older, their ability to adapt to speakers' accents during learning tasks becomes more restricted. The findings in both the word comprehension and word learning literature suggest that although older children may adapt to unfamiliar accents during comprehension tasks, there may still be adverse impacts on what children learn. However, it is unclear from these studies if accent variation has short-term effects on word learning that eventually dissipate with more learning opportunities with the same speaker and on the same word. This raises questions on how children who speak different dialects adapt to speaker variation and what the potential short- or long-term effects on learning are.

Dialect mismatch word recognition and sentence comprehension

Less is known about how dialect variation impacts spoken language comprehension and word learning. It is imperative to understand how AAE-speaking children learn in different dialects via a spoken medium since spoken language is a primary medium of instruction as children matriculate through school. The research on how AAE- and MAE speakers process dialect variation mainly focuses on how adult MAE speakers process AAE and child AAE speakers process MAE. Research demonstrates that MAE-speaking adults are more likely to use their linguistic knowledge of MAE to determine how they interpret AAE morphology in sentences (Beyer et al., 2015; Beyer & Hudson-Kam, 2015; García et al., 2022), which causes MAE-speaking adults to misparse AAE sentences and experience pseudo-comprehensions. Pseudo-comprehensions occur when listeners believe they correctly interpreted what they heard even though their interpretation was inappropriate (Beyer et al., 2015; Beyer & Hudson-Kam, 2015; Roy, 1987). Furthermore, when adult MAE speakers' processing is monitored in real-time using an electroencephalographic (EEG) method, AAE features not produced in MAE are interpreted as errors, indicated by a P600 effect (García et al., 2022). Conversely, bidialectal AAE-MAE speakers can leverage their linguistic knowledge of AAE morphology to accurately comprehend sentences (Weissler & Brennan, 2020).

Research has found that AAE-speaking children are less sensitive to MAE phonological and morphological features that are zero or optionally marked in AAE during word and sentence comprehension tasks (Beyer & Hudson-Kam, 2015; Byrd et al., 2023; De Villers & Johnson, 2007; Edwards et al., 2014; Terry et al., 2010; Terry et al., 2022). This results in AAE-speaking children misinterpreting MAE sentences, a finding of interest for its potential impacts in the classroom. When examined in an online processing task using eye tracking, Byrd (2023) found that AAE-speaking children were sensitive to contrastive verb morphology (e.g., auxiliary verb *was or were*). However, the auxiliary verb was not an informative cue to revise their interpretations of MAE sentences. Furthermore, Erskine (2023) found that the impact of linguistic mismatch on sentence processing may be context specific. In that study, AAE-speaking children performed worse at processing unfamiliar dialects when semantic context and social cues were missing. However, the same children processed sentences produced in AAE and MAE similarly when semantic and social cues were presented. This suggests that in the absence of a cue-rich environment, children may rely more on linguistic cues, but when other cues are present, AAE-speaking children can integrate them to guide their processing (Erskine, 2023).

To date, Terry and colleagues (2010, 2022) have provided the only studies that have attempted to link the effects of linguistic mismatch in sentence processing to performance on an academic task. Terry and colleagues (2010) examined how contrastive features, such as third-person singular -*s*, impacted performance on verbal math problems and the potential processing costs. Third-person singular -*s* was selected because it is not a feature produced in AAE, and it has been argued that AAE grammar has no morphological equivalent (Johnson, 2005; Newkirk-Turner & Green, 2016, 2021). Terry et al. (2010) found that AAE-speaking children were less accurate when solving math word problems that contained third-person singular -*s* relative to problems that did not contain these features. These results were hypothesized to be caused by processing costs associated with encountering a linguistic feature not a part of the AAE morphological structure (Terry et al., 2010).

Terry et al. (2022) expanded on that work by examining how AAE-speaking children processed third-person singular -*s* in sentence comprehension and verbal math problems and used EEG to measure real-time processing. The sentence processing task results demonstrated that AAE-speaking children treated third-person singular -*s* as ungrammatical, as reflected in a bilateral early anterior-central negativity in the EEG results. Furthermore, an increase in working memory load was detected when processing verbal math problems with third-person singular -*s*, as indicated by a bilateral late long-lasting anterior-central negativity in the EEG.

In addition to the processing costs observed by Terry and colleagues, several studies have shown that AAE-speaking children are less likely to rely on contrastive phonology and verb morphology to determine subject number, which adversely impacts how they process MAE sentences (Beyer & Hudson-Kam, 2015; Byrd et al., 2023; De Villers & Johnson, 2007; Edwards et al., 2014; Terry et al., 2010; Terry et al., 2022). For example, Byrd et al. (2023) found that AAE-speaking children were less likely to use the contrast between *was* and *were* to identify ambiguous singular and plural subject noun phrases. Furthermore, Byrd and colleagues found that dialect density (the number of AAE features used by the participants) predicted the use of this contrastive feature. However, as noted above, there have not been any studies that directly examine whether AAE-speaking children are less likely than their MAE-speaking peers to rely on contrastive phonology and verb morphology in a learning task. This study addressed that gap by examining how children use linguistic information to infer word meanings, a process more broadly known as syntactic bootstrapping.

Linguistic mismatch and syntactic bootstrapping

All forms of learning require children to use their prior knowledge to scaffold and encode new information (Carmicheal & Hayes, 2001; Smith et al., 2021). For example, when learning new words, children integrate multiple cues within sentences, including morphological and syntactic features, to infer the meaning of new words, a process broadly known as syntactic bootstrapping (Apfelbaum & McMurrary, 2016; Fisher, 1996; Gertner & Fisher, 2012; Gleitman, 1990; Gleitman et al., 2019; Lidz, 2020; Naigles, 1996). This process allows children to build syntactic frames that they can use to make inferences about the grammatical properties of their language as well as the meanings of specific words (Fisher, 1996; Gleitman, 1990; Gleitman et al., 2019; Kline et al, 2017; Huang et al., 2019; Lidz, 2020; Naigles, 1996; Pozzan, et al., 2016; Yu & Smith; 2007). Since syntactic bootstrapping relies on children's prior linguistic knowledge to guide what cues are relevant and reliable to assist with word learning (Gertner & Fisher, 2012; Snedeker & Trueswell, 2004), it is plausible that when learning new words in MAE, linguistic mismatch may influence how AAE-speaking children use morphosyntactic cues to infer the grammatical properties of words. For example, if a listener's experience is that verb morphology is variably produced in your dialect, like AAE, this listener may not attend to the verb morphology to derive grammatical properties of novel verbs. In this case, the listener's experience with variable verb morphology may lead to the reliance on different strategies or cues to guide word interpretation.

A way to test how a listener's linguistic knowledge and experience interact with word learning is to examine how linguistic mismatch impacts children's inferences about the number of agents that involved in a verb's meaning. Multiple studies have examined how children have used syntactic information to make inferences about the number of agents completing a novel verb (Arunachalam & Waxman, 2010; Messenger et al., 2015; Pozzan et al., 2016; Yuan & Fisher, 2009). For example, Messenger et al. (2015) examined how toddlers encoded the syntactic properties of a novel verb. Toddlers heard a dialogue with a novel verb embedded in either transitive (e.g., *"Anna mooped the baby"*) or intransitive (e.g., *Anna mooped"*) sentences. Then, toddlers were shown a two-agent casual event and a one-agent event and heard the novel verb in isolation (e.g., "*Find mopping!"*). Results demonstrated that toddlers looked longer at two-agent causal events after hearing transitive versus intransitive dialogues. This showed toddlers could derive syntactic information in a distributional learning situation to guide early word learning. School-aged children are also using probabilistic expectations based on previous linguistic experiences to learn categories and meaning of words (Hall et al., 2017; Huang & Arnold, 2017; Martin et al., 2022), meaning how syntactic cues support inferences about word meaning plays a vital role in building children's vocabulary throughout their development.

Since inflectional verb morphology is a contrastive feature between AAE and MAE, linguistic mismatch between AAE and MAE may lead to differences in how school-aged AAE-speaking children use inflectional verb morphology to make inferences about grammatical properties of a novel verb. If this line of reasoning is true, this would provide direct evidence that linguistic mismatch impacts a form of learning.

The current study

This study examines how AAE- and MAE-speaking children use inflectional verb morphology related to subject-verb agreement to learn the grammatical properties of novel verbs. This study poses two research questions. First, are there group differences in how AAE- and MAE-speaking children use third-person singular -*s* and *was/were* to infer the meaning of novel verbs? Second, does dialect density predict performance on the word learning task?

Participants completed a word learning task with familiarization and test phases to address these research questions. In the familiarization phase, participants watched a video of two people talking and listened to dialogues that contained ambiguous or unambiguous subjects, contrastive verb morphology (i.e., third-person singular -*s* and was/were), and novel verbs. The purpose of this phase was to see how participants used subject-verb agreement to a) infer the number of subjects in the sentence and b) infer the number of participants the novel verb required. Dialogues that contained ambiguous subjects provided an opportunity for inflectional verb morphology to be used as the primary cue to make inferences about the number of subjects in the sentence and then the number of participants completing the novel verb. In the test phase, participants were shown two action videos and instructed to select the video that showed the novel verb. This phase examined how participants used subject-verb agreement to infer the novel verb meaning. The primary metric for assessing learning was if participants selected the video where the number of people completing the video matched the number of subjects indicated in the familiarization phase. For example, if the familiarization phase used singular verb morphology, participants should select the video of a 1-participant event. This examined how participants used information about subject-verb agreement derived from the inflectional verb morphology to infer verb meanings.

Based on previous research that has shown dialect differences impact spoken language processing and comprehension (Beyer & Hudson-Kam, 2015; Byrd et al., 2023; De Villers & Johnson, 2007; Edwards et al., 2014; Terry et al., 2010; Terry et al., 2022), I predict group differences in how AAE- and MAE-speaking children use contrastive verb morphology to infer novel verb meanings. Research has found that children track the frequency of linguistic structures and use experience with different linguistic cues to shape future use during comprehension and processing tasks (Huang et al., 2019; Wonnacott, 2011). For AAE-speaking children, they may not track third person singular -*s* and *was* cues during word learning because these are not reliable linguistic cues to infer subject number in AAE. Thus, when encountered with these cues in a word learning task, AAE-speaking children may not find these cues reliable nor informative to make inferences about participant numbers. This hypothesis is further supported by work from Byrd (2024b) demonstrated that although AAE-speaking children are sensitive to contrastive verb morphology, it was not an informative cue to determine subject number.

I also predict that individual differences such as age, vocabulary size, and dialect density will predict performance on the task. How children adapt to linguistic variation, use linguistic and non-linguistic cues, and leverage previous linguistic knowledge depends on participants' age (Buac, 2019; Huang et al., 2019; Potter & Saffran, 2017; Schmale, et al. 2011; Schmale et al., 2012; Schmale et al., 2015; Wonnacott, 2011), which means that age may be influential on children's performance on the word learning task. Furthermore, dialect density and vocabulary size have been found to predict how children perform on sentence comprehension tasks (Byrd et al., 2023; Edwards et al., 2014); therefore, they may also predict performance on word learning tasks.

An alternative hypothesis is that there will not be group differences in how AAE- and MAE-speaking children use inflectional verb morphology to infer novel verb meanings. Although the previously mentioned predictions are plausible, it is important to remember that children rely on a multitude of non-linguistic cues (e.g., social, emotional, visual scenes, spatial and temporal context) to learn words (Berman et al., 2013; Domanski, 2024; Erskine, 2023; Roy et al., 2015; Weatherhead et al., 2021). So, although dialect has robust effects on spoken language comprehension, the impacts on word learning could be marginal, and linguistic mismatch may not lead to differences in how children learn words. Whether the null or alternative hypothesis is true, the results from this study provide more information about linguistic mismatch impacts word learning.

Methods

Participants

This study recruited 49 participants, ages 5;0-11;0 years old, from the Maryland/DC and Virginia areas. Due to the novelty of the experimental design, a relatively wide age range of participants was recruited to evaluate how individual characteristics, such as age and dialect, influenced performance on the word learning task. Like Chapter 3, recruitment methods included a university database, partnerships with two private schools and one public school in Maryland, and distribution of fliers in local communities. Many African American participants were recruited through school partnerships. Four participants were excluded because their parents reported they had a developmental delay, language delay, or Individualized Education Plan (IEP). Based on parent reports, all other participants had typical speech and language development. All participants passed a hearing screening at the beginning of testing. Parents of participants provided informed consent. Families received compensation for their participation, and children received a small gift.

Table 1 provides demographic information and test scores for all participants, and Figure 1 provides visual descriptions of the relationships between participants' dialect density and age (Figure 1a), dialect density and race (Figure 1b), and dialect density and parent income (Figure 1c). Figure 1a. shows that participants of different ages are represented throughout the dialect density ranges. A Pearson's *r* correlation test on dialect density and age demonstrated that participants' age was not significantly related to their dialect density scores (r = -0.28, p = 0.07). Figure 1b. demonstrates that the sample was primarily African American and that European American participants had dialect density scores lower than 0.41. Further analyses revealed there was a weak relationship between participants' race and dialect density scores (F (1,43) = 3.33, p = 0.08). Figure 1c. illustrates there is no significant relationship between participants' dialect density scores and parent income (F (5,26) = 1.17, p = 0.35), which could be attributed to 31% of parents declining to report their income.

Materials

Parent Survey

Parents of child participants completed a two-part survey. Part 1 evaluated parents' experiences with different dialects of American English, and part 2 collected demographic information such as race, parent education level, and total family income. The survey was 15-20 minutes long and administered asynchronously and virtually to parents. The survey was optional; parents could skip questions they did not want to answer or decline to complete. Approximately 73% of parents completed the parent survey. Responses from part 1 of the survey were not included in the analysis for this study.

Language Measures

Participants were administered two standardized assessments. The *Peabody Picture Vocabulary Test, 5th edition* (PPVT-5) (Weintraub et al., 2013) is a standardized measure of receptive vocabulary skills. Participants were presented with four images and instructed to point to or tell the examiner the number of pictures that best matched the word they heard. The *Diagnostic Evaluation of Language Variation-Screener Test: Part 1* (DELV-ST) (Seymour et al., 2003) is a screening test designed to describe dialectal variation from MAE by evaluating the production of contrastive features between MAE and AAE. The DELV-ST Part 1 provides an age-referenced criterion score that identifies if a participant is a: (a) MAE speaker, (b) has some variation from MAE, or (c) strong variation from MAE. This criterion score was used to identify if a student spoke a non-mainstream or mainstream dialect and assign participants to groups. For this study, criterion scores of some variation from MAE or strong variation from MAE were collapsed together into the category of non-mainstream dialect (i.e., AAE) speakers since these criterion scores indicated they used some non-mainstream features in features in production.

In addition, a dialect density score was calculated based on how many AAE features a speaker uses on the DELV-ST and was used as a continuous measure of dialect. This score was calculated by dividing the number of non-mainstream features produced by the number of scorable items (Terry et al., 2010; Terry & Connor, 2012; Terry et al., 2012). Therefore, a student who used only MAE features would score a 0, and a participant who used only AAE features would score a 1.

Table 1. Participant Demographics

	AAE Listeners	**MAE Listeners**
n	15	30
Female	8	18
Mean Age	8;7	7;3
range	5;4-11;0	5;0-10;9
PPVT-5th Edition		
Mean SS[12] (SD[13])	113 (17)	114 (13)
Range	91-153	86-160
Dialect Density[14]		
Mean SS (SD)	0.44 (0.25)	0.16 (0.13)
Range	0.00-0.92	0.00-0.40
Race		
African American	15	19
European American	0	12
Family Income		
$20,000-40,000	0	4
$41,000-60,000	0	1
$61,000-100,000	2	7
$100,000-200,000	7	9
More than $200,000	1	3
Declined to report	6	6

[12] SS stands for Standard Score
[13] SD stands for Standard Deviation
[14] Dialect Density was calculated by taking the number of non-mainstream features produced on the DELV-ST and dividing by the total number of scorable items

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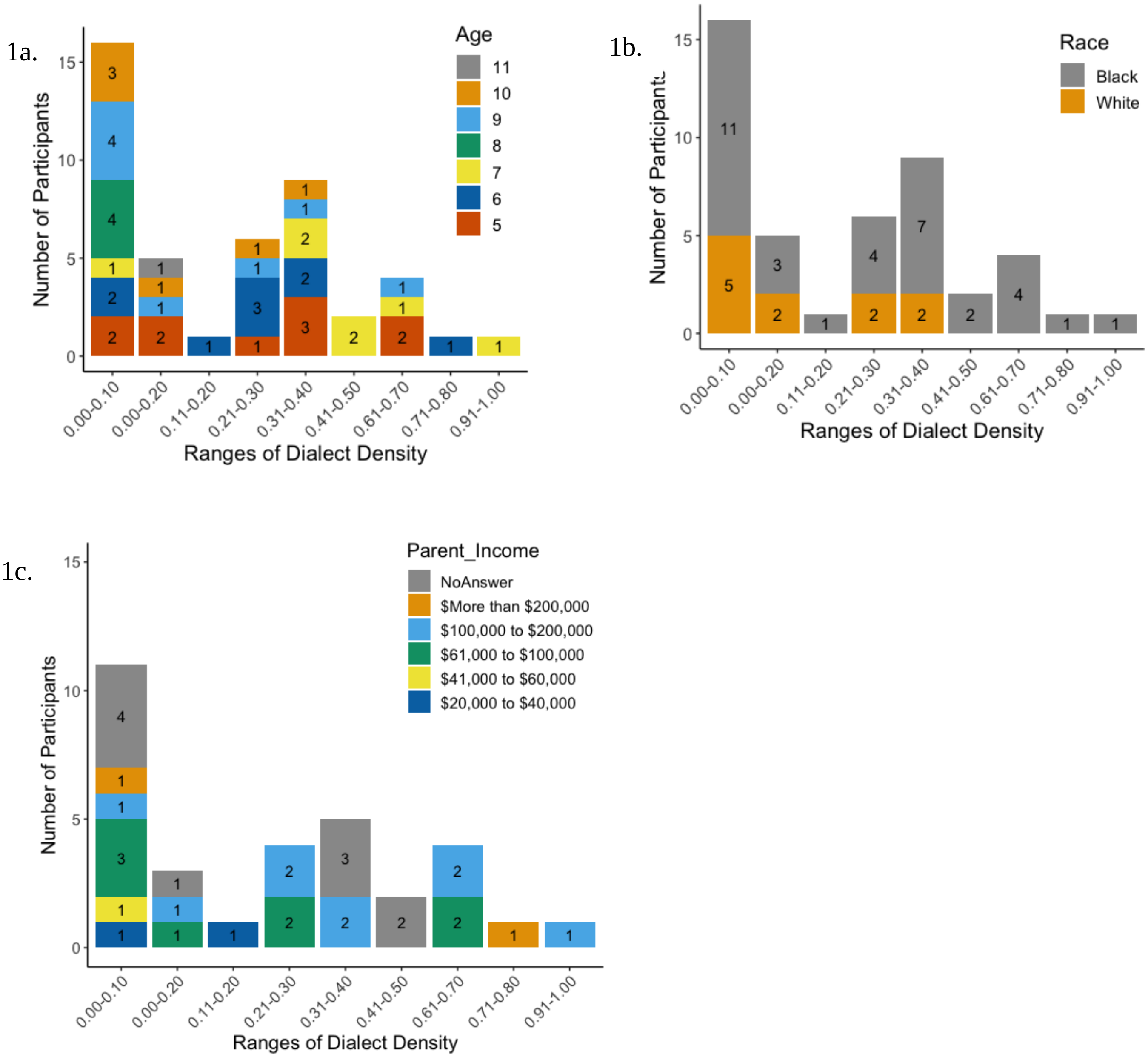

Figure 1. Histograms of the number of participants as a function of age, dialect density, race, and total family income for all participants (n=45). Figure 1a shows the number of participants as a function of dialect density and age. Figure 1b shows the number of participants as a function of dialect density and race. Figure 1c shows the number of participants as a function of dialect density and parent income.

Word Learning Task

A word learning task was developed based on pilot work to evaluate how children who speak AAE and MAE use inflectional verb morphology to learn syntactic information about a novel verb in MAE sentences. The task consisted of three parts: a training phase, practice trials, and critical trials. The training phase introduced participants to character names and the task itself. Practice trials allowed participants to complete trials with both a familiarization and test phase and receive feedback if necessary. Lastly, critical trials contained both a familiarization and test phase and tested how participants used subject-verb agreement to leverage information from inflectional verb morphology to infer novel verb meanings. Additional information about task development and norming can be found in Appendix C. Figure 2 provides an example of the task.

Training phase. Participants were introduced to the task under the pretense of playing a sticker collection game. Before beginning the experimental trials in the word learning task, participants were given a story introducing them to six characters: *Jeremiah, Carter and Joe, Carolyn May*, and *Carol n' May.* In this introduction, participants were shown a layered clipart picture as they were introduced to each character's name. The clipart images provided visual support to bring awareness that the name "*Carolyn May"* was perceptually ambiguous and could represent one or two participants. During the video, participants were asked to repeat the names of each character after they heard them and point to the picture associated with the character's name to evaluate whether participants knew the characters' names and how many people they represented. At the video's conclusion, participants were given instructions on how to complete the task. They were told to listen closely, watch the video, and then select the video that best matched what they heard.

Practice trials. Next, each participant completed six practice trials. The first two practice trials involved two known verbs (i.e., *handshaking* and *sleeping*) to familiarize participants with the experimental procedure: watching and selecting the video that best matched what they heard. The second set of practice trials consisted of four trials with novel verbs (e.g., presented with each character's name and the corresponding singular or plural verb morphology. These trials were identical to the experimental trials and prepared participants to use the information from the familiarization phase to learn if the novel verb involved one or two participants. If a participant incorrectly answered a practice item, they were given feedback to think about how many people were needed to complete the novel verb. They then rewatched the familiarization video and completed the practice trial again.

Critical trials. After the practice trials, each participant took part in 16 critical trials that contained 4 tokens of each condition (i.e., unambiguous singular noun phrase, unambiguous conjoined noun phrase, ambiguous singular conjoined noun phrase, ambiguous plural conjoined noun phrase) with a novel verb. Each novel verb was only heard once. Items were counterbalanced using a Latin Square design to prevent order effects, and pseudo-randomization was used to produce four lists that differed in the order in which each item was presented to participants and differed in which names were paired with each novel verb. This design ensured that each participant was exposed to every condition, preserved the novelty of the ambiguous names, and controlled for item order effects.

Each critical trial unfolded in two parts. First, during the familiarization phase, children watched a video and listened to a story. The familiarization phase allowed participants to use information derived from verb morphology to form inferences about the novel verb. Two female speakers, ages 18-21 years old, recorded the distributional learning videos. Both spoke MAE and were from the mid-Atlantic United States. Three things were manipulated in the conversation: 1) whether the subject name was ambiguous (e.g., *Carolyn May, Carol n' May*, female) or unambiguous (e.g., *Jeremiah, Carter and Joe*, male), 2) the inflectional morphology (e.g., was/were, third person singular -s), and 3) the name of the novel verb. The subject names were selected based on the norming results of Byrd et al. (2023) to choose a token of *Carolyn May* that was ambiguous between singular and plural. The sentences used in the conversation were intransitive (e.g., *"Carolyn May were blorking"*). Plural verb morphology was paired with conjoined noun phrases (e.g., *Carter and Joe, Carol n' May*), and singular verb morphology was paired with singular noun phrases (e.g., *Jeremiah, Carolyn May*). Unambiguous names were used for control trials, and ambiguous names for experimental trials. All distributional learning videos were 16-18 seconds long. See Appendix D for examples of distributional learning dialogues.

The familiarization phase was followed by the test phase, which aimed to examine participants' inferences about the novel verb they heard in the distributional learning phase. Participants heard a sentence and saw two videos of people completing different actions: one video with one person in the frame and another video with two people in the frame. Action videos were fixed so that videos with one person were always on the left and videos with two people were on the right. Action videos consisted of exercise or dance movements that had been normed as being perceived as actions that could only be completed with one person or two people. See Appendix C for information about video norming. Child-directed sentences were used to draw the participants' attention to the action videos (e.g., *Wow, look meeping! Find the video that shows meeping*). The sentences were recorded by a 29-year-old female who spoke

MAE and was from the Southeastern region of the United States. Auditory stimuli in the test phase began playing 70 milliseconds before the action videos began playing.

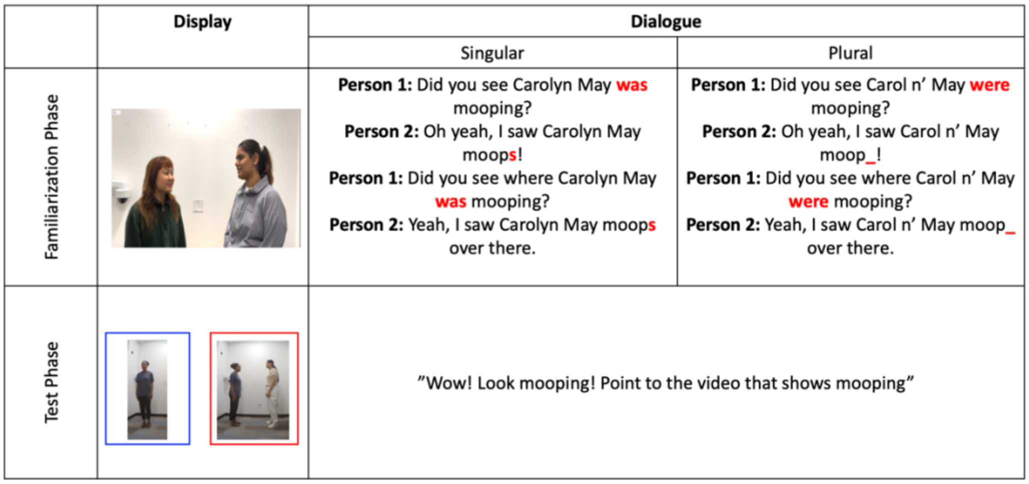

Figure 2. Example of Word Learning Task.

Results

Logistic mixed-effects models were fitted to trial-level data and random effects of subjects to investigate the impact of linguistic mismatch on children's word learning. Analyses were conducted to address two research questions: 1) Are there group differences in how AAE- and MAE-speaking children use third-person singular *-s* and *was/were* to infer the meaning of novel verbs? And 2) Do individual characteristics such as age, vocabulary size, and dialect density predict performance on the word learning task? In addition, exploratory analyses were conducted to examine how older children, ages seven and older, performed on the word learning task. All models were built using the backward stepwise elimination process to find the best fitting model, which was determined by the model AIC. Participant-level variables, such as vocabulary and age, were selected for the model-building process based on previous literature showing that age, linguistic experience, and linguistic knowledge can influence how infants and children learn words in accents or dialects that may be less familiar. Interactions included in the models were based on the experimental questions and did not include all possible interactions.

Each model also evaluated the same dependent variable, which was the participants' number of plural responses. Plural Responses is a dichotomous variable where participants received a score of "1" if they selected an action video with two participants and "0" if they selected an action video with one participant. Since a plural bias had previously been observed for the subject noun phrase "*Carolyn May"* (Byrd et al., 2023; Byrd, 2023a), using Plural Responses as the dependent variable allowed for the evaluation of how participants used inflectional verb morphology to guide inferences about the number of participants completing a novel verb. Each model was tested to ensure it did not violate parametric assumptions. Age, dialect density, and vocabulary scores were centered because the distributions were skewed. Models were fit with the lme4 package (version 1.1-21; Bates et al., 2015) in R (version 3.6.1) using the restricted maximum likelihood estimation. No observations were excluded or replaced in analyses.

Question 1: Are there group differences in the use of inflectional verb morphology?

To examine group differences in how AAE- and MAE-speaking children use inflectional verb morphology to infer novel verb meanings, the data from all participants were analyzed, and separate logistic mixed effects models were created -- one for the learning contexts that contained unambiguous subjects (i.e., *Jeremiah* and *Carter and Joe*) and another for the ambiguous subject (i.e., *Carolyn May*). The dependent variable, Plural Responses, was predicted by the fixed effects of Vocabulary (centered), Dialect Group (AAE/MAE), Verb Type (Singular/Plural), and Age (centered). In addition, the models explored a Dialect Group by Subject Type interaction and an Age by Subject Type interaction. Models included a by-participant random intercept and was leveled so that Dialect Group *AAE* and Verb Type *singular* as the reference groups.

Unambiguous context. Plural Responses in the unambiguous contexts were evaluated to ensure participants understood the task and completed it in a similar manner. Here, participants could use the subject's gender (i.e., boys), the subject names (i.e., *Jeremiah* or *Carter and Joe*), and the verb morphology to make inferences about the number of participants completing the novel verb. These redundant cues meant participants should perform similarly regardless of their dialect. Figure 3a demonstrates that overall, children used available linguistic cues to determine the number of participants for the novel verb. Regardless of the participants' dialect, younger and older children had fewer plural responses after the singular condition than after the plural condition. Although younger children relative to older children had increased variability in the number of plural responses in the singular condition, their responses differed from chance.

In the model, there was a main effect of Verb type (p <.001), meaning AAE-speaking children, the reference group, had more plural responses in the plural Verb Type condition than in the singular Verb Type condition. Furthermore, there was an Age by Verb type interaction, meaning that as Age increased, there was more of an effect of the inflectional verb morphology (p <.001). No other main effects or interactions were significant. Specifically, the effect of Dialect Group and the Dialect Group by Verb Type interaction were not significant. A summary of parameter estimates is provided in Table 2.

Table 2. Summary of parameter estimates for the logistic mixed-effects model fit to Plural Responses in the unambiguous distributional learning context.

Fixed Effects

	β	***SE***	***z***
Intercept	-2.19	0.60	-3.69***
Vocabulary	-0.03	0.42	-0.08
Age	-0.92	0.51	-1.82
Verb Type: Plural	6.14	1.04	5.91***
Dialect Group: MAE	-0.37	0.70	-0.53
Age x Verb Type	2.17	0.54	3.95***
Dialect Group x Verb Type	-0.70	1.03	-0.68

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	1.41	1.19

p <.001***, p < .01 **, p < .05*

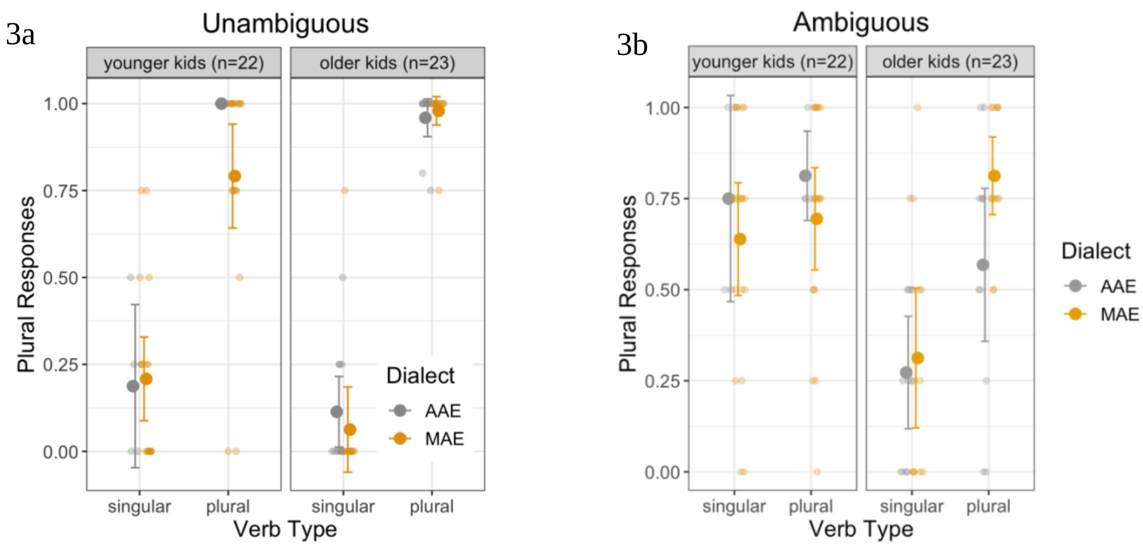

Figure 3. Plural responses for each Dialect Group in the Unambiguous and Ambiguous distributional learning context. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Ambiguous context. Plural responses in the ambiguous contexts were evaluated to examine if there were group differences in the use of inflectional verb morphology and to make inferences about the number of participants required for a novel verb. Since the subject is perceptually ambiguous, participants must rely on the inflectional verb morphology to infer the number of participants required to complete the novel verb.

Figure 3b demonstrates that older children who spoke AAE and MAE had more plural responses after the plural verb condition and fewer after the singular condition. In contrast, younger children who spoke AAE and MAE had similar plural responses after both plural and singular conditions. There was a main effect of Age (p <.001), meaning as age increased, AAE-speaking children were less likely to infer the novel verb required two people in the singular Verb Type condition. Furthermore, there was an Age by Subject type interaction (p <.001), meaning that as Age increased, there was more of an effect of Verb Type on how older children used inflectional verb morphology to make inferences about the syntactic properties of novel verbs. No other main effects or interactions were significant. Specifically, the effect of Dialect Group and the Dialect Group by Verb Type interaction were not significant. A summary of parameter estimates is provided in Table 3.

Table 3. Summary of parameter estimates for the logistic mixed model fit to Plural Responses in the ambiguous distributional learning context.

Fixed Effects

	β	***SE***	***z***
Intercept	-0.16	0.40	-0.40
Vocabulary	0.37	0.26	1.42
Age	-1.27	0.32	-4.02***
Verb Type: Plural	0.72	0.44	1.62
Dialect Group: MAE	-0.01	0.49	-0.02
Age x Verb Type	1.16	0.27	4.24***
Dialect Group x Verb Type	-0.72	0.55	1.29

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.72	0.85

p <.001***, p < .01 **, p < .05*

Exploratory analysis 1*: *Do dialect effects emerge among older participants?

The results from the initial analysis demonstrated that age predicted performance on the word learning task. Regardless of their dialect, younger children were less likely to use verb morphology to infer novel verb meanings. While age is predictive of how children learn words when listening to speakers of different accents, findings from spoken language processing and comprehension studies demonstrate robust effects of dialect on listening tasks regardless of age. The findings from question 1 raise two questions 1) Could the observed results be due to the wide age range of the sample, which is obscuring dialect effects? or 2) Is it possible that dialect has marginal impacts on word learning?

To address those two questions, an exploratory analysis was conducted with only the sample of participants ages 7 and older (*n*=26). The age of participants in this sample ranged from 7;0 to 11;0 with a median age of 9;4. Their dialect density scores ranged from 0.00 to 0.93, with the mean dialect density score being 0.23. In this sample, 12 participants were categorized as AAE speakers and 14 as MAE speakers. The mean PPVT-5 standard score of the sample was 112, with the scores ranging from 91 to 160. Most participants in this sample identified as African American except for three who identified as European American.

Two logistic mixed effects models were used to examine how Plural Responses were predicted by the fixed effects of Vocabulary (centered), Dialect Group (AAE/MAE), Verb Type (Singular/Plural) and Age (centered) in both unambiguous and ambiguous distributional learning contexts. In addition, a Dialect Group by Subject Type interaction, and an Age by Subject Type interaction were examined in both models. The Models included a by-participant random intercept and were leveled so that Dialect Group *AAE* and Verb Type *singular* as the reference groups.

Unambiguous context. Figure 4a shows that regardless of participants' dialect, children have fewer plural responses in the singular condition and more plural responses in the plural condition. Both dialect groups performed similarly on the task and used available cues (i.e., gender, subject, inflectional verb morphology) to infer the number of participants for the novel verbs. A main effect of Verb type (p <.001) in the unambiguous distributional learning contexts, which demonstrates that AAE-speaking children had more plural responses in the plural Verb Type than the singular Verb Type. There were no other significant main effects or interactions within this model. A summary of parameter estimates is provided in Table 4.

Table 4. Summary of parameter estimates for the logistic mixed-effects model fit to Plural Responses in the unambiguous distributional learning context for children seven and older.

Fixed Effects

	β	***SE***	***z***
Intercept	-2.74	1.50	-1.82
Vocabulary	-0.03	0.86	-0.03
Age	-1.03	1.28	-0.81
Verb Type: Plural	7.21	2.40	3.01**
Dialect Group: MAE	-1.82	1.68	-1.09
Age x Verb Type	1.47	1.61	0.91
Dialect Group x Verb Type	2.96	2.36	0.21

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	5.99	2.60

p <.001***, p < .01 **, p < .05*

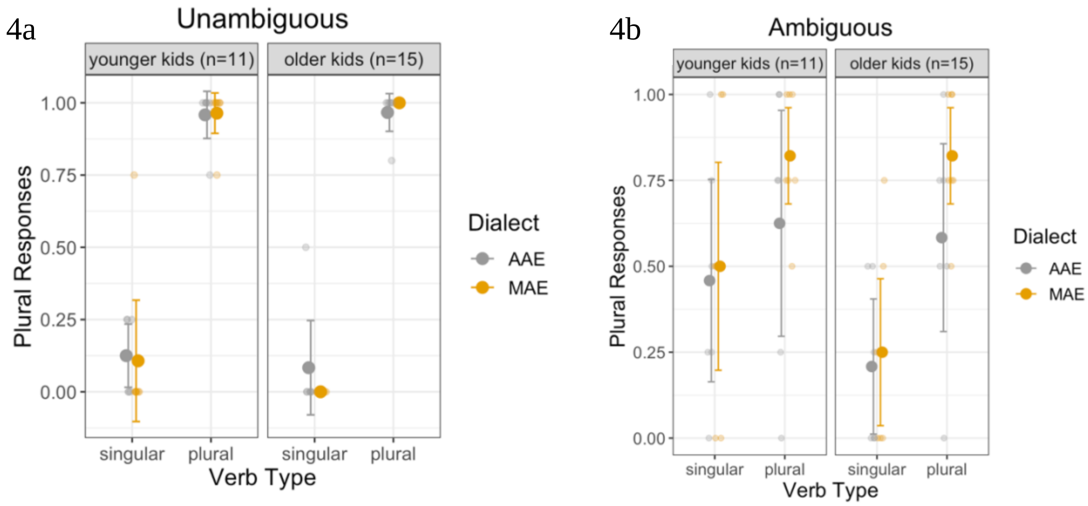

Figure 4. Plural responses for each Dialect Group in the Unambiguous and Ambiguous distributional learning context. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Ambiguous context. Figure 4b shows that older children in both dialects had fewer plural responses in the singular condition and more plural responses after the plural conditions; however, younger children in both dialects had similar amounts of plural responses in singular and plural conditions. The results from this model show a main effect of Age (p <.001), meaning as Age increased, AAE-speaking children had fewer plural responses in the singular Verb Type. In addition, there was an Age by Subject type interaction (p <.001), meaning that as Age increased, participants were more sensitive to the inflectional verb morphology as a cue to infer the number of participants the novel verb required. There were no other significant main effects or interactions in this model. A summary of parameter estimates is provided in Table 5.

Table 5. Summary of parameter estimates for the logistic mixed-effects model fit to Plural Responses in the ambiguous distributional learning context for children seven and older.

Fixed Effects

	β	***SE***	***z***
Intercept	0.52	0.52	1.01
Vocabulary	0.08	0.28	0.29
Age	-1.88	0.49	-3.81***
Verb Type: Plural	0.06	0.62	0.10
Dialect Group: MAE	0.01	0.56	0.01
Age x Verb Type	1.67	0.56	2.98***
Dialect Group x Verb Type	1.16	0.69	1.68

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.41	0.64

p <.001***, p < .01 **, p < .05*

Question 2: Does dialect density predict performance on the word learning task?

To address the second research question: "*Does dialect density predict performance on the word learning task,* a sample of all African American participants (*n*=34) was analyzed. African American participants were used to address this question because they had a wider range of density scores (i.e., 0.00-0.93) than their European American (0.00-0.40) counterparts. Participants ranged from ages 5;0 to 11;0 with the median age of 7;8. Their dialect density scores ranged from 0.00 to 0.93, with the mean dialect density score being 0.29. The mean PPVT-5 standard score of the sample was 112, with the scores ranging from 86 to 153.

A logistic mixed effects model was built to evaluate how dialect density influences children's use of inflectional verb morphology to infer the meaning of novel verbs in ambiguous distributional learning contexts. Dialect density is a continuous measure of dialect, with scores closer to 0 indicating the production of more MAE-like features and scores closer to 1 indicating the production of more AAE-like features. The dependent variable, Plural Responses, was predicted by the fixed effects of Vocabulary (centered), Dialect Group (AAE/MAE), Verb Type

(Singular/Plural), and Age (centered). In addition, models explored a Dialect Group by Subject Type interaction and an Age by Subject Type interaction. The model included a by-participant random intercept and was leveled to that Verb Type *singular* was the reference group.

Figure 5 shows that older participants had fewer plural responses in the singular condition and more plural responses in the plural condition. In contrast, younger children had similarly high levels of plural responses in singular and plural conditions. Furthermore, participants with lower dialect densities had fewer plural responses in the singular condition and more plural responses in the plural condition. In contrast, participants with higher dialect densities had similar levels of plural responses in singular and plural conditions. There was a main effect of Age (p <.001), meaning as Age increased, children had fewer plural responses in the singular Verb Type condition. There was also a main effect of Verb Type (p <.001), meaning children had more plural responses in the plural condition than in the singular condition. There was an Age by Verb Type interaction (p <.05), meaning that as age increased, older children were more sensitive to the inflectional verb morphology and more likely to use it to guide inferences about word meanings. There was also a Dialect Density by Verb Type interaction (p <.01), which shows that as Dialect Density increased there was less of an effect of inflectional verb morphology on number of Plural Responses. A summary of parameter estimates is provided in Table 6.

Table 6. Summary of parameter estimates for the logistic mixed-effects model fit to Dialect Density on Plural Responses in the ambiguous distributional learning context.

Fixed Effects

	β	***SE***	***z***
Intercept	0.06	0.25	0.26
Vocabulary	0.50	0.31	1.59
Age	-1.39	0.36	-3.86***
Verb Type: Plural	1.36	0.32	4.19***
Dialect Density	0.13	0.23	0.54
Age x Verb Type	0.64	0.32	2.00*
Dialect Density x Verb Type	-0.83	0.29	-2.77**

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.53	0.73

p <.001***, p < .01 **, p < .05*

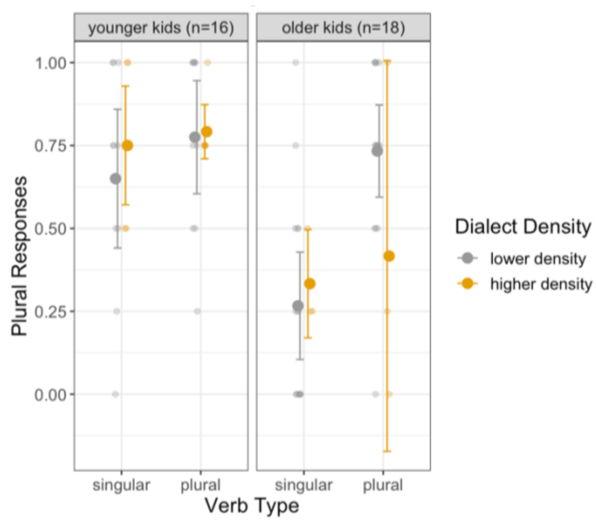

Figure 5. Influence of Dialect Density and Age on inferences that novel verb is plural in singular and plural conditions in the ambiguous context. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Exploratory analysis 2: Does dialect density predict older children's performance on the word learning task?

The analyses on dialect density and word learning revealed that participants' age and dialect density predicted how inflectional verb morphology was used to infer verb meanings. These findings raise questions about when dialect density influences word learning: Is it only observed in older children who performed better on this task? To address this question, an exploratory analysis was conducted with only the African American participants who were 7 and older (n=23). This analysis focused on older children because the first exploratory analysis revealed that older children were more likely to use verb morphology to infer novel verb meanings. This sample's participants had ages ranging from 7;0-11;0 with the median age being 9;5. Their dialect density scores ranged from 0.00. to 0.93, with the mean dialect density score being 0.26. The mean PPVT-5 standard score of the sample was 111, with scores ranging from 91 to 153.

A logistic mixed effects model was used to examine whether Plural Responses were predicted by the fixed effects of Vocabulary (centered), Dialect Density (centered), Verb Type (Singular/Plural), and Age (centered) in the ambiguous distributional learning contexts. In addition, a Dialect Density by Subject Type interaction and an Age by Subject Type interaction were examined. The Model included a by-participant random intercept and was leveled so that Verb Type *singular* was the reference group.

Figure 6 shows that participants with lower dialect density scores were more likely to have fewer plural responses in the singular condition and more plural responses in the plural condition; conversely, participants with higher dialect densities were likely to have more plural responses after singular and plural conditions. There was a main effect of Age ($p < .001$), meaning that as Age increased, the number of Plural Responses in the Singular Verb Type condition decreased. There was also a main effect of Verb Type (p <.05), showing more plural responses in the Plural Verb Type condition than singular. In addition, there was an interaction between the Participants' Dialect Density and Verb Type (p <.001). This interaction demonstrates that as Dialect Density increases, there was less of an effect on the inflectional verb morphology. See Table 7 for a summary of parameter estimates.

Table 7. Summary of parameter estimates for the logistic mixed-effects model fit to Dialect Density on Plural Responses in the ambiguous distributional learning context for children seven and older.

Fixed Effects

	β	***SE***	***z***
Intercept	0.83	0.42	1.99*
Vocabulary	-0.02	0.32	-0.08
Age	-1.89	0.49	-3.83***
Verb Type: Plural	1.47	0.68	2.16*
Dialect Density	-0.10	0.26	-0.39
Age x Verb Type	0.58	0.67	0.87
Dialect Density x Verb Type	-1.14	0.40	-2.84**

Random Effects

Parameter	**Variance**	**SD**
Subject (Intercept)	0.10	0.32

p <.001***, p < .01 **, p < .05*

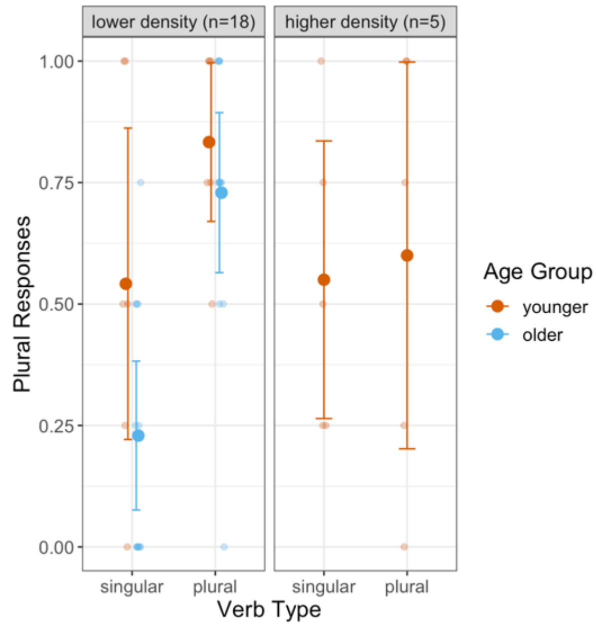

Figure 6. Influence of Dialect Density on Plural Responses in Singular and Plural Conditions in ambiguous context in African American kids seven and older. Group means are shown by the colored circle between the error bars. Error bars show +/- 1 standard error, and dots show individual data points.

Discussion

The purpose of this study was to examine how AAE- and MAE-speaking children used contrastive verb morphology (i.e., third-person singular -*s* and *was/were*) to infer the meaning of a novel verb. The first research question examined how AAE- and MAE-speaking children used verb morphology related to subject-verb agreement to infer verb meanings. In the distributional learning context featuring unambiguous subjects, all children, regardless of their age or dialect, used available linguistic cues (i.e., word order, subject, gender, inflectional verb morphology) to infer the number of participants required for the novel verb. This means that when children heard a singular subject with singular verb morphology, they selected a video with 1 participant. When they heard a plural subject with plural verb morphology, they selected a video with 2 participants. These results demonstrate that when children have access to linguistic cues unaffected by dialect differences, AAE- and MAE-speaking children will make similar inferences about the grammatical properties of novel verbs.

In the distributional learning contexts with ambiguous subjects, there was a main effect of age and significant interaction between age and verb type. Participants' age and not their dialect predicted how they used inflectional verb morphology to infer novel verb meanings. Older children were more likely to use inflectional verb morphology (i.e., third person singular *-s*, was/were) to infer if a novel verb was a 1- or 2-participant event. This demonstrates that children's linguistic knowledge about inflectional verb morphology and the information it communicates may be more important than dialect in how they use linguistic information to learn words than the dialect they speak.

The second research question examined how dialect density, or the number of AAE features a participant produced, predicted the performance of African American participants in distributional learning contexts with ambiguous subjects. Dialect density is a continuous rather than a categorical measure of dialect use and, as such, is often a more sensitive measure of listeners' linguistic experience. African American participants were used to address this question because they had a wider range of dialect density scores than their European American peers. Results demonstrated that age and dialect density predicted how African American participants used verb morphology to infer verb meanings. As age increased, participants were more likely to use verb morphology to infer the number of participants completing a novel verb. This result aligns with findings from the first research question, which showed that older children leverage their linguistic knowledge to use verb morphology to infer verb meanings. Furthermore, the more features of AAE a child produced, the less likely they were to use inflectional verb morphology to infer novel verb meanings. Thus, despite the negative findings for the overall study when listeners were simply categorized as AAE or MAE speakers, there is evidence that linguistic mismatch affects word learning, at least in some contexts with some children. The remainder of the chapter discusses hypotheses for the observed age and dialect density effects observed in the results and future implications.

Does participants' age impact word learning?

When the subject noun phrase was ambiguous in the distributional learning context, age predicted how children used verb morphology as a linguistic cue to infer verb meanings. Regardless of participants' dialect, older children were more likely to attend to third-person singular -*s* and *was*/*were* to infer the number of participants required for the novel verb. This result aligns with previous research that shows that as children get older, they perform better on word recognition and learning tasks that involve speakers with accents that differ from their own (Bent, 2014; Holt & Bent, 2017; Nathan & Wells, 2001; Nathan et al., 1998; Newman et al., 2018; Potter & Saffran, 2017; Ryall & Pisoni, 2007; Schmale et al. 2012, 2015). However, this result stands in contrast to research that demonstrates that younger children are reliably using whole syllable verb morphology, like *was* or *were,* to determine the plurality of subjects and objects (Kouider et al., 2006; Lukyanenko & Fisher, 2016; Wood et al., 2009), which would suggest that verb morphology should be a reliable cue to infer verb meanings.

There could be several reasons for why younger children were less sensitive to verb morphology as cues during the word learning task. First, although younger children may reliably use whole syllable verb morphology as comprehension cues, research has shown that children do not reliably use verb morphology with lower perceptual saliency, like third person singular -*s* (Bortolini et al., 2006; De Villers & Johnson, 2007; Johnson, 2005; Leonard et al., 1997;

Leonard, 2014). For instance, De Villers & Johnson (2007) and Johnson (2005) found that MAE-speaking children do not reliably use third-person singular -*s* as a comprehension cue until age 7, even though they consistently produced the feature. Based on that finding, it is possible that older children, but not younger children, could leverage their knowledge of third-person singular -*s* and so the younger children could only use *was/were,* but not third-person singular -*s* to infer verb meanings, which provided more learning opportunities for the older children.

Second, it is possible that it takes longer for verb morphology to be used to make inferences about new information. Studies have shown that as children mature, they are exposed to more distributional input from adults that allows them to develop probabilistic expectations that help them interpret sentences (Huang et al., 2013; Huang et al., 2023; MacWhinney et al., 1984). Thus, it is plausible that more linguistic experience with different distributional patterns benefits word learning. Older children have more experience with distributional input from adults and may have a better mental representation of what information verb morphology reflects, which increases their likelihood of using that information to make inferences. Younger children may still be mastering other skills from a distributional learning context, like word order to help identify agents (Chan, 2009), which could explain why most of their responses aligned with the two-person bias. In this case, age captures children's linguistic knowledge of verb morphology derived from the distributional input of the adults around them. This hypothesis suggests that the more linguistic experience children have, the better they will use linguistic cues to infer verb meanings.

Finally, it is possible younger children had difficulty revising their initial parse that *Carolyn May* sounded like two people. Several studies have shown that children have difficulty integrating late-arriving evidence to revise their initial parse of a sentence (Trueswell et al., 1999; Anderson et al., 2011; Choi & Trueswell, 2010; Hurewitz et al., 2000; Ovans et al., 2020; Weighall, 2008). Furthermore, research has found that statistical properties of children's input relate to how they revise ambiguous sentences. For instance, Ovans and colleagues (2020) found that when children encounter nouns in a sentence that are infrequently produced, they are more likely to fail to detect the point of disambiguation. This is because children have competing error signals from the noun and the late-arriving information, which makes the point of disambiguation a weak cue. In this case, it is possible that younger children received an error signal when they heard the noun *Carolyn May*, a proper noun they have less experience with, which made it difficult to detect and integrate late-arriving information from the verb morphology to infer verb meanings. Older children may have more exposure to the noun or could recall from the training video that *Carolyn May* could be one or two girls, which prompted them to integrate later arriving information.

The hypotheses for why younger children are less sensitive to verb morphology during the word learning task are not mutually exclusive and highlight that children's cognitive and linguistic development play an important role in what cues they use for word learning. Since most word learning studies that investigate syntactic bootstrapping focus on infants, further work is needed in school-aged children to understand how children with more developed language systems leverage linguistic cues during word learning.

Lastly, despite previous literature demonstrating the effects of participants' dialect group (AAE vs. MAE) on sentence processing and comprehension, that effect was not observed in the categorical analysis. It is possible that this lack of a significant effect was because this study was underpowered (there are only 26 speakers in this exploratory analysis). Future analyses with additional participants, particularly older children, may demonstrate a significant effect of dialect group on Plural Responses for the AAE speakers relative to the MAE speakers.

Does dialect density impact word learning?

For dialect density, the more dialect features produced, the less likely African American children were to use verb morphology to infer verb meanings aligned with MAE interpretations. Children who produced more dialect features seemed to rely on their knowledge of AAE to guide their inferences about verb meanings. This finding aligns with research that demonstrates that AAE speakers use the linguistic knowledge of their dialect to process and comprehend sentences (Byrd et al., 2023; Beyer & Hudson-Kam, 2012; De Villers & Johnson, 2007; Edwards et al., 2014), and provides preliminary evidence that linguistic mismatch can impact a learning process. However, because there was both a Dialect Density by Verb Type interaction and an Age by Verb Type interaction, these results raise the question of when linguistic mismatch impacts word learning.

An analysis of African American participants ages 7 and older revealed a significant interaction between dialect density and verb type. African American children older than 7 with higher dialect densities were less likely to use verb morphology to infer verb meanings. This finding provides preliminary evidence that linguistic mismatch may impact word learning in children who produce high levels of AAE features. Since research has shown that even MAE-speaking children do not reliably use non-perceptually salient verb morphology cues, such as third-person singular -*s* as comprehension cues until age 7 (De Villers & Johnson, 2007; Johnson, 2005); it is possible we see more of an effect of dialect in children older than age 7 because first, children need to master the grammatical constraints of their dialect before they can begin to use their linguistic knowledge about verb morphology to make inferences about word meanings. In this case, children who produced more AAE features may first have to learn that verb morphology is variably produced in AAE, which limits the informativeness of the cue before linguistic mismatch can impact how AAE-speaking children use verb morphology to infer word meanings.

The results also demonstrated a main effect of age, which highlighted that linguistic mismatch impacted how the younger children in this sample (7;0-9;5) with higher dialect densities learned words. As age increased, participants were more likely to use contrastive verb morphology for word learning. However, this effect may be driven by the fact that this sample did not have any children older than 9;5 with higher dialect densities. Therefore, more work is needed to determine if this main effect of age is capturing an aspect of children's development or if it is due to the limitations of this study. Overall, the results from this analysis should be interpreted with caution due to the small sample size and low number of participants with higher dialect density scores.

Conclusions and Future Implications

Despite robust findings demonstrating that dialect influences how AAE-speaking children process and comprehend MAE sentences, the findings from this study demonstrated relatively small effects of linguistic mismatch on word learning. The effects of linguistic mismatch on word learning were observed only in a relatively older sample of children with higher dialect densities. This may be because the study was underpowered or because the task was difficult for the younger children, which increased variability among this sample. However, it should be noted that the primary predictor of how children performed on the word learning task was their age, which highlights that factors other than children's dialect, such as linguistic knowledge and experience, may be more predictive of how children use verb morphology for word learning.

The findings from this study leave open questions about how linguistic mismatch impacts learning more generally and what implications these results have on the academic outcomes of AAE-speaking children. These questions are relevant when we think about the classroom environment. When children are embedded in environments that include nonlinguistic and linguistic cues, like the classroom, the impacts of linguistic mismatch may be even less present. Like sentence processing, word learning also relies on the integration of visual, social, and linguistic cues (Berman et al., 2013; Domanski, 2024; Erskine, 2023; King, 2019; Knowlton & Gomes, 2022; Nadig & Sedivy, 2002; Roy et al., 2015; Weatherhead et al., 2021; Yu & Ballard, 2007). While it is possible to run a study with greater power by including more participants or to design a task that is easier for younger children, it may be the case that learning tasks, as opposed to recognition tasks, inherently demand the integration of linguistic and extra-linguistic information and thus are less vulnerable to the effects of linguistic mismatch. More work is needed to test this to determine how AAE-speaking children perform in other learning contexts with linguistic and non-linguistic information.

Chapter 5: General Discussion

The primary objective of this dissertation was to increase our understanding of how linguistic mismatch impacts spoken language comprehension and learning in AAE-speaking children. Researchers have hypothesized that linguistic mismatch, the dialect differences between AAE and MAE, impact the academic performance of AAE-speaking children, due to the phonological and morphological differences between the dialect they speak at home and the language of academic instruction (Charity et al., 2004; Gatlin & Wanzek, 2015; Washington et al., 2018). While this relationship is plausible, there has been limited research examining *how* linguistic mismatch affects the underlying cognitive processes that support academic outcomes, which would help explain *why* there is a relationship between speaking AAE and academic outcomes. This dissertation addressed that gap by exploring how linguistic mismatch impacted spoken language comprehension and word learning. The focus of this research was on spoken language because it is the primary medium of instruction in the classroom, and accurately understanding what your teacher is saying is necessary to build other academic skills, such as reading and writing. Therefore, understanding the effects of linguistic mismatch on spoken language processes provides an avenue to hypothesize how linguistic mismatch relates to academic outcomes of interest, such as reading and writing.

Three studies were conducted in this dissertation to: 1) examine if linguistic mismatch impacted spoken language comprehension even when the contrastive feature is phonetically salient in an offline task (Chapter 2, [Byrd et al., 2023]), 2) examine how linguistic mismatch impacted spoken language comprehension in an online task (Chapter 3, [Byrd, 2024a]), and 3) examine if linguistic mismatch impacts word learning (Chapter 4, [Byrd, 2024b]). Furthermore, this dissertation examined how linguistic contexts that did or did not include redundant linguistic cues impacted processing and learning. In this dissertation, sentences with unambiguous subjects allowed children to use cues from the subject noun phrase and the auxiliary verb, which provided redundant cues to infer the subject number. In contrast, sentences with ambiguous subjects had only one cue that could determine the subject number, the auxiliary verb. Sentences with both unambiguous and ambiguous subjects mirrored naturalistic context where access to redundant cues can be obscured by noise or inattention. Lastly, the participants in this dissertation were primarily African Americans from middle to high-income households, which differs from other studies that have primarily included AAE speakers from lower-income households. This provided a unique opportunity to examine how African American AAE and MAE speakers from middle- to high-income households performed on spoken language tasks in MAE.

Does linguistic mismatch impact performance on spoken language tasks?

Previous studies provided evidence that linguistic mismatch impacted how AAE-speaking children comprehend MAE sentences (Beyer & Hudson-Kam, 2015; De Villers & Johnson, 2007); however, the results were confounded because the contrastive features were not phonetically salient, such as third-person singular -*s*. Therefore, it was difficult to disentangle whether the observed effects in spoken language comprehension were due to listeners' dialect or the phonetic saliency of the linguistic features selected. The results from the first study in Chapter 2 (Byrd et al., 2023) demonstrated that when AAE-speaking children have access to linguistic cues that are not impacted by linguistic differences (e.g., cues from the subject, shared verb morphology), they will comprehend MAE sentences similarly to their MAE-speaking peers. This finding was observed in sentences containing unambiguous subjects, where AAE- and MAE-speaking children performed similarly, based on whether the subject noun phrase was singular or plural. This finding supports results from Beyer and Hudson-Kam (2012) and Erskine

(2023), who demonstrated that linguistic mismatch is context-specific. When AAE-speaking children can access shared morphology or predictive semantic information, they are more accurate at comprehending MAE sentences.

The results in the ambiguous condition showed that even when contrastive verb morphology has high phonetic saliency, AAE speakers did not use verb morphology as a comprehension cue to determine whether the subject noun phrase is singular or plural. These findings were also replicated by Byrd (2024a), who demonstrated that AAE-speaking children were less accurate at comprehending MAE sentences, as evidenced by their offline (pointing) responses on an eye-tracking task. Furthermore, these findings were observed when dialect was measured as either a categorical (i.e., dialect groups) or continuous variable (i.e., dialect density). Collectively, these results support previous work that AAE-speaking children are less accurate at comprehending words and sentences with contrastive dialect features (Beyer & Hudson-Kam, 2012; De Villers & Johnson, 2007; Edwards et al., 2014), and establish that linguistic mismatch can impact spoken language comprehension regardless of the phonetic saliency of the linguistic feature. However, the findings from this study left remaining questions about *why* AAE-speaking children are less accurate in comprehending MAE sentences with contrastive verb morphology and *how* they used contrastive verb morphology to parse sentences.

Chapter 3 addressed those questions by examining how AAE- and MAE-speaking children used *was* and *were* to parse MAE sentences. The results from the sentence processing experiment demonstrated that when AAE-speaking children had access to linguistic cues that were not impacted by linguistic differences (i.e., gender, subject noun phrase), they parsed sentences similarly to their MAE-speaking peers. This finding was evident in the unambiguous sentences, where results showed that both AAE- and MAE-speaking had more looks to the correct target throughout the sentence. Furthermore, it was observed in ambiguous sentences that contained the auxiliary verb *were*, where results showed that both AAE- and MAE-speaking children had more looks to the target throughout the sentence. *Were* is only produced with plural subjects in AAE and MAE, which makes it a shared morphological feature between the dialects (Beyer et al., 2015; Green, 2002; Rickford, 1999). This explains why children of both dialect groups used *were* to parse sentences similarly. Again, this supports the notion that linguistic mismatch is more likely to impact spoken language comprehension and processing in contexts where shared linguistic structures are obscured (Beyer & Hudson-Kam, 2012) or contexts lacking social and semantic cues (Erskine, 2023).

While group differences were observed in ambiguous sentences, specifically in sentences that contained the auxiliary verb *was*, for the offline pointing responses in both Byrd et al. (2023) and Byrd (2024a), they were *not* observed during the verb phrase in the eye-tracking task. At first, participants in both dialect groups had more looks to the verb distractor (i.e., image of two girls); However, when the auxiliary verb *was* was presented, both groups decreased their looks to the verb distractor and increased their looks to the target. The results demonstrate that AAE- and MAE-speaking children were sensitive to *was* as a cue. These findings do not support hypotheses that AAE-speaking children are insensitive to contrastive verb morphology, as has been claimed based on results in offline sentence comprehension tasks (Beyer & Hudson-Kam, 2012; Byrd et al., 2023; De Villers & Johnson, 2007).

While the MAE- and AAE-speaking children had similar eye gaze patterns during the verb phrase, MAE speakers revised their initial interpretation and had more looks to the target after the sentence had ended. By contrast, looks to target for the AAE speakers never rose above chance. Thus, it seems that the MAE speakers were sensitive to the auxiliary verb *was* and could leverage this information to revise their initial interpretation of the sentences, while the AAE speakers could not. This is likely because *was* is only produced with singular subjects in MAE, which means the cue provides reliable information about subject number. However, *was* is produced with singular and plural subjects in AAE, so it does not provide reliable information about subject number. While AAE-speaking children were sensitive to *was* during the verb phrase, their gaze patterns indicated that *was* wasn't informative enough to revise their initial interpretations, leaving them at chance on how they parsed the sentences. The lack of revision in AAE-speaking children could be because AAE-speaking children weigh other cues more than verb morphology. While analyses of the subject window demonstrate that AAE-speaking children do not weigh the subject more than the auxiliary verb, they could weigh other linguistic cues (e.g., semantic, reflexive pronouns) or non-linguistic cues (e.g., social, racial) not tested in this study to support sentence processing. Additionally, it is possible that *was* only provides probabilistic information to AAE-speaking children, which requires them to wait for other cues to confirm their initial parse. These results support the claim that AAE-speaking children have learned that *was* is not a reliable or informative cue for subject number, so they should rely on other cues.

The results from the sentence processing study demonstrate that linguistic mismatch impacts a cognitive process that underlies academic performance and suggests that linguistic mismatch may reduce access to redundant and informative linguistic cues that could support sentence processing. Redundant linguistic cues facilitate comprehension and learning in young children (Gerken et al., 2005; Morgan et al., 1987; Tal & Arnon, 2022; Witt & Gillete, 1999); if linguistic mismatch does decrease access to informative redundant information, there could be cascading impacts on learning.

The third and final study in Chapter 4 examined the effect of linguistic mismatch on learning by examining how linguistic mismatch impacted how AAE-speaking children used inflectional verb morphology to infer novel verb meanings. The results from this study demonstrated that when AAE-speaking and MAE-speaking children listened to distributional learning context that contained an unambiguous subject, they used all available cues (i.e., gender, subject, inflectional verb morphology) to infer whether a novel verb was a 1- or 2-participant event. This result highlights that linguistic mismatch is unlikely to impact verb learning in a learning context where AAE speakers can access informative redundant linguistic cues. This result supports previous studies that have demonstrated that linguistic mismatch is context-specific (Beyer & Hudson-Kam, 2012; Byrd et al., 2023; Edwards et al., 2014; Erskine, 2023) and adds to the literature by demonstrating that there are linguistic contexts where dialect differences will not impact learning.

When participants listened to distributional learning contexts containing ambiguous subjects, their age and not their dialect predicted how they used inflectional verb morphology to infer novel verb meanings. Older children were more likely to use inflectional verb morphology (i.e., third person singular -s, was/were) to infer if a novel verb was a 1- or 2-participant event which aligns with previous literature that showed older children are more likely to leverage their linguistic knowledge and experiences to adapt to speaker variability presented in learning task via a spoken medium (Bent, 2014; Holt & Bent, 2017; Nathan & Wells, 2001; Nathan et al., 1998; Newman et al., 2018; Potter & Saffran, 2017; Ryall & Pisoni, 2007; Schmale et al. 2012, 2015).

It should be noted that there are several ways in which these results are not consistent with previous research. First, several studies have shown that dialect has robust effects on sentence processing and comprehension tasks regardless of the participant's age, implying dialect should impact how children leverage linguistic cues for word learning (Beyer & Hudson-Kam, 2015; Beyer et al., 2015; Byrd, 2024a; Byrd et al., 2023; Beyer & Hudson-Kam, 2015; De Villers & Johnson, 2007; Edwards et al., 2014; Erskine, 2023; Terry et al., 2010; Terry et al., 2022). However, the lack of a significant effect of dialect in the categorical analysis may be because the study was under-powered.

Second, research has also shown that children as young as five are reliably using inflectional verb morphology to process and comprehend sentences (Kouider et al., 2006; Lukyanenko & Fisher, 2016; Wood et al., 2009), which would suggest that younger children should use inflectional verb morphology for word learning. A potential explanation for younger children's performance is they have not had enough experience with verb morphology to reliably use it as a cue to infer novel verb meaning, which aligns with findings that although young children may produce inflectional verb morphology, they are not reliably using it for comprehension cues (De Villers & Johnson, 2007; Johnson, 2005), at least for verb morphology that is not phonetically salient. Alternatively, younger children may have had difficulty using inflectional verb morphology to revise their initial interpretations of the sentence to successfully infer novel verb meanings (Trueswell et al., 1999; Anderson et al., 2011; Choi & Trueswell, 2010; Hurewitz et al., 2000; Ovans et al., 2020; Weighall, 2008).

Since results demonstrated that younger students had greater difficulty completing the word learning task, exploratory analyses evaluated the effects of dialect in older children. Results demonstrated that African American children ages 7 and older with high dialect density scores were less likely to use inflectional verb morphology to infer the number of participants completing a novel verb, evidenced by having more plural responses in singular and plural contexts. This finding provides preliminary evidence that linguistic mismatch impacts word learning, mainly in children who produce many features of AAE and older children with greater linguistic knowledge and experience. This result aligns with previous literature demonstrating that AAE-speaking children use their knowledge of AAE to process and comprehend sentences (Byrd et al., 2023; Beyer & Hudson-Kam, 2012; De Villers & Johnson, 2007). Additionally, this finding suggests that AAE-speaking children must first master the grammatical constraints of how verb morphology is produced in their dialect before they can begin to use their linguistic knowledge about verb morphology to make inferences about word meanings. For example, AAE-speaking children may first have to learn that verb morphology is variably produced in AAE before linguistic mismatch can impact how AAE-speaking children use verb morphology to infer word meanings. Since the sample size for this analysis was small and there were no children older than 9;5 who had higher dialect densities, more work is needed to confirm the effects of dialect density on word learning.

Classroom Implications

Overall, the findings from this dissertation have provided preliminary evidence that linguistic mismatch impacts both spoken language comprehension and word learning in African American children with high dialect density scores. The results from this dissertation and others (Caesar & Kerins, 2020; Hendricks & Adolf, 2020; Terry et al., 2016; Washington et al., 2018; Williams et al., 2020) continue to highlight that African American students who have a high dialect density score are the group most likely to experience academic consequences because of linguistic mismatch. It is likely that students who frequently produce more features of AAE are using their knowledge of AAE to guide how they process and learn in MAE. This finding has implications not only for how AAE-speaking children perform on oral language tasks, like offline comprehension, but for written language tasks as well.

The development of written language skills, such as reading and writing, are inextricably linked to children's oral language skills (Brice, 2004; Graham et al., 2020; Gregg & Hafer, 2001; Kroll, 1981; Puranik & Lonigan, 2011, 2012; Stoeckel et al., 2013; Treiman & Bourassa, 2000). Research has shown that bilingual children can experience a cross-language phonological orthographic transfer where the phonological knowledge and features they produce in their first language influence how they decode words in their second language (Chung et al., 2019; Comeau et al., 1999; D'Angiulli et al., 2001, Sun-Alperin & Wang, 2011; Sun et al., 2022; Wang et al., 2006). Given the results in this dissertation, it is plausible that AAE-speaking children use their knowledge of AAE phonology and morphology to process written language as well. For studies that have found a relationship between speaking AAE and poorer literacy outcomes (e.g., Charity et al., 2004; Gatlin & Wanzek, 2015; Washington et al., 2018), the findings from this dissertation could provide an explanation for *why* African American children with high dialect density scores experience a linguistic mismatch when decoding words while reading. However, more research is needed to determine if a cross-dialect phonological orthographic transfer is explains the correlation between AAE and literacy.

Using knowledge of AAE to guide sentence processing and comprehension in oral and written language is a sign of appropriate language development for AAE-speaking children. However, in classrooms that require students to comprehend MAE sentences accurately, using the knowledge of a non-mainstream dialect leaves AAE-speaking children at a disadvantage. This has led to an urgent need to develop strategies that create linguistic equity in the classroom. Previous research has suggested that African American students who have higher dialect densities can benefit from explicit instruction on knowledge and production of MAE features, a process known broadly as dialect shifting (Gatlin et al., 2020; Johnson et al., 2017; Craig, 2018; Byrd & Brown, 2021; Edwards & Rosin, 2016; Washington et al., 2018). These benefits include improving metalinguistic awareness, dialect awareness, standardized test scores, and teachers' attitudes surrounding AAE use (Byrd & Brown, 2021; Conner, 2008; Craig & Washington, 2006; Edwards & Rosin, 2016; Wheeler, 2008). However, despite the benefits, teaching children to dialect shift has been criticized for its reinforcement of appropriateness frameworks that restrict the use of AAE to certain times and places (Gilyard, 2011; Young, 2009; Young et al., 2014). Furthermore, there is preliminary evidence that dialect-shifting curriculums may have limited impacts on improving academic outcomes (Maher et al., under review). With controversy surrounding this approach, the findings from this dissertation can offer an avenue for another approach.

The findings from this dissertation and others (Beyer & Hudson-Kam, 2012; Erskine, 2023) have demonstrated that linguistic mismatch is context-specific, meaning it primarily occurs in linguistic contexts where children must rely on contrastive phonological or morphological features to understand sentences and words. However, when children can access redundant and informative linguistic cues, they are unlikely to experience a linguistic mismatch. Thus, it is plausible that increasing teachers' awareness about AAE and encouraging them to use redundant linguistic and non-linguistic cues could increase AAE-speaking children's access to the information from their teacher. Furthermore, increasing teachers' knowledge of AAE (Godley & Reaser, 2018) and providing them with tools to incorporate culturally and linguistically relevant teaching pedagogies has been demonstrated to positively impact the writing outcomes of high school and college students who frequently produce features of AAE

(Hankerson, 2022; Alim, 2010; Alim & Smitherman, 2012; Siegel, 2006). Therefore, it is possible that general strategies that teachers are already implementing (i.e., using visual supports during lessons) and incorporating culturally relevant pedagogies could support the learning outcomes of AAE-speaking children by leveraging their current linguistic and cultural knowledge. However, future work would need to develop protocols to implement cultural and linguistic protocols for younger children and test their initial implications on academic outcomes.

Future Directions

As we work to better understand the impacts of linguistic mismatch on spoken language processing and learning, it is important to determine its long- and short-term effects on sentence processing and word learning. The findings from this study have outlined potential short-term effects, including difficulty using contrastive verb morphology to revise initial parses of MAE sentences and decreased accuracy in inferring the meaning of novel verbs in MAE sentences. Still, the long-term implications remain unclear. One possibility based on the findings of this research is that decreased accuracy in word learning could impact how AAE-speaking children learn and build their vocabulary over time. Future research needs to investigate if any long-term impacts are specifically related to listening and learning in a different dialect or if children learn to adjust to speaker variation over time.

Furthermore, more research is needed on how AAE-speaking children integrate linguistic and non-linguistic cues when processing sentences and learning. Within a naturalistic context where children have more access to redundant linguistic and non-linguistic cues, AAE-speaking children can integrate other cues to support processing and learning. Furthermore, word learning and learning are not only dependent on linguistic processes (Berman et al., 2013; Domanski, 2024; Erskine, 2023; King, 2019; Knowlton & Gomes, 2022; Nadig & Sedivy, 2002; Roy et al., 2015; Tripp et al., 2021; Weatherhead et al., 2021; Yu & Ballard, 2007), so the effects of linguistic mismatch may be decreased in the presence of other types of cues. Future studies should explore how children process and learn when listening to MAE sentences with different levels of linguistic and non-linguistic cues that are not impacted by linguistic mismatch.

Additionally, work is needed to understand why children with high dialect density are more likely to experience academic consequences due to linguistic mismatch. Is it because this group of children is not proficient at dialect shifting? By the middle of elementary school, most AAE-speaking children have been exposed to 3 or more years of instruction in MAE, and many of these children will dialect shift during formal tasks, such as taking a standardized test (Craig et al., 2009; Craig & Washington, 2004; Craig & Washington, 2006). Is it due to teacher attitudes and education regarding the use of AAE? There has been research to demonstrate that teachers' (Blake & Cutler, 2003; Diem & Hendricks, 2021; Newkirk-Turner et al., 2013) and students' (Clayton, 2015, 2018; Glen, 2010; Hakim, 2023; Hill, 2019) attitudes regarding AAE can impact AAE-speaking student's learning experiences. Or is it due to a lack of opportunities to leverage AAE-speaking children's linguistic and cultural knowledge for learning in academic spaces? To support positive academic outcomes in children with a higher dialect density, these questions must be addressed to understand what linguistic and social factors are shaping the educational experiences of AAE-speaking children.

Additional work is also needed to understand the long-term processing costs of listening and learning in a dialect that differs from your own. Thus far, studies have discussed how the processing and sociopsychological costs of dialect shifting between two different dialects (i.e., AAE and MAE) can increase cognitive load, which can lead to fewer resources for learning (Baker-Bell, 2020; Boulton, 2016; Durkee & Williams, 2015; Johnson et al. 2022; Kroll &

Townsend, 2022). Less is known about the short- or long-term processing costs of listening and learning in a dialect that differs from your own increase or decrease cognitive load. To date, only Terry and colleagues (2010, 2022) have shown that processing MAE sentences with contrastive dialect features leads to an increased working memory load. However, it remains unknown if this is a temporary processing cost that is eventually resolved or if it has cascading effects that could also impact learning processes, which means the impact of cognitive load may be underestimated. To fully understand the relationship between linguistic mismatch and cognitive processes, researchers should continue to explore how cognitive load impacts spoken language processing and learning.

Lastly, researchers should examine if the linguistic mismatch hypothesis best explains how dialect use is related to academic outcomes. Although the findings from this study demonstrated that linguistic mismatch impacts a learning process, the effects were marginal compared to results that show robust effects of dialect on how AAE-speaking children process and comprehend MAE sentences. Therefore, it is possible that learning in MAE is not just about the presence of contrastive linguistic features but potentially about sociolinguistic cues that children might leverage for comprehension and learning. Since dialect use correlates with social identity, it is possible that learning in MAE is more about whether AAE speakers feel as though MAE speakers are trustworthy sources of information. Erskine (2023) hypothesized that a speaker's identity, as determined by race and dialect, was a cue children used to build epistemic trust. Epistemic trust is built when listeners identify relevant social cues, like a familiar dialect, to determine the reliability of the information they heard from a speaker (Koenig & Harris, 2007). Research has shown that epistemic trust is a malleable factor that can impact how students learn (Durkin & Shafto, 2015), which means that if AAE-speaking children do not deem teachers who speak MAE as trustworthy and reliable sources of information, it could impact how likely they are to attend and learn from this speaker. While there is limited work to support this theory, it provides another viable avenue to explore how the multi-dimensional information communicated via a speaker's dialect informs how listeners process and learn.

Appendices

Appendix A.

Table A1. Amazon Mechanical Turk results for name norming. Table shows the percent of people who perceived the name as 1, 2, 3, or 4 people.

Subject name	Predicate	% perceived as 1 person	% perceived as 2 people	% perceived as 3 people	% perceived as 4 people	total n of listeners
Alexander	baked cookies	1.00	0.00	0.00	0.00	27
Alexander	listened to music	1.00	0.00	0.00	0.00	18
Alexander	made a pie	1.00	0.00	0.00	0.00	18
Alexander	sang a song	1.00	0.00	0.00	0.00	9
Carolyn May	baked cookies	0.67	0.33	0.00	0.00	27
Carolyn May	listened to music	0.22	0.78	0.00	0.00	9
Carolyn May	made a pie	0.50	0.50	0.00	0.00	18
Carolyn May	sang a song	0.56	0.44	0.00	0.00	18
Carter and James	baked cookies	0.00	1.00	0.00	0.00	27
Carter and James	listened to music	0.06	0.94	0.00	0.00	18
Carter and James	made a pie	0.11	0.89	0.00	0.00	18
Carter and James	sang a song	0.11	0.89	0.00	0.00	9
Carter, Jackson, and Allie	listened to music	0.00	0.11	0.89	0.00	9
Carter, Jackson, and Allie	sang a song	0.06	0.33	0.61	0.00	18
Ellen Grace	baked cookies	0.44	0.56	0.00	0.00	18
Ellen Grace	listened to music	0.33	0.67	0.00	0.00	9
Ellen Grace	made a pie	0.67	0.33	0.00	0.00	18

Ellen Grace	sang a song	0.67	0.33	0.00	0.00	27
Janice, Don, Carol, and John	baked cookies	0.00	0.00	0.00	1.00	9
Janice, Don, Carol, and John	listened to music	0.06	0.11	0.06	0.78	18
Janice, Don, Carol, and John	made a pie	0.00	0.00	0.00	1.00	18
Janice, Don, Carol, and John	sang a song	0.04	0.04	0.00	0.93	27
Jerimiah	baked cookies	1.00	0.00	0.00	0.00	27
Jerimiah	listened to music	1.00	0.00	0.00	0.00	9
Jerimiah	sang a song	1.00	0.00	0.00	0.00	18
Joanne Grace	baked cookies	0.50	0.50	0.00	0.00	18
Joanne Grace	listened to music	0.33	0.67	0.00	0.00	9
Joanne Grace	sang a song	0.59	0.41	0.00	0.00	27
Joanne Lee	baked cookies	0.83	0.17	0.00	0.00	18
Joanne Lee	listened to music	0.56	0.44	0.00	0.00	9
Joanne Lee	made a pie	0.71	0.29	0.00	0.00	17
Joanne Lee	sang a song	0.70	0.30	0.00	0.00	27
Joe, Susan, Andy, and Molly	baked cookies	0.00	0.00	0.00	1.00	9
Joe, Susan, Andy, and Molly	listened to music	0.06	0.00	0.00	0.94	18
Joe, Susan, Andy, and Molly	sang a song	0.00	0.00	0.00	1.00	17
Julianne Rose	baked cookies	0.50	0.50	0.00	0.00	18
Julianne Rose	listened to music	0.48	0.52	0.00	0.00	27
Julianne Rose	made a pie	0.44	0.56	0.00	0.00	18

Julianne Rose	sang a song	0.22	0.78	0.00	0.00	9
Kerriane Lee	baked cookies	0.22	0.78	0.00	0.00	18
Kerriane Lee	listened to music	0.17	0.83	0.00	0.00	18
Kerriane Lee	made a pie	0.22	0.78	0.00	0.00	9
Kerriane Lee	sang a song	0.22	0.78	0.00	0.00	27
Lianne Grace	baked cookies	0.44	0.56	0.00	0.00	18
Lianne Grace	listened to music	0.50	0.50	0.00	0.00	8
Lianne Grace	made a pie	0.41	0.59	0.00	0.00	27
Lianne Grace	sang a song	0.39	0.61	0.00	0.00	18
Lillian Grace	baked cookies	0.11	0.89	0.00	0.00	18
Lillian Grace	listened to music	0.00	1.00	0.00	0.00	9
Lillian Grace	sang a song	0.33	0.67	0.00	0.00	18
Marian Page	baked cookies	0.15	0.85	0.00	0.00	27
Marian Page	listened to music	0.11	0.89	0.00	0.00	9
Marian Page	made a pie	0.33	0.67	0.00	0.00	18
Marian Page	sang a song	0.22	0.78	0.00	0.00	18
Marian Rose	baked cookies	0.28	0.72	0.00	0.00	18
Marian Rose	listened to music	0.06	0.94	0.00	0.00	18
Marilyn Grace	baked cookies	0.56	0.44	0.00	0.00	18
Marilyn Grace	listened to music	0.56	0.44	0.00	0.00	18
Marilyn Grace	made a pie	0.22	0.78	0.00	0.00	9
Marilyn Grace	sang a song	0.56	0.44	0.00	0.00	27
Noah, James, and May	baked cookies	0.00	0.00	1.00	0.00	9
Noah, James, and May	listened to music	0.00	0.06	0.94	0.00	18
Noah, James, and May	made a pie	0.17	0.11	0.72	0.00	18
Noah, James, and May	sang a song	0.04	0.22	0.74	0.00	27

Rachel and May	baked cookies	0.00	1.00	0.00	0.00	18
Rachel and May	listened to music	0.00	1.00	0.00	0.00	18
Rachel and May	made a pie	0.11	0.89	0.00	0.00	9
Rachel and May	sang a song	0.11	0.89	0.00	0.00	27

Appendix B.

Table B1. Age of acquisition (in year) for verb and direct object of stimuli sentences for Chapters 2 and 3.

Sentences (verb phrases)	Age of acquisition for verb	Age of acquisition for direct object
...eating a pizza	2.78	4.67
...baking a cake	3.45	3.26
...walking a dog	3.45	2.8
...washing a car	4	3.37
...reading a book	4.11	3.68
...kicking a ball	4.47	2.9
...riding a horse	4.67	4.15
...pulling a wagon	4.79	5.22
...folding a blanket	4.95	3.61
...climbing a tree	5.3	3.57
...touching the frog	5.16	4.32
...holding the basket	4.67	5.67

...building the sandcastle	4.45	6.42
...painting the wall	4.45	3.79
...jumping the fence	2.84	6.28
...moving the box	4.62	4.3
...drinking the milkshake	3.47	4.4
...hugging the teddy bear	3.47	4.21
...picking the apples	5.4	4.15
...planting the flowers	3.87	3.11
...throwing the baseball	4.14	4.83
...hanging the clothes	6.68	3.11
...blowing the bubbles	4	3.79
...sweeping the floor	4.2	4.44
...fixing the bike	5	4.79
...pushing the cart	4.26	6.16
...brushing the cat	3.78	3.68

...feeding the rabbit	4.17	3.94
...watching a movie	4.33	3.56
...cleaning a table	3.89	4.39

Sentences (verb phrases)	**Age of acquisition for verb**	**Age of acquisition for direct object**
...eating a pizza	2.78	4.67
...baking a cake	3.45	3.26
...walking a dog	3.45	2.8
...washing a car	4	3.37
...reading a book	4.11	3.68
...kicking a ball	4.47	2.9
...riding a horse	4.67	4.15
...pulling a wagon	4.79	5.22
...folding a blanket	4.95	3.61
...climbing a tree	5.3	3.57

...touching the frog	5.16	4.32
...holding the basket	4.67	5.67
...building the sandcastle	4.45	6.42
...painting the wall	4.45	3.79
...jumping the fence	2.84	6.28
...moving the box	4.62	4.3
...drinking the milkshake	3.47	4.4
...hugging the teddy bear	3.47	4.21
...picking the apples	5.4	4.15
...planting the flowers	3.87	3.11
...throwing the baseball	4.14	4.83
...hanging the clothes	6.68	3.11
...blowing the bubbles	4	3.79
...sweeping the floor	4.2	4.44
...fixing the bike	5	4.79

...pushing the cart	4.26	6.16
...brushing the cat	3.78	3.68
...feeding the rabbit	4.17	3.94
...watching a movie	4.33	3.56
...cleaning a table	3.89	4.39

Appendix C.

Development and Norming of Word Learning Task

The world learning task was designed based on previous studies that used distributional learning to evaluate how toddlers learn verbs (Arunchalm et al., 2016; Arunchalm & Dennis, 2018). The goal of the word learning task was to evaluate how children who speak various dialects of American English use inflectional verb morphology to learn syntactic information about a novel verb; therefore, significant modifications were made to investigate the current research question. The task consisted of a familiarization and test phase with visual and auditory stimuli embedded in a PowerPoint presentation. Video and task norming procedures are described below.

Video Norming. Before these videos were included in the task, they were normed on Prolific, a web-based platform, with adults to determine if the video showed a one- or two- two-agent action. During norming, 18 adults ages 18-50 were asked to rate 35 videos, 18 one-agent and 17 two-agent videos. Participants were asked, "How likely is it that the action depicted above requires two people?" and instructed to use a Likert scale from "unlikely" to "likely" to rate their answer. Before participants began rating videos, they were given an example video with familiar actions like hugging and running. Participants were instructed to rate hugging as "likely" to be an action that requires two people and running to be rated as "unlikely" to require two people. All videos had two people in the video frame to ensure the rating was based on the perception of the action and not the number of people in the frame. Based on the norming, three two-person videos were excluded due to their low likelihood of being perceived as a two-person action, and 2 one-person videos were excluded due to their low likelihood of being perceived as a one-person action. The same videos that were normed were used in the experimental task. See Figure C1 for an example of the norming task and Figure C2 for norming results.

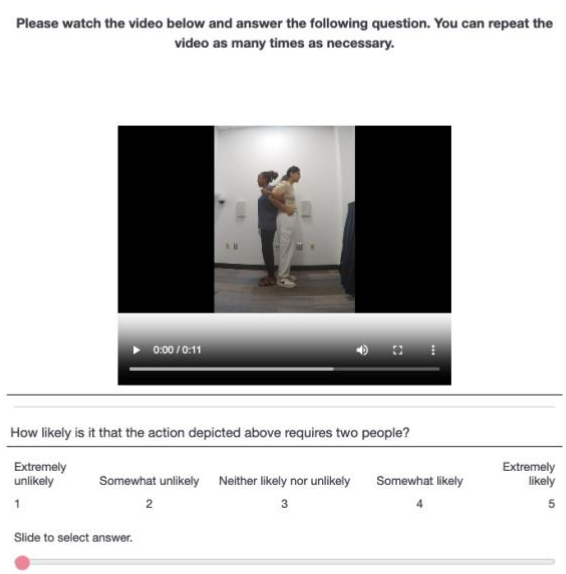

Figure C1. Example of the video norming procedure presented to adult participants on Prolific.

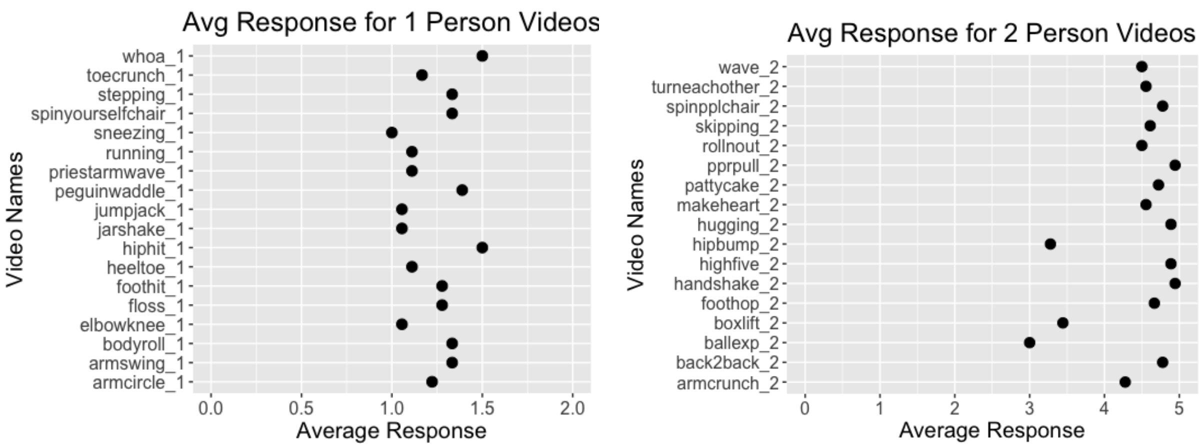

Figure C2. Norming results of the verb action videos. Video names were used internally to describe videos but were never presented to participants.

Norming word learning task design.

Since linguistic variation and word learning have not been explored, two word learning task were designed and piloted. Both designs included a familiarization phase where participants saw two people having a conversation where the subject and novel verb were repeated four times. There were four instances of inflectional morphology to provide information about how my agents may be needed to act out the verb (two instances of auxiliary verb *was/were* and two of zero or overt marking of third person singular -s). In the test phase, participants were presented with two action videos. Action videos were fixed throughout the task, with one-agent videos always appearing on the left and two-agent videos appearing on the right. Both designs also contained a video that introduced participants to the characters and two practice trials with known verbs (i.e., running and handshaking) to familiarize them with the structure of the task, which was to listen to a conversation and then select the video that best depicted the verb they heard.

The main difference between each design was the number of people in the video frame for the action videos in the test phase. In Design 1 had two people in the frame for the one-agent and two-agent actions. Design 2, one person was depicted in the one-agent action and two people in the two-agent action. Designs 1 and 2 were piloted with 30 adults each, 60 total, on Prolific, a web-based platform. All adults provided consent before beginning the task and were between the ages of 18 and 50.

Results showed that adult participants were more likely to use the inflectional morphology to determine how many agents were necessary to complete the action of the novel verb when there was one person in the video frame for the one-agent action and two people in the video frame for the two-agent action. Design 1 was likely more successful because it reduced task demands; therefore, design 1 was used as the structure for the word learning task. See Figure D3 for the norming results with adults.

Design 2 was also piloted with children ages 5;0-10;0. Results demonstrated that children benefited from additional practice with novel verbs before beginning the task. Therefore, four additional practice items were added: 2 unambiguous trials with novel verbs (e.g., "Jeremiah/Carter and Joe meep") and 2 ambiguous trials with novel verbs (e.g., "Carolyn May meep”). In addition, children benefited from having the action videos played on a loop to provide more time to observe the actions. Pilot results demonstrated that these modifications increased children’s accuracy in the trials that contained unambiguous subjects (e.g., Jeremiah, Carter and Joe).

C3a C3b

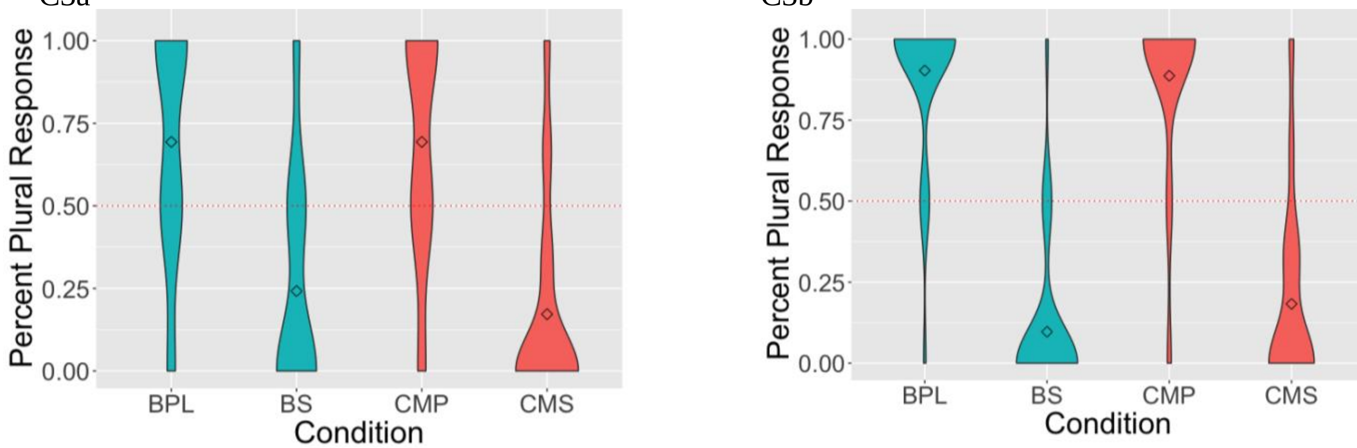

Figure C3. Piloting results of the different task designs. Figure C3a demonstrates piloting results from Design 1, where participants saw two people in each action video. Figure C3b demonstrates piloting results from Design 2 where participants saw two people in each action video.

Appendix D.

Examples of dialogues used in distributional learning contexts in the word learning task. Dialogue formats were counterbalanced so that names and verb morphology were equally presented with each dialogue structure.

1. Dialogue with unambiguous name and singular verb morphology

Speaker 1: Look, Jeremiah moops!
Speaker 2: Oh Yeah! I saw Jeremiah was mooping!
Speaker 1: Oh, you saw that Jeremiah moops?
Speaker 2: Yeah! I saw Jeremiah was mooping over there!

2. Dialogue with unambiguous name and plural verb morphology

Speaker 1: Did you know Carter and Joe were mooping?
Speaker 2: Oh Yeah! I knew Carter and Joe moop.
Speaker 1: Really? You knew Carter and Joe were mooping?
Speaker 2: Of course! Carter and Joe always moop!

3. Dialogue with ambiguous name and singular verb morphology

Speaker 1: Did you know Carolyn May was mooping?
Speaker 2: Oh Yeah! I knew Carolyn May moops.
Speaker 1: Really? You knew Carolyn May was mooping?
Speaker 2: Of course! Carolyn May always moops!

4. Dialogue with ambiguous name and plural verb morphology

Speaker 1: Look, Carol n' May moop!
Speaker 2: Oh Yeah! I saw Carol n' May were mooping!
Speaker 1: Oh, you saw that Carol n' May moop?
Speaker 2: Yeah! I saw Carol n' May were mooping over there!

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