11-25-2013

Dense Recordings Reveal Typical and Atypical Development of Tense Productivity in a Child Previously Diagnosed with ASD

Iris Chin
University of Connecticut, iris.chin@uconn.edu

Dense Recordings Reveal Typical and Atypical Development of Tense Productivity in a Child Previously Diagnosed with ASD

Iris Chin

B.A., Loyola University of Chicago, 2009

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

At the

University of Connecticut

2013

APPROVAL PAGE

Masters of Arts Thesis

Dense Recordings Reveal Typical and Atypical Development of Tense Productivity in a Child Previously Diagnosed with ASD

Presented by

Iris Chin, B.A.

Major Advisor_____
Letitia Naigles

Associate Advisor_____
Marie Coppola

Associate Advisor_____
Matthew Goodwin

University of Connecticut

2013

Abstract

Research on tense development has found that typically developing (TD) children are productive with tense morphology starting between two to two-and-a-half years old. Research findings on children with autism spectrum disorder (ASD), however, have been mixed. To better understand how tense development may differ between TD children and children with ASD, we examined the speech of two children, one TD [Cleo] and one that previously presented symptoms of ASD [Audrey]. This study is novel in its use of the Speechome Recorder, which collects dense audio-video recordings of children's speech in home environments. We found that both children were productive with present and past tense markers. Audrey, however, produced a future form, "I'm a verb," at a much higher frequency compared to Cleo. Further analyses of Audrey's production found that this frame may be a variant of "going to verb," but reasons for its use while having access to a more canonical form are still unclear. Second, as Adolph et al. (2008) have demonstrated that developmental trajectories of motor skills can be misrepresented with large sampling intervals, a second set of analyses were conducted investigating whether similar sampling effects could be found in language development. Misrepresentations of developmental trajectories began to emerge when the sampling interval increased from daily to weekly sampling. Taken together we were able to demonstrate that a) children with past symptoms of ASD can be comparable to TD children in their tense productivity, and b) dense sampling is needed in order to accurately capture developmental change.

Acknowledgement

I would like to first thank our two families that participated in this study and who agreed to have the Speechome Recorder installed in their homes. I would also like to thank the members of the Child Language Lab, in particular Devin Rubin, Andrea Tovar, Emily Potrzeba, and Michelle Cheng who played an immeasurable role in collecting and transcribing the data. Special thanks also goes to Soroush Vosoughi, who gave wonderful insight into how to analyze our data. Further thanks go to my committee members Matthew Goodwin and Marie Coppola, who provided invaluable feedback and also a different point of view to my research. I would also like to thank William Snyder and members of Gradlab, from which I received valuable comments. Finally, I would like to thank my advisor Letitia Naigles immensely for her patience and guidance throughout this whole process. This research was funded by NIHDCD R01 2DC007428 and ARRA Supplement 3R01DC007428-0451.

Introduction

References to time are pervasive in discourse. While producing an utterance, we are not limited to conversing about only the present, but can refer to events that occurred in the past and that will occur in the future. When representing time in a linear fashion, we can reference both its location on a timeline as well as by its duration or completeness. How then exactly is time *expressed*? There generally appears to be three ways in which time is conveyed. The first is what Comrie (1985) refers to as lexically composite expressions, which involve the use of precise time expressions to further specify the temporal location or duration of an event (e.g., "8:30am," "nanoseconds," "quarter to 9:00am"). The second involves the use of lexical items that semantically encode for the location of time such as adverbials "after," "now," and "tomorrow." The third is tense, the "grammaticalized expression of location in time" (Comrie, 1985, p. 9); it is commonly expressed with morphological markers. The focus of this thesis is on children's development of tense marker use. More specifically, we investigate whether there are differences in the productive use of tense markers in typically and atypically developing children using a novel, dense data sampling method that has not been previously utilized to explore this topic.

The Task of the Child

When comparing typological differences in how tense is marked, it becomes clear that the task of acquiring and learning how to use tense markers is not an easy one. While some languages lack tense marking (e.g., Chinese), others specify time into past, present, and future categories. How each language marks for these temporal categories (e.g., on the auxiliary, on the main verb, etc.) may differ. For example, in English, the suffix "-ed" is attached to a regular verb to mark past tense. In French, however, markings on both the auxiliary (e.g., "avoir" or "être") and the verb are required for past tense. The task of the child acquiring any language is therefore

to discover a) how time is expressed specifically in their native language and b) if it is a language that utilizes tense, which morphemes express which tenses.

A child acquiring English, in particular, must first learn that English is a tense language and that temporal locations of events are divided into broad categories of past and present. There is some debate as to whether the future is expressed with a grammatical form as opposed to a lexical form (Comrie, 1985; Salkie, 2010). This is due to the fact that the morpheme commonly associated with the future, "will," has additional modal uses. However, other forms similarly have multiple uses (e.g., "-ed" morpheme marking for both past tense and past participle), yet are still considered tense markers. Therefore, we believe that not having a unique one-to-one mapping between the future morpheme "will" and future meaning should not be used as an exclusion criteria for future tense in English. As such, we treat future as a tense category of English in this thesis, with "will" as its canonical marker.

The second task of a child acquiring English is to understand the correct morpheme to tense mappings. In English, references to present events can be expressed through the "-s" marker when the subject is third person singular (e.g., "She likes to sing"). The past can be expressed through the affix "-ed" (regular verb) or may involve a vowel change (e.g., "eat" and "ate"), suppletion (e.g., "go" and "went"), or null marking (e.g., "put" and "put") for irregular verbs. Future events can be expressed through the aforementioned modal "will verb" (e.g., "I will graduate in three years") and also commonly through the use of the "going to verb" frame (e.g., "I'm going to eat a large sandwich").

This is not to say, however, that these mappings are transparent in English. Listed below are examples that demonstrate the complicated relationship between tenses and their respective

markers. Thus, if a child were to simply assume that tense is carried always and only by an affix on the verb, s/he will acquire English tense incorrectly.

1a) Present Indicative/Simple Present: "Mary orders a lot of food."

1b) Present Progressive: "Mary is ordering a lot of food."

1c) Past Indicative/Simple Past: "Mary ordered a lot of food."

1d) Past Progressive: "Mary was ordering a lot of food."

1e) Future Indicative: "Mary will order a lot of food."

1f) Future Progressive: "Mary is going to order a lot of food."

For the simple past and simple present (1c and 1a, respectively), tense is marked by an affix on the main verb. For present progressive and past progressive (1b and 1d, respectively), however, tense is marked not on the main verb but on the auxiliary. The "-ing" marker is not marking for tense, but rather is referring to the duration or ongoing nature of the event. The concept of the completeness or ongoing characteristic of an event is what is referred to as "*aspect*." In fact, we find, as presented in the examples above, that in English, tense is conflated with aspect (Wagner, 2012). For example, in 1c, the "-ed" morpheme is used to indicate not only that the event has taken place in the past, but also indicates that the event has been completed. To disentangle tense and aspect for the "-ed" marker, we can examine the following utterance: "Mary has ordered a lot of food." Here, the "-ed" marker on "order" is used to indicate that the act of ordering is complete. The location of the event in time, on the other hand, is indicated by the present tense marking on the auxiliary "have."

Therefore, a child's task of learning a tense language is not a simple one. For those acquiring English, the child needs to first parse the speech stream so as to distinguish morphemes used to mark tense. S/he then needs to learn mappings between morphological markers and their

respective temporal concepts, despite a) markers can be conflated with aspect; b) marking for tense can be either on the auxiliary or main verb; and c) more than one marker can be used to indicate the same tense (e.g., marking past tense on regular compared to irregular verbs). Yet, typically developing (TD) children appear to acquire tense early in language acquisition. By the age of two and a half, children begin to comprehend and produce tense markers (Brown, 1973; Cazden, 1968; de Villers & de Villers, 1973; Honhenstein & Akhtar, 2007; Wagner, Swensen, & Naigles, 2009).

In addition to age of acquisition, however, there are further questions that can be explored regarding children's development of tense, such as the order in which tense markers are acquired (Brown, 1973; Cazden, 1968) or how the acquisition of tense and aspect relate to each other (Wagner, 2001). The focus of the current thesis is on the *productive* use of tense markers. Productivity is important in that it provides the ability to generate novel forms, rather than being limited to repeating the same forms heard in the input. Investigating how children come to be productive, through the types of rules and forms they entertain across development, can inform us about the nature of their language system, and how it may change over time. Focusing on tense, this thesis refers to productivity as the ability of the child to utilize these morphological markers in a rule-based, generalizable way, across both familiar and novel verbs. Evidence for generalizability in speech production can be demonstrated through the use of markers on a variety of different verbs versus only on a subset of verbs, in specific contexts. Evidence for rule-based use could be demonstrated through the application or subtraction of the tense affixes from both novel and familiar verbs. As children are unlikely to have heard tensed forms of novel verbs in their input, the ability to appropriately provide morphological markers in obligatory contexts would then demonstrate that they have a) computationally parsed morphemes from their input

and b) have an understanding of how they should be used. Similarly, the ability to drop affixes from familiar verbs provides evidence that a child is not simply acquiring a tensed verb as a frozen form from their input but, rather, is treating the marker as a separate grammatical morpheme. Lastly, evidence of productivity from production data is provided by errors of commission, in which markers are incorrectly added, rather than incorrectly omitted (e.g., "Girl eat dinner"). Again, as it is unlikely that children hear such errors in their input, when children produce these errors (e.g., incorrectly adding "-ed" markers to irregular verbs), they may reflect rules the child has acquired, albeit applied incorrectly. Evidence for productive comprehension of tense differs slightly, in that children have to demonstrate (e.g., through pointing or eye gaze) the ability to a) differentiate between two events, each depicting the same action type (e.g., a novel action labeled "zif"), but differing in when the event occurred ("zifed" or "zifing"), or b) choosing the matching event depiction when presented with a verb marked for a particular tense. Indeed, the issue of productivity has been the focus of many studies on tense and findings suggest that typical children use tense makers productively early in acquisition.

Acquisition of Tense in Typically Developing (TD) Children

Production Studies. Early studies examining children's early spontaneous speech suggest that the progressive marker "-ing" is among the first morphemes to emerge (Brown, 1973; Cazden, 1968). Using the first three speech samples in which a morpheme was produced in 90% of obligatory contexts[1] as their criterion for "acquisition," all children in Brown (1973) acquired the progressive marker by the time they were able to produce utterances with a mean

[1] The 90% criterion was chosen because for several inflections, change in the percentage of when the morpheme was supplied in an obligatory context appeared to pattern erratically until reaching the 90% mark, where a leveling off begins. This pattern of leveling off may be an indication that the acquisition process has stabilized and as such was adopted. Brown (1973) however does acknowledge that this is, to an extent, an arbitrary marker.

length of utterance (MLU) of 2.55 (age range between 22 months to 34 months). While children did not reach the 90% criteria for past tense forms (irregular or regular) by the end of the study (age range between 27 months to 4 years old), all children supplied these markers in at least 80% of obligatory contexts, suggesting that they were close to acquiring these linguistic forms.

However, the 90% criterion may be thought of as a very conservative criterion. All three children had begun to produce *both* progressive and past tense forms at the beginning of the study (age range 18 months to 27 months) but merely did not reach the criterion set by Cazden and Brown by the end of the study. In addition, it is unclear whether this criterion truly reflects *productivity* with these markers, as analysis on the types of verbs used with these different tense markers was not reflected in their acquisition criterion.

Studies utilizing elicited production, however, provide some additional support to the spontaneous speech findings. Hohenstein and Akhtar's (2007) investigation of 2 year olds' ability to drop and add affixes to novel verbs (i.e., "dack," "gop," and "pim") suggest that older 2 year olds have productive knowledge of the progressive marker as well as the "-ed" past marker, albeit the latter is more fragile. To investigate whether children were dropping affixes simply due to phonological ease and not because of the abstraction of tense markers, children were taught four novel words, each with the "-ing" ending: "dacking," "gopping," "pimming," and "tebbing." Two of the novel words were associated with actions (verb) and two with objects (noun). If the dropping of inflections was due to phonological ease, then when presented with a novel noun ending in "ing" and verb-"ing," children should drop the affix from both noun and verb at equal rates. Exclusive dropping of the "-ing" affix from novel verbs and not novel nouns by the children provided further demonstration of children's ability to computationally apply this morphological marker.

Other evidence for abstraction of tense markers, more specifically the "-ed" marker, can be found during the period in which children make overgeneralization errors when marking the past. Described as a U-shaped trajectory, children first initially mark irregular verbs for the past correctly (Marcus et al., 1992; Marcus, 1996). However, as children begin to utilize the "-ed" affix on regular verbs (between the ages of 2 to 3 years old), a period of overgeneralization occurs. More specifically, children erroneously apply the morphological marker for regular past "-ed" to irregular verbs (e.g., "breaked"). While the frequency is low (about the rate of 4.2% for preschoolers in Marcus, 1996) and errors never overtake correct uses of regular and irregular markers, there does indeed appear to be a stable period of time in which these errors occur most frequently (Marcus et al., 1992). These errors are particularly informative, as they suggest that children have parsed and extracted the "-ed" morpheme from their input and are beginning to learn how to apply them in a rule-based way. This also appears to be a typical phenomenon, as nearly all children were found to overgeneralize in Marcus et al. (1992).

Comprehension Studies. Evidence from comprehension studies provides additional support for early productivity of tense markers. Wagner, Swensen, and Naigles (2009), using the method of intermodal preferential looking (IPL), found that by 26 months, children have productive comprehension of present progressive and past tense markers with familiar verbs. In this study, children heard an utterance while watching two different, simultaneously presented videos: one depicting a completed action and the other, an ongoing action. They were then asked to look at the video that matched the audio. Children were able to correctly match the past form of a familiar verb to its completed rendition and the progressive form to the ongoing rendition. With novel verbs (i.e., "geed" and "krad"), children around 30 months were able to match the progressive form to the ongoing version of the verb but had difficulty matching the past form to

the completed version. This may be due to a preference for the progressive, which would be unsurprising, as the progressive marker appears to be one of the first morphemes acquired (Brown, 1973). Overall, then, we find that children at 30 months are beginning to be able to map tense markers to novel verbs, albeit fragilely for the "-ed" marker, suggesting emergence of productivity with these linguistics forms.

Thus far, there seems to be considerable support for children's early productivity with past and present tense/aspect markers beginning from the age of 2 to 2-and-a-half years old. What of future tense markers? As mentioned previously, there is some debate as to whether reference to the future is grammaticalized in English. As such, future tense is less studied compared to present and past tense. Studies that have examined future tense have generally found that comprehension emerges similarly early. Wagner (2001), for example, found that by 2 years of age (age range = 23 to 38 month olds; mean age = 33 months), children were able to correctly differentiate past, present, and future tenses. The paradigm utilized in this study involved a toy kitty that moved along a timeline (represented as a road) that included three different locations, performing an event at each location. First, the toy went to each location along the road and performed the action. The toy then repeated the trail and the child was asked to show where the kitty a) "is verb-ing," b) "was verb-ing," and c) "is gonna verb." The children's task was to select the location that matched the test sentences. While the 2 year olds performed more poorly than 3 year olds in their ability to map the location to the corresponding tense, they did demonstrate the ability to differentiate between the three tenses, suggesting that they are beginning to comprehend not only present and past, but also future tense.

Another comprehension study by Valian (2006) also found early differentiation of tenses in 2 year olds. In this study, children were given an utterance and asked to find the matching

picture or prop. Three types of contrasts were presented to the children: "will verb" versus "did verb" (e.g., "will/did tie"); copula "is adjective" versus copula "was adjective" (e.g., "is/was sad"); and progressive "is verb-ing" versus progressive "was verb-ing" (e.g., "is/was crying"). Children performed well in both "will/did" and copula contrasts but poorly on the progressive "is/was" contrast, suggesting that comprehension of the tense marker "will" emerges as early if not earlier than that of present and past. Both Valian (2006) and Wagner (2001), however, focused only on children's comprehension of future tense markers and frames, and more studies investigating the production of future expressions are needed. The present study will add to this literature by introducing production measures of future tense as well as a comparison between the productivity of "will verb" and "going to verb."

In sum, both production and comprehension data suggest that TD children begin to acquire tense/aspect morphology around 2 to 2 and half years of age. Children are able to map morphological markers to familiar as well as novel words. They also make errors in overgeneralizing the past tense "-ed" regular marker onto irregular verbs. This demonstrates that children are not initially acquiring these morphological markers as frozen forms with a limited number of verbs. Rather, TD children appear to be able to abstract and apply these morphological markers productively. This suggests that TD children tend to be rule oriented and also relatively proficient in acquiring grammatical rules. This, however, is much in doubt in children with autism spectrum disorder, as discussed more in the next section.

Acquisition of Tense in children with ASD

Autism spectrum disorders (ASD) consist of a group of neurodevelopmental disorders characterized by social deficits, communication impairments, and presence of stereotyped and repetitive behaviors (DSM IV-TR, APA, 2000). Among communication impairments, children

with ASD are thought to engage in echolalic and formulaic language (Tager-Flusberg & Calkins, 1990). Echolalia refers to the delayed or immediate repetition of utterances made by other individuals (e.g., a child answering back "want to play?" with an affirmative intent when asked "want to play?" by an adult or caregiver). Their speech, then, appear to be less indicative of showing rules. As such, it is unclear whether children with ASD use tense markers in ways comparable to typically developing children.

While there has been much research on language development in children with ASD (see Eigsti et al., 2007 for review), research examining more specifically the morphosyntactic development in this population has been scarcer and findings have been generally mixed. Waterhouse and Fein (1982) conclude that while children in their study with ASD appeared to be delayed in areas of semantics and syntax compared to TD controls, they nonetheless were able to acquire these forms. More specifically, when children were matched on MLU, those with ASD (M_{age} = 10.08 years) did not differ significantly from the TD group (M_{age} = 3.75 years) in the extent of their acquisition of Brown's (1973) 14 grammatical morphemes (M = 9.28 and M = 10.64, respectively). Both groups of children were producing present progressive, past irregular, and past regular markings. Other work, however, has suggested that children with ASD produce less complex sentences (Eigsti, Bennetto, & Dadlani, 2007) as well as omit more tense morphemes (Bartolucci, Pierce, & Streiner, 1980; Howlin, 1984) compared TD children. What has been proposed is that there may be different developmental profiles among children with ASD, and that possibly, only a subgroup has significant deficits in the morphosyntactic domain.

Using an elicitation task for past (irregular and regular) and present (third person singular) tense markers, Roberts, Rice, and Tager-Flusberg (2004) found two subgroups of children with ASD in their study, one of which performed comparably to language matched TD

children whereas the other omitted morphological markers for the past and present tense at significantly higher rates compared to TD children. In addition, this latter group appeared to produce more echolalic responses and answer more frequently with an erroneous progressive marker, suggesting possible deviance. This is not to say, however, that no deficits were found in the former group of children with ASD. While they performed comparably to TD controls, these children were significantly older, with a mean age of 9 years compared to the TD group with a mean age of 5 years. It therefore appears that delay in the acquisition of morphological markers in tense is still present in children with ASD.

Findings from Tek et al. (2013) provide additional support for the ability of a subgroup of children with ASD to acquire tense morphology. Examining the frequency of use of Brown's 14 grammatical morphemes in children's spontaneous speech over the course of two years (mean initial age for autism group was 32.85 months and 20.59 months for the TD group), two different ASD groups again emerged. Those in the high verbal ASD group (defined by a median split on an expressive language scale; ASD-HV) displayed similar growth trajectories as TD children with regards to morphological development. By the end of the study, these children were not significantly different from the TD children in their frequency of production of the progressive, past irregular and regular, and third person singular markers. Those in the low verbal ASD group (ASD-LV), however, produced significantly fewer morphological markers of tense compared to the TD group. Examining children's growth rate over the duration of the study again revealed similarities between the TD and ASD-HV groups but significantly flatter growth rates for the ASD-LV children.

While comprehension studies in this area are even sparser than production studies, work in our own lab suggests that by 4 years of age, children with ASD begin to demonstrate

understanding of progressive and past tense markers (Tovar et al., submitted). When tested via IPL, children with ASD were able to correctly match the "-ing" and past morphemes to their respective videos, like the TD children in Wagner et al. (2009). A larger effect size found for the progressive marker suggests that children with ASD may have a more robust understanding of this marker. Indeed, this is consistent with both production and comprehension findings in TD children, where the "–ing" morpheme is the first to be productively produced (Brown, 1973) and is the morpheme which children appear to demonstrate a preference for (Wagner et al., 2009).

In sum, production and comprehension data appears to suggest that a sizeable number of children with ASD acquire tense/aspect similarly to their TD counterparts, albeit with some delay. For these children, the ability to map morphological markers to their respective conceptual time reference appears to be present by at least 4 years of age. However, there appears to be a second group of children with ASD who do not acquire productive use of tense, even by the age of 9. In addition, types of production errors suggest not only that this subgroup of children are delayed at acquiring tense, but also possibly that they deviate from the typical trajectory altogether.

However, these studies do not fully demonstrate productive use of these morphological markers. Tek et al. (2013), for example, only examined the number of occurrences of each of the morphemes. The different *types* of verbs used with each morphological marker were not accounted for. As such, a child may be producing a morpheme with the same verb multiple times. Tovar et al. (submitted) is also limited in the use of only familiar verbs. In such circumstances, it becomes unclear the extent to which these studies are capturing productive comprehension and production, versus frozen use and understanding of the tense morphemes. It should also be noted that none of these studies investigated the acquisition of future tense in ASD. The current study

provides some insight to this latter issue through the examination of future tense use in a child that had previously exhibited symptoms of ASD. Lastly, studies examining tense use in children have often focused on children's *abilities* to use tense productively at a particular time point or the age at which the ability appears. The focus of the current thesis is on how children *develop* such productivity over time. Studies examining this issue have typically used spontaneous speech collected longitudinally. Tek et al. (2013), for example, drew from spontaneous speech produced during short semi-structured play sessions that were collected every six months. As some have proposed, however, sampling at large intervals may not provide an accurate depiction of children's development of language abilities (Adolph, Robinson, Young, & Gill-Alvarez, 2008; Adolph & Robinson, 2011; Naigles, 2012).

Dense data collection

Thus far, investigations of language development have traditionally employed longitudinal collection of spontaneous speech such as those utilized by Brown (1973) and Tek et al. (2013), as well as diary studies (Naigles, Hoff, & Vear, 2009; Tomasello, 1992). However, these methods may be limited in their ability to represent true developmental change. Intervals between the collection of spontaneous speech samples such as in Brown (1973) are often large and as such, changes occurring between collection points and possible factors that contribute to such change are not captured. Conversely, a particular form might be recorded during a period when it is first emerging but without dense sampling, this form might not be consistently captured and as such deemed an outlier. Diary studies, on the other hand, are limited by the development of the child. As children's speech becomes more complex, it becomes more and more difficult for parents to record all of what the child is producing in real time. Therefore, while diary studies are best aimed at examining the *emergence* of a particular form, they are not

efficient in capturing how the development of a form unfolds to the point at which it is fully acquired.

Distorted or incomplete depictions of developmental trajectories can have potentially erroneous effects. Not only may they cause incorrect predictions about when a particular skill is acquired, therefore setting incorrect standards to what is considered "typical development," they may also influence theories proposed to explain acquisition of a particular structure. Such an example can be seen from the overgeneralization of the past tense phenomenon, which was initially thought to occur with high frequency, across all verbs (Davids & Engen, 1975). However, when examining the period of overgeneralization across multiple children with relatively denser corpora, Marcus et al. (1992) discovered that, as discussed previously, the overgeneralization rate of "-ed" never overtakes the correct marking of irregular verbs and indeed, the frequency of overgeneralization was quite small. In having a more accurate understanding the overgeneralization phenomenon, new models (e.g., "rule-and-memory model" as well as connectionist models; Marcus, 1996) that were able to better account for the patterning between the frequency of overgeneralizations relative to correct regular and irregular verb markings were posited.

Thus, microgenetic sampling has been advocated as a better method to gain more accurate representations of development (Adolph et al., 2008; Adolph & Robinson, 2011; Siegler & Crowley, 1991). The microgenetic method consists of frequent data collection, sampled at small intervals, beginning from when the phenomenon of interest is emerging until when it has reached a stable state. However, the question always emerges in this context: how should one judge whether an interval is small enough?

Adolph et al. (2008) investigated this issue – more specifically, asking the question, at what interval does the developmental trajectory become misrepresented—by examining the development of 32 motor skills. Parents were asked to keep a daily record marking whether their infants demonstrated 32 motor skills of interest. The sampling frequency was then manipulated, such that it simulated 2 to 31 day intervals, accounting for the phase of sampling.[2] Adolph et al. (2008) found that the developmental shape was quickly distorted as the sampling interval increased. Sensitivity to changes (measured by the number of transitions from presence to absence and vice versa of motor skills) during development dropped sharply for intervals that were longer than two to three days. The age of acquisition of motor skills was also distorted as intervals increased. A simulated weekly collection interval, for example, shifted the acquisition age of the 32 motor skills by an average of 6.31 days. Therefore, it appears that distortions of developmental trajectories can emerge merely when collection intervals increase from daily to 3-day intervals, when sensitivity drops off most dramatically.

How might sampling rate affect research in the domain of language acquisition? Would similar distortions be found and if so, is daily sampling an appropriate collection interval? Such a method has not been traditionally used to study language development, but there appears to be some shift in utilizing the microgenetic approach as evidenced by the dense databases currently being collected by the Max Planck Institute (Lieven & Behrens, 2012). Twelve children, not limited to just those acquiring English, were recorded with wireless microphones for approximately 5 hours per week for various durations, some ranging from 2 months to over a

[2] In order to rule out differences caused simply due to when the filtering of data occurred, all possible phases were created for each sampling interval. For example, 30 "phases" were created for the simulated monthly sampling rates, meaning that collection point 1 could occur at any point in the first month and collection point 2 would then be dependent on the initial "start date/" collection point 1.

year. Research utilizing this method has been useful in providing a better understanding of children's language development. For example, using densely collected samples from one child, Thomas-Brian, demonstrated that children's correction of overgeneralization errors was gradual rather than "all or nothing" in the sense that once the correct irregular form is acquired, over-generalization errors cease (Lieven & Behrens, 2012). This may have been more difficult to demonstrate with a less densely sampled dataset, in which this period of gradual change would be missed. Additionally, the Language Environment Analysis (LENA; http://www.lenafoundation.org) system, a small portable device that can continuously audio-record children's speech for up to 16 hours, is now beginning to be employed to study language development in both typical and atypical populations. Several studies have utilized the LENA recorder to find correlations between the frequency of language produced in different language environments to children's standardized language scores (e.g., for TD children: Weisleder & Fernald, in press; Zimmerman et al., 2009; for children with ASD: Dykstra et al., 2012; Warren et al., 2010).

However, investigation of how using dense data collection can specifically improve understanding of how children acquire language has been less studied. Among the few studies that have investigated this issue, Rowland and Fletcher (2006) found that smaller samples are unreliable in representing children's errors rates, as they can substantially over- or underestimate errors. In their study, speech from one child, Lara, was collected through diary collection (a method previously discussed) in conjunction with audio recordings, which were collected once every two weeks. Focusing on one month of the collected data, Rowland and Fletcher (2006) generated five different sampling sets: a) the diary sample in addition to the total hours of audio recording (8 hours in total); b) the complete audio sample (8 hours); c) 4-hour sample (averaging

one hour per week in which data was collected); d) 2-hour samples (averaging half-an-hour per week); and e) 1-hour samples (average half-an-hour every 2 weeks). For the latter three, seven samples, each composing of different utterances, were created for each set in order to have a measure of variance across the different set sizes. When examining the error rates of copula and auxiliary use in WH-questions, it was found that smaller sample sizes had larger variability in their ability to accurately capture the percentage of errors that the child had produced when compared to the complete data set (i.e., diary sample with audio recordings). For example, variance in the error rates of the 4-hour samples ranged from 12-57%; error rates for 2-hour and 1-hour samples ranged from 0 to 100%. Taken together, utilizing small sample sizes lead to inaccurate representations of children's language ability.

There are, however, several limitations associated with the study by Rowland and Fletcher (2006). First, in utilizing a diary study and audio recordings, much of the context is lost. Second, while the sample sets represented different interval sizes (every week or every 2 weeks), they were compiled by randomly selecting utterances from the whole corpus. For example, the 4-hour samples each contained 50 Wh-questions that were randomly selected from the corpus; the 2-hour samples, on the other hand, each contained 25 Wh-questions, selected randomly from the corpus. In employing this method rather than extracting small subsets of the data in chronological order, the change of error rates over time is lost. In fact, Rowland and Fletcher (2006) did not evaluate how differences in sampling can alter understanding of children's language abilities *across development*. As such, it is still unclear whether such drastic change in the shape of developmental trajectories as presented in Adolph et al. (2008) would be seen in language development research.

Summary and Prospectus

Currently, there are numerous studies suggesting that typically developing children both comprehend and produce tense markers productively beginning around the age of 2 to 2 and a half years. This is less well understood in children with ASD, who are typically characterized as utilizing formulaic language. It appears that only a subgroup of children with ASD acquire tense and this is accompanied with a delay. Whether tense is used productively in this group of children, however, is unknown, as previous studies have simply focused only on the frequency of use. Additionally, more specific examination of how future tense develops in both TD children and children with ASD is needed, as this has not been explored at all in the latter population and only minimally in the former. Lastly, while Adolph and colleagues have demonstrated how sampling can affect representation of motor development, this type of investigation has yet to be extended to the language development domain.

The current thesis has several aims. First, we aim to address the issue of what additional information can be learned about the development of tense when utilizing a *dense* corpus. In order to address this, we employed the use of the Speechome Recorder (SR), a novel recording device developed by Deb Roy and his Cognitive Machines group at the MIT Media Lab (Roy et al., 2006; Vosoughi, Goodwin, Washabaugh, & Roy, 2012). This innovative device, discussed more in the Methods section, allows for continuous audio recording, similar to the LENA system, but improves on it by including simultaneous video recording that provides more context (i.e., information on referent objects, use of gestures or non-verbal communication, and other environmental stimuli) to children's speech. We installed this device in the homes of two children: one who had previously exhibited symptoms of ASD [Audrey] and one TD child [Cleo], and investigated their development of tense. As such, we utilize a dense corpus rather than a

"thin" corpus (Lieven & Behrens, 2012, p. 239) such as Brown (1973) or Tek et al. (2013). Second, we aim to add to the literature on future tense acquisition by examining this in an atypical population and also by adding production data. Lastly, we aim to investigate to what extent we see distortions comparable to those in Adolph et al. (2008) in language acquisition research when using large data collection intervals. More specifically, we hope to identify at which collection interval changes in developmental trajectories emerge by manipulating sampling intervals of the future tense data set.

Predictions. As Audrey was a highly verbal child at the beginning of the study, we expected some development of tense markers, albeit with some delay, similar to the high verbal children with ASD in Tek et al. (2013). We also expected some deviance due to past symptoms with ASD. Focusing more specifically on future tense, it is expected that the TD child, Cleo, would utilize both "going to" and "will" productively, as previous studies have demonstrated that future tense emerges at comparable ages to past and present tense in TD children. It is unclear, however, whether Audrey would show delays and/or deviance in her use of future tense as this has not been explored before in children with ASD. Lastly, regarding the effect of sampling intervals, we predicted that distortions of future tense use would begin to emerge quickly – when the interval size increased from daily to three-day sampling, as found by Adolph et al. (2008).

Methods

Participants

As previously mentioned, we installed *Speechome Recorders* (SRs) in two families' homes. In one family, the target child was "Audrey," who had exhibited autistic symptoms prior to the age of 30 months. According to her parents' report, examples of autistic symptoms consisted of limited expressions of emotions, a delay in pointing, and having an unusual interest

in fans and lights. In addition, the restricted and repetitive behaviors subsection of the Autism Diagnostic Interview (ADI; Rutter, Le Couteur, & Lord, 2003) yielded a score over the autism cutoff. When Audrey joined this study at 32 months of age, however, she did not meet ASD criteria: Autism Diagnostic Observation Scale score = 0 (Lord, Rutter, DiLavore, & Risis, 1989); Mullen, Early Learning Composite = 103 (Mullen, 1994); Vineland, Adaptive Behavior Composite = 108 (Sparrow, Balla, & Cicchetti, 1984). We remained interested in whether delays or deviance in Audrey's language development would be observed; therefore, we installed the SR in the playroom in her home for approximately four months (Age range = 33.70 to 37.93 months). Over this period of time, 35.07 hours over 36 Sessions were recorded (M = 3.47 days and SD = 5.92 days between recordings). Both play sessions with family members (n = 22) and therapy sessions (n =14) were recorded. This thesis presents Audrey's language development across the duration of the whole study (refer to Table 1 for details).

Our second child, Cleo, was a TD child who had not exhibited any symptoms of ASD prior to the start of our study (Mullen, Early Learning Composite = 106; Ages and Stages, Personal-Social section, Domain score = 35, on schedule); she served as a control to Audrey. The SR was installed in the family's playroom for four months (Age range = 24.20 to 28.07 months). Over this period of time, a total of 40.53 hours was recorded. Sessions consisted of mostly free play with the mother and/or father, with a few occurrences in which a babysitter was also present. To make comparisons between the two children at similar language levels, this thesis presents Cleo's language development across 13 sessions during which her mean length of utterance (MLU) could be matched to Audrey's (Table 2). Table 3 provides a summary of how the two children compare across the 13 sessions.

Table 1

Audrey's Development of Language Across 4 months

Session	Age	MLU	Types	Tokens	Types/Tokens	Tokens/Utterances
1	33.70	2.73	111	406	0.27	2.76
2	33.73	2.76	125	285	0.44	2.69
3	33.80	2.45	127	359	0.35	2.39
4	33.87	2.74	166	600	0.28	2.60
5	33;93	2.61	150	504	0.30	2.58
6	33.97	2.85	348	2570	0.14	2.86
7	33.97	2.41	160	708	0.23	2.37
8	34.00	2.75	352	2226	0.16	2.71
9	34.03	3.13	384	3229	0.12	3.00
10	34.07	2.85	156	785	0.20	2.74
11	34.03	3.28	157	560	0.28	3.16
12	34.03	2.62	128	435	0.29	2.79
13	34.17	2.48	122	336	0.36	2.38
14	34.20	2.85	190	781	0.24	2.69
15	34.23	3.06	175	729	0.24	2.92
16	34.37	2.24	88	182	0.48	2.00
17	34.43	2.67	363	2807	0.13	2.62
18	34.47	2.38	89	207	0.43	2.25
19	34.53	2.99	236	1486	0.16	2.73
20	34.67	3.02	422	3443	0.12	2.92
21	35.07	2.91	128	494	0.26	2.71
22	35.07	2.58	159	630	0.25	2.43
23	35.30	3.06	314	2345	0.13	2.92
24	35.37	3.33	178	960	0.19	3.16
25	35.43	2.80	341	3472	0.10	2.70
26	35.53	2.77	297	1666	0.18	2.65
27	35.67	3.00	237	1351	0.18	2.84
28	35.67	2.76	138	575	0.24	2.92
29	36.00	3.45	81	311	0.26	3.38
30	36.03	2.79	124	448	0.28	2.80
31	36.03	2.95	148	523	0.28	2.68
32	36.17	3.12	193	884	0.22	3.00
33	36.80	2.97	264	1409	0.19	2.94
34	36.87	2.70	114	362	0.31	2.68
35	37.83	3.10	44	97	0.45	3.13
36	37.93	3.12	61	111	0.55	3.26
Total	--	--	6870	38276	9.29	99.38
Mean	35.00	2.84	190.83	1063.22	0.26	2.75

Table 2

Cleo's Development of Language Across 13 Sessions

Session	Age	MLU	Types	Tokens	Types/Tokens	Tokens/Utterances
1	27.40	2.86	107	344	0.31	2.67
2	27.40	3.06	193	1003	0.19	2.98
3	27.43	2.98	115	473	0.24	2.96
4	27.50	2.83	148	583	0.25	2.58
5	27.53	3.06	166	632	0.26	3.01
6	27.60	2.78	131	446	0.29	2.82
7	27.80	2.61	67	165	0.41	2.58
8	27.83	3.12	108	361	0.30	3.34
9	27.97	2.80	215	754	0.29	2.98
10	27.97	2.40	34	71	0.48	2.37
11	27.97	3.00	244	1317	0.19	3.27
12	28.03	3.21	46	109	0.42	3.30
13	28.07	2.89	24	140	0.17	0.89
Total	--	--	1598.00	6398.00	3.80	35.75
Mean	27.73	2.89	122.92	492.15	0.29	2.75

Table 3

Comparison of Cleo and Audrey across the subset of 13 sessions

Subject	**Cleo**	**Audrey**
Mean MLU	2.89	2.81
MLU Range	2.40-3.212	2.24-3.28
Mean Number of Utterances	174.54	426.00
Average Length of Session	32.94 min	59.65 min
Age Range	27.40-28.07 months	34.03-35.07 months
Mean Word Types	122.92	202.92
Mean Word Types/Utterances	0.29	0.66
Mean Word Tokens	492.15	1190.31
Mean Word Tokens/Utterances	2.75	2.69

Speechome Recorder

Data were collected through a novel device called the *Speechome Recorder* (SR; Vosoughi, Goodwin, Washabaugh, & Roy, 2012), a portable version of the original *Speechome* (Roy et al., 2006) that allowed for simultaneous audio and video recording (Figure 1). Our

current *Speechome Recorder,* while maintaining these functions, was built such that it could be installed into a single room of a family's home (Naigles, Chin, Vosoughi, Goodwin, & Roy, 2011; Naigles, 2012; Vosoughi et al., 2012). It was unobtrusive and was designed to appear similar to overhead furniture lighting. The height of the SR extended to the ceiling of the room and could be easily adjusted to fit the room configurations and dimensions of the families' homes. No on-site experimenter was needed, thereby capturing more naturalistic interactions. This is particularly important when studying special populations, such as children with ASD, where having a novel person in the room can not only be distracting but also may make children feel uncomfortable. While the recorder was installed in only one room in the home, a variety of interactions involving different speakers and different activities were still captured. This, therefore, gave us a measure of children's language production across different settings.

Figure 1. *The Speechome Recorder*. Adapted from "A Portable Audio/Video Recorder for Longitudinal Study of Child Development," by S. Vosoughi, M. Goodwin, B. Washabaugh, and D. Roy, 2012, In *Proceedings of the 14th ACM International Conference on Multimodal Interaction* (pp.193-200). New York, NY: ACM. Adapted with permission.

The SR has two wide angle, fish-eye cameras, one placed overhead and one facing the front. This allowed us to capture a wide, general view of the room, thereby recording activities that took place across a large area with multiple participants, as well as a more specific view for activities that involved just the child and caregiver (Figure 2). Recordings from multiple angles was also beneficial for situations in which a referential object or person was blocked in one angle; the secondary camera often was able to capture it.

Figure 2. Different views from the overhead and frontal cameras. Adapted from "A Portable Audio/Video Recorder for Longitudinal Study of Child Development," by S. Vosoughi, M. Goodwin, B. Washabaugh, and D. Roy, 2012, In *Proceedings of the 14th ACM International Conference on Multimodal Interaction* (pp. 193-200). New York, NY: ACM. Adapted with permission.

Another important feature of the SR that makes it unique is its ability to continuously record child-caregiver interactions over multiple days and weeks without experimenter intervention. While traditionally an experimenter's presence is required, at least for maintenance related purposes, the SR has 4 terabyte (TB) of storage abilities, which allows for up to 60 days of continuous audio and video recording. Recordings were automatically uploaded every night to MIT servers enabling audio and video capture to be transcribed and analyzed while the data were still being collected. The SR was also outfitted with various system diagnostic tools such that it could be powered on/off as well as debugged remotely. Therefore, the SR could hypothetically

run itself for months without the need for maintenance or for an experimenter to be present. These design features contributed to the inconspicuous nature of the recorder for the children and their families.

In order to maintain privacy for the families, caregivers were allowed to turn the SR on and off as desired using a touch screen interface built into the device. Also using the touch screen, parents were able to review and mark any videos for deletion or to indicate events that they judged to be special or interesting during particular sessions (Figure 3). To ensure that recordings used in the analysis consisted of only participants who had provided informed consent, all willing participants first took a picture using the front camera in the SR. Accessing the pictures of all consenting participants, the SR and a human auditor then scanned all video recordings and matched faces in the videos to the pictures. In theory, when a video containing an individual who had not previously consented was found, the video would be marked. Following this, an attempt to get the individual's consent would be made and if unsuccessful, all videos containing this individual would be deleted. In our deployments, all reviews of the video content revealed only consented participants.

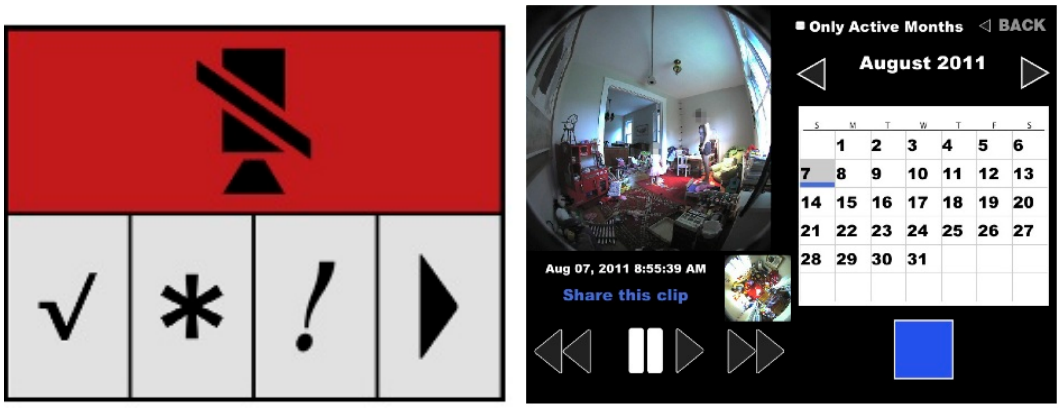

Figure 3. User interfaces used by families to turn on/off the SR and mark or delete sessions. Adapted from "A Portable Audio/Video Recorder for Longitudinal Study of Child Development," by S. Vosoughi, M. Goodwin, B. Washabaugh, and D. Roy, 2012, In *Proceedings of the 14th ACM International Conference on Multimodal Interaction* (pp.193-200). New York, NY: ACM. Adapted with permission.

Blitzscribing

Because of the immense amount of data collected by the SR, an alternative to traditional methods of transcribing was needed (Vosoughi et al., 2012). The method of transcribing the videos in our current study was as follows: a) the audio from the recordings was first processed through noise-reduction software, removing extraneous noise; b) the audio was filtered again through a speech detector and segments with only human speech were extracted; c) the audio was then segmented into utterances delimited by pauses or other breaks in speech and uploaded to the Blitzscribing interface, where human transcribers listened and transcribed the utterances. This transcribing protocol, therefore, is novel in that much of the non-speech segments are removed, thereby speeding up the process. Three individuals transcribed the recordings. Reliability between the first and second transcribers was 90.4% while reliability was 91.2% between the second and third transcribers.

After utterances were transcribed, they were compiled by session and converted into CHAT format (MacWhinney, 2000) to allow for extraction of general frequency and MLU counts as well as more specific analyses (discussed in more detail below). A final pass of the transcriptions, now with the corresponding videos, was made by the author to correct for any errors, insert missing utterances, and also to make notes on the context in which the adult-child interactions were occurring. This was especially important when trying to evaluate the appropriateness of tense markings and of null markings. For example, in the utterance “I put this down,” it is unclear based on just the transcript or even audio as to whether this was a correct past tense form (no marking) or whether it referred to an ongoing event, but the speaker did not mark for the progressive. However, if the video showed that the child produced the utterance

shortly after she put down a toy, this provided more clarification that the verb was most likely correctly unmarked for the past tense.

Speech Analysis

Using CLAN's analysis tools (MacWhinney, 2000), the MLU and frequency counts of types and tokens for each session were calculated. All verbs were then extracted and coded for whether they referred to the present, past, or future. Further subdivisions of each tense type along with examples are provided in Table 4. Each tense was further scrutinized for the specific verbs it was used with and the incorporation of new verbs over time. Following most reports on early tense acquisition (Broen & Santema, 1983; Brown, 1973; de Villiers & de Villiers, 1972; Marchman, 1997; Rispoli, Hadley, & Holt, 2009; etc.), the copula was not included in the analysis as it is typically treated separately from other forms.

Table 4

Coding of Tense Types

Tense Type	**Example**
Present	
Correctly Unmarked (1st and 2nd person)	*I want scissors*
Incorrectly Unmarked	*Girl come off*
Correctly Marked (3PS)	*Baby likes that*
Incorrectly Marked	*I gets little baby*
Correct Progressive	*They are baking*
Incorrect Progressive	*The baby sleeping*
Past	
Regular	*He ripped it*
Irregular	*I saw them*
Overgeneralization	*I breaked it*
Auxiliary + verb	*I was jumping*
Future	
Going to/Gonna verb	*I'm gonna do it*
Will/'ll verb	*I'll get it started*
I'm a verb	*I'm a jump*

Table 4 shows an unconventional frame used by both children, namely "I'm a verb." We believe this frame was used to express futurity because these utterances were produced immediately preceding the actions that were described. Using the example from Audrey's speech, shortly after she produced "I'm a jump" she walked over to the trampoline and began to jump. More over, this frame has been attested in African American English (AAE), and is typically thought to be equivalent to the contracted form of "I'm gonna verb" (Green, 2002). Because of the context and the existence of this frame in an American English dialect, we treated these utterances as expressing futurity.

When the context did not conclusively indicate the tense of the utterance, the verb was labeled as un-codeable and excluded from further analyzes. Frozen forms or phrases (e.g., singing the "clean up" song) and repetitions were also excluded. A verb was counted as a repetition when it followed within three utterances of an exact adult duplicate.

Future Tense Analyses

Parents/caregiver use. We first investigated the role of input by looking at the uses of future frames in the parents and other surrounding adults' speech for both children. We extracted the verbs which occurred with "will/'ll," "going to/gonna," or "I'm a" through CLAN's analysis tools, now with the focus on the adults' speech. They were then tallied and totaled for each frame type.

The role of input for three children in the CHILDES database (MacWhinney & Snow, 1990), Sarah (Brown, 1973), Naomi (Sachs, 1983), and Abe (Kuczaj, 1976), was also examined using the same analysis in order to have additional TD comparisons.

Audrey's future tense use. As findings from these analyses suggested that Audrey's expression of futurity might have been atypical with regards to the use of the "I'm a verb" frame, additional analyses comparing her use of the three frames were performed.

Telicity. Verbs used in each of the three frames were categorized as telic or atelic (Wagner, 2012). Telicity refers to the "completeness" of an event expressed through the verb or verb phrase. Atelicity refers to the incompleteness or "ongoing" property of the event. Verbs were coded for telicity first by verb type (e.g., atelic for "I'll **stand**" and telic for "I'll **get** my water"). For verbs that could have both telic and atelic meanings (e.g., "jump"), the transcript and/or video were referenced for each future utterance to decide whether the verb was atelic (e.g., "I'll jump [on the trampoline]") or telic (e.g., "I'm gonna jump over the couch").

Length of verb phrase. We hypothesized that Audrey's use of the "I'm a verb" frame was related to processing constraints. As such, we examined the length of the verb phrase of each future utterance. More specifically, the number of syllables that followed after the main verb for each future utterance was counted and then averaged across utterances for each frame type.

Timing difference. We attempted to examine whether the time between when Audrey produced an utterance and when she began to execute the action described by the utterance differed according to frame. We first marked when each future frame utterance was completely produced and when the corresponding action was first being performed. We then subtracted the two time stamps to determine how long it took Audrey to execute the action after making the utterance. However, as coding was progressing, we noticed that there were occurrences in which the video and audio drifted out of sync. As this was not consistent within and between videos, it was difficult to make corrections to the videos themselves. Therefore, while coding for possible

timing differences was initiated, we realized that these audio-video timing differences made such analyses unreliable. Therefore, this analysis was not included in the final results.

Atypical Use in Other Subdomains

In order to determine whether atypical or typical development was confined to only Audrey's tense use, we also examined two other constructions that typically emerge during this age range: verb-particle constructions and noun-noun compounds (e.g., "I put the book down" and "ribbon hat," respectively; Snyder, 2001; Snyder & Stromswold, 1997). In order to find verb-particle constructions, all occurrences of a verb with a preposition were extracted. A coder then manually scrutinized the output and eliminated utterances that were erroneously pulled from CLAN or were combinations of a verb with a prepositional phrase (e.g., "I sat on the chair"). Following this, all remaining utterances were marked for whether they had correct verb-particle constructions and whether they were verb-object-particle (e.g., "We have to clean it up") or verb-particle-object constructions (e.g., "I can clean up the tissue").

To analyze the children's noun-noun compounds, all utterances with two consecutive nouns were extracted. A coder then manually scrutinized the output to confirm only noun-noun compounds were retrieved. The remaining noun-noun compound constructions were then marked for whether they were novel (e.g., "couch toy") or lexicalized (e.g., "dollhouse").

Interval Testing Analysis

We assessed the effect of interval size on the shape of developmental trajectories by treating our data to reflect three-days, weekly, biweekly, and monthly data collection intervals. More specifically, from our complete data set, we extracted data every three days, every week, every two weeks, and so forth. The longest session within the interval was selected to ensure that any distortions of the trajectory were not simply caused by the fact that the data points fell on

particularly short sessions. While this meant that intervals were not perfectly spaced three days, seven days, etc. apart, it may be important to note that this is common in other longitudinal studies (Lieven & Behrens, 2012).

Results

In Part I, we present Audrey and Cleo's individual use of tense across the duration of the study. Then, the children will be compared in their development of tense using the subset of the data when their MLU is matched. As a preview to these results, Audrey's present and past tense use appears typical. However, her future tense use appears atypical. Thus, in Part II, we present more detailed analyses focusing on her future tense use as well as that of Cleo, and other children from the CHILDES database (MacWhinney & Snow, 1990). The future tense uses of parents are also presented. In Part III, analyses demonstrating the impact of different data collection intervals are presented.

Audrey's Use of Tense

Audrey produced utterances with an average MLU of 2.85 (ranged between 2.38 to 3.45) over the 4.20 months of the study. She produced a mean of 190.83 word types and 1063.22 word tokens per session (refer to Table 1 for details on each individual session). Across all sessions, 5524 verb tokens (213 verb types) were produced. Out of all verb tokens, 3913 (70.84%) referred to the present, 334 (6.05%) referred to the past, and 256 (4.63%) referred to the future. Seven hundred and sixty four (13.83%) tokens were in the infinitive form and an additional 257 verb tokens (4.65%) were produced but were un-codeable with regard to tense due to lack of information from the context or incompleteness of the utterance.

For verbs used to refer to present states or activities, 2852 (72.89% of all present tokens) were correctly unmarked while 205 tokens (5.24%) were correctly marked for third person

singular and 369 (9.43%) for the progressive. Thus, a majority of the errors were ones of omission, in which verbs were unmarked (343 tokens, 8.77%, e.g., "I close the door;" "birdy come say bawk to"). However, 18 errors of commission (0.46% of all present tokens) were also produced (e.g., "that we eats," "we needs a spoon") (See Table 5).

Table 5

Audrey's Use of Present Tense

		Total Tokens	Percent (out of total of present tokens)
No marking			
	Correct	2852	72.89%
	Incorrect	343	8.77%
3rd person singular			
	Correct	205	5.24%
	Incorrect	18	0.46%
Progressive			
	Correct	369	9.43%
	Incorrect	126	3.22%
Total		3913	

When referencing the past, Audrey produced both regular and irregular forms, in addition to the use of a tensed auxiliary with an unmarked verb (e.g., "I didn't cry"). Out of these three types, the irregular form was the most commonly produced (211 tokens, 63.17% of all past tokens; Table 6). Four overgeneralizations (e.g., *breaked, broked, throwed,* and *dided*) as well as three errors of incorrectly utilizing an auxiliary with a tensed verb (e.g., *I did won; you cannot broke it again*) were made.

Overall then, it appears that Audrey's use of present and past tense was consistent with the literature describing the use of tense in TD children at this level of MLU. A majority of present tokens was correctly unmarked, although occurrences of marking for the progressive and third person singular were also found. In her past tense use, we find that both regular as well as irregular forms were produced.

Table 6

Audrey's Use of Past Tense

		Total Tokens	Percent (out of total of past tokens)
Regular			
	Correct	90	26.95%
	Incorrect:	5	1.50%
	Overgeneralization	4	
	Tense[3]	1	
Irregular			
	Correct	210	62.87%
	Incorrect	1	0.30%
With Aux			
	Correct	25	7.49%
	Incorrect	3	0.90%
Total		334	

Audrey's use of these morphological markers with a variety of verb types across the study, moreover suggests productivity with these markers. Across the 36 sessions, a total of 22 different verb types were marked for third person singular. Within each session, a mean of 2.11 verb types were marked for the third person singular. Similarly, when examining Audrey's use of the progressive marker, we found that overall 77 unique verb types were marked as such and a mean of 8.53 verb types per session were marked for the progressive. This provides support to the claim that the morphological rules in marking for the present tense had been extracted and were able to be applied productively by Audrey. Further evidence of productivity with morphological markers was found in her past tense use, in which 31 and 30 verb types were marked for the irregular and regular past, respectively, across the 36 sessions. Within each session, a mean of 3.03 verb types and a mean of 1.56 verb types were marked for the past

[3] Audrey erroneously produced "he missed a phone" when the context (i.e., experimenter trying to find his phone that he had left at home) implied that "miss" should have been marked with a present progressive marker "he is missing a phone."

irregular and regular, respectively per session. More importantly, her four instances of overgeneralizations with the "-ed" marker further supported the notion that Audrey had productive use of the past tense marking.

Audrey produced 256 expressions referring to the future, in three forms: a) "going to verb;" b) "will verb," with their respective contracted forms (e.g., I'm/I am gonna and I'll); and c) "I'm a verb" frame. Among the three frames, "going to verb" was the most commonly used, with 106 occurrences; the "I'm a verb" frame was the least produced form (72 occurrences). Regarding their rates of growth averaged across sessions, "will verb" and "going to verb" grew at the same rate (M = 0.008 tokens/number of utterances) while "I'm a verb" grew at a slower rate on average (M = 0.003 tokens/number of utterances; Figure 4).

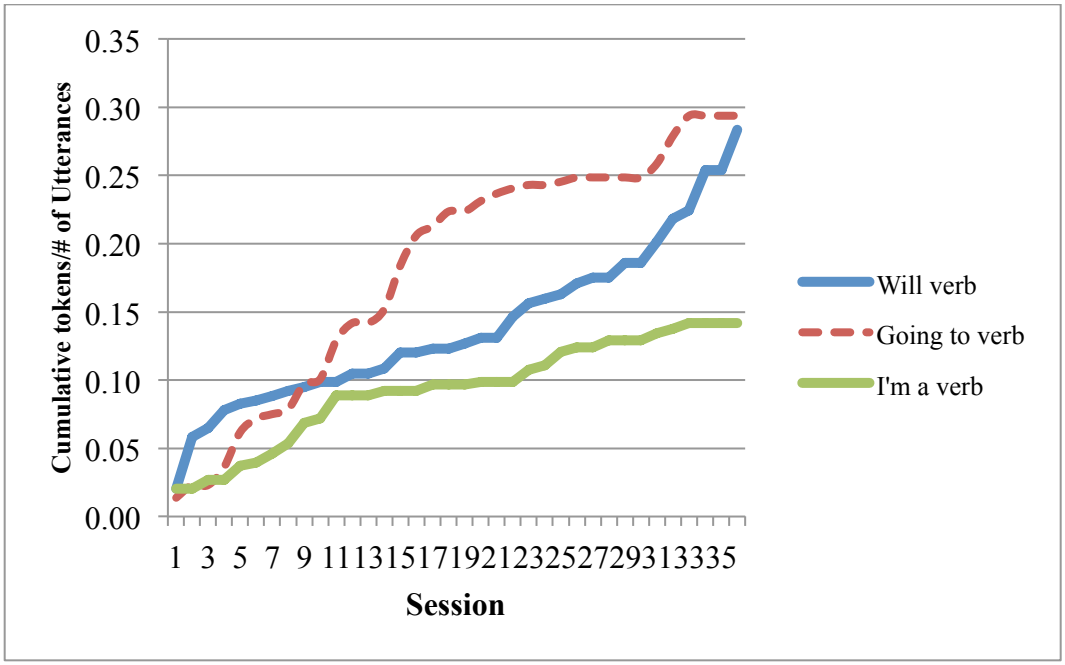

Figure 4. Cumulative growth of Audrey's use of all three future frames.

A polynomial regression was used to find the best-fit line of each the three future frames' growth curves. This revealed that although the "will verb" and "going to verb" frames averaged

similar growth rates across sessions, the overall shape of their trajectory differed. While a quadratic model best characterized the use of "will verb" frames,

$$y = 0.064 + 0.002x - 6.62X10^{-6}x^2, \text{ adjusted } R^2 = 0.96, p < 0.01$$

a cubic model was better at describing the shape of "going to verb" uses across the 36 sessions

$$y = 0.009 + 0.011x - 1.491X10^{-4}x^2 + 6.396X10^{-7}x^3, \text{ adjusted } R^2 = 0.95, p < 0.01.$$

Lastly, the shape of "I'm a verb" was best fitted with a cubic model, similar to that of the "going to verb" trajectory:

$$y = 0.025 + 0.004x - 4.870X10^{-5}x^2 + 1.980X10^{-7}x^3, \text{ adjusted } R^2 = 0.92, p < 0.01.$$

Therefore, it appears that each frame was progressing at a different trajectory. The "will verb" frame differed from "going to verb" and "I'm a verb" frames in its shape. "Going to verb" and "I'm a verb" frames have similar growth curve shapes but are progressing at different rates.

Cleo's Use of Tense

Focusing on the 13 sessions in which Cleo was comparable to Audrey in MLU (MLU averaged 2.89, ranged between 2.40 to 3.21; Table 2 and 3), we find that a total of 965 verb tokens and 113 verb types were produced. Among them, 777 (80.52%) tokens referred to the present, 39 (4.04%) tokens to the past, and 49 (5.08%) tokens to the future. For utterances that referred to the present, a majority (558 tokens, 71.81% out of all present tokens) was correctly unmarked while 20 (2.57%) were correctly marked for the third person singular and 50 (6.44%) correctly marked for the progressive (see Table 7).

Focusing on the productivity of these markers across sessions, we found that a total of 12 verb types were marked for the third person singular while 27 verb types were marked for the progressive. Within each session, an average of 1.46 verb types were marked for third person singular and 3.00 verb types for the progressive. Errors consisted of leaving verbs unmarked

(118 tokens) and incorrectly marking for first person singular (1 occurrence; e.g., "I, I gets little babies in there").

Table 7

Cleo's Use of Present Tense

		Total Tokens	Percent (out of total present tokens)
No marking			
	Correct	558	71.81%
	Incorrect	118	15.19%
Third Person Singular			
	Correct	20	2.57%
	Incorrect	3	0.39%
Progressive			
	Correct	50	6.44%
	Incorrect	28	3.60%
Total		777	

Most of Cleo's use of past tense forms consisted of verbs with an irregular form (26 tokens, 66.66% of past tense tokens and 12 types), although regular (8 tokens, 20.51% and 8 types) and tensed auxiliary with an unmarked verb (5 tokens, 12.82% and 4 types) forms were also produced (Table 8).

Table 8

Cleo's Use of Past Tense

		Total Tokens	Percent (out of total past)
Regular			
	Correct	7	17.95%
	Incorrect	1	2.56%
Irregular			
	Correct	25	64.10%
	Incorrect	1	2.56%
With Aux			
	Correct	5	12.82%
	Incorrect	0	0.00%
Total		39	

Among the past tense errors, one overgeneralization (i.e., *drawed*) was found. Lastly, the same three future frames were found in Cleo's speech as had been found in Audrey's. The two children differed, however, in that for Cleo, the "will verb" frame was most commonly used (29 tokens, 59.18% and 20 types). This was followed by the "going to verb" frame (17 tokens, 34.69% and 11 types). The "I'm a verb" frame was used the least (3 tokens, 6.12% and 2 types; Refer to Figure 5).

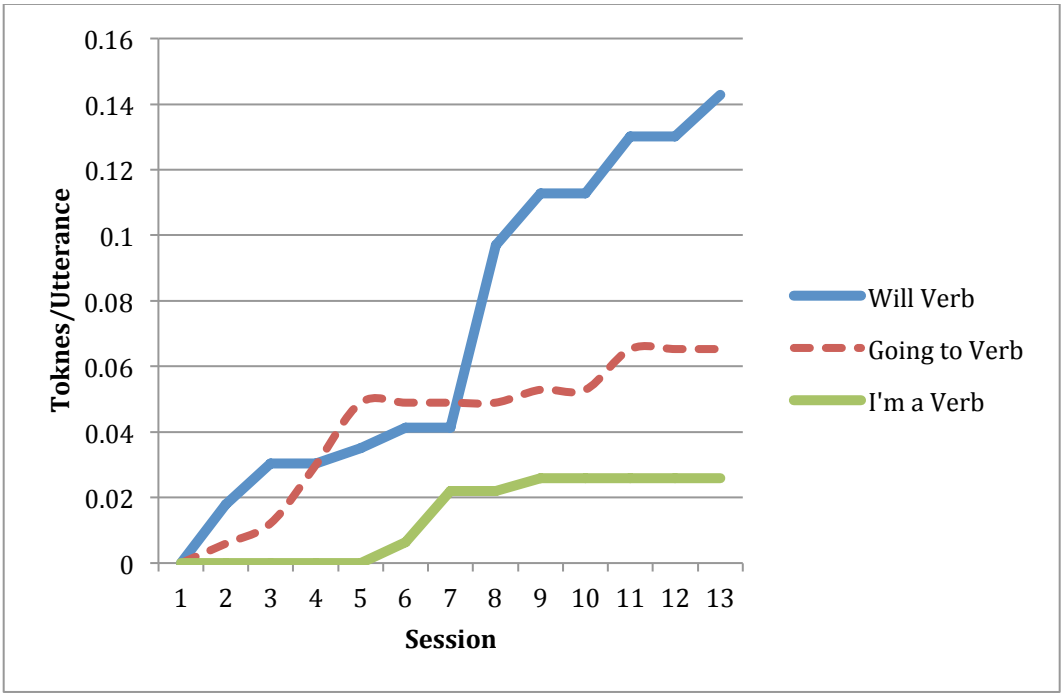

Figure 5. Cumulative growth of Cleo's use of all three future frames.

Comparison between Audrey and Cleo

As Audrey's MLU exceeds Cleo's in her later sessions, we next compared only the sessions in which Audrey and Cleo were the most comparable in MLU. This was done by extracting 13 sessions from Audrey's complete data set in which her MLU range best matched Cleo's 13 sessions. The resulting subset came from sessions 9 to 21, where Audrey's mean MLU was 2.81 (ranged between 2.24 to 3.28; Table 3).

Comparisons between the 26 sessions (13 from each child) revealed that Audrey and Cleo appear to be comparable in some aspects of their tense use but not others. Among the similarities, a majority of the verb tokens was used to refer to the present for both children (70.46% for Audrey and 80.52% for Cleo) and out of such tokens, most were correctly unmarked (71.84% for Audrey and 71.81% for Cleo; Table 9).

Table 9

Comparison of Cleo and Audrey's Present Tense Use

		Total Tokens		Percent out of Total Present	
		Audrey	Cleo	Audrey	Cleo
No marking					
	Correct	1138	558	71.84%	71.81%
	Incorrect	126	118	7.95%	15.19%
Marking					
	Correct	93	20	5.87%	2.57%
	Incorrect	6	3	0.38%	0.39%
Progressive					
	Correct	165	50	10.42%	6.44%
	Incorrect	56	28	3.54%	3.60%
Total		1584	777		

A similar pattern was found for past tense utterances, in which both Audrey and Cleo used mostly irregular forms (55.91% and 66.66%, respectively; Table 10). With regards to the errors made, both Audrey and Cleo made the most errors in (incorrectly) leaving the verb unmarked for the present tense (7.95% and 15.19%, respectively). In addition, Audrey and Cleo each made two errors when talking about past activities (1.57% and 5.12% respectively). Cleo produced one overgeneralization and one commission error (i.e., "I gots a shirt"). Audrey similarly produced 1 overgeneralization (three other overgeneralizations occurred before and after these 13 sessions) but her error of commission involved erroneously adding an auxiliary to an already tensed verb (i.e., "I did won").

Table 10

Comparison of Cleo and Audrey's Past Tense Use

		Total Tokens		Percent (out of Total Past)	
Regular		Audrey	Cleo	Audrey	Cleo
	Correct	42	7	33.07%	17.95%
	Incorrect	1	1	0.79%	2.56%
Irregular					
	Correct	71	25	55.91%	64.10%
	Incorrect	0	1	0.00%	2.56%
With Aux					
	Correct	12	5	9.45%	12.82%
	Incorrect	1	0	0.79%	0.00%
Total		127	39		

With regard to their use of the future tense, differences in the frequency of use of the three frames were found. While Audrey used mostly "going to verb" (55.66%) to express future activities, followed by "I'm a verb" (26.42%), Cleo used mostly the "will verb" frame (59.18%), with the "I'm a verb" frame being the least produced (6.12%). It therefore appears that Audrey has a preference for using "going to verb" to refer to future events while Cleo has a preference for "will verb." These differences in frequency of "going to verb" and "will verb" use could be indicative of atypicality in Audrey. On the other hand, these differences may have emerged simply due to fewer future tense uses by Cleo overall, as Audrey produced more than twice the amount of future utterances compared to Cleo during this time period (Table 11).

Table 11

Comparison of Cleo and Audrey's Future Tense Use

	Total Tokens		Percent (out of Total Future)	
	Audrey	Cleo	Audrey	Cleo
Will verb	19	29	17.92%	59.18%
Going to verb	59	17	55.66%	34.69%
I'm a verb	28	3	26.42%	6.12%
Total	106	49		

To determine whether the difference in the frequency of "going to verb" and "will verb" use was indeed simply due to fewer utterances produced, we examined the use of "going to verb" and "will verb" frames in three other typically developing children from the CHILDES database (MacWhinney & Snow, 1990). We only report on the subset of each child's data in which they are comparable to Audrey's MLU (range = between 2.38 to 3.45; *M* = 2.85).

Comparison with other children

Naomi. Across 38 sessions (Age range = 22.17 months to 27.00 months; MLU range = 2.02 to 3.46; *M* = 2.52), 6 tokens of "will verb" and 57 tokens of "going to verb" were produced.

Sarah. Across 35 sessions (Age range = 33.29 months to 42.16 months; MLU range = 1.818 to 3.4; *M* = 2.76), Sarah produced 68 "will verb" frames and 37 "going to verb" frames.[4]

Adam. Recordings between the ages of 27.30 months to 35.13 months across 14 sessions (MLU range = 2.42 to 3.25; *M* = 2.75) revealed 13 productions of the "will verb" frame and 8 productions of the "going to verb" frame.

There, therefore, appear to be two groups of children within this MLU range: those who prefer to use "going to verb" when referring to future events and those who prefer to use "will verb." Naomi falls under the former category and Audrey patterns similarly to her. Children who fall under the latter category include Adam and Sarah; Cleo appears to pattern with these children.

Parental Input. Regarding the children's input, all five children had very similar exposures to future frames. The caregivers all used more "will verb" frames compared to "going to verb" frames both within and across the sessions (Table 12).

[4] There was one session in which the MLU was in the lower range (1.81). Removing this session, the MLU range was between 2.126 and 3.4 (*M* = 2.786).

Table 12

Caregiver Use of "Will" and "Going to" Future Frames (Tokens)

	Audrey	Cleo	Sarah	Naomi	Adam
"Will verb"	883	152	294	109	122
"Going to verb"	867	108	204	91	83

Thus, the children do not uniformly pattern similarly to their parents' use of future frames. This suggests that there are individual differences in how frequently different future frames are used, irrespective of the input. As such, the difference between Cleo and Audrey's use of "going to verb" and "will verb" is likely not atypical and is likely not driven by a neurological or developmental disorder.

"I'm a verb" Frame Analysis

While Audrey's use of "going to verb" and "will verb" appears to be typical, her use of the "I'm a verb" as a future frame suggests possible atypical development for two reasons. First, this frame is attested in African American English (Green, 2002). As Audrey is not of African American heritage, this raises the question of how she came to acquire this frame.

Second, although the "I'm a verb" frame appears in Cleo's speech, it only occurred three times in the corpus while occurring 28 times in the respective subset of Audrey's data. Compared with Cleo then, Audrey's frequency of use of this frame seems atypical. However, Cleo produced fewer utterances during the relevant sessions so additional uses of "I'm a verb" could have been missed. Therefore, comparisons with the three other children's productions from the CHILDES database (MacWhinney & Snow, 1985) were used to investigate whether a similar frame could be found.

Comparison with other children in "I'm a verb" use. Only Sarah and Adam produced this particular frame. More specifically, five occurrences of this frame were found in Sarah's corpus: two in its un-contracted form (e.g., "I am a hold it") and three in its contracted form (e.g., "I'm a play"). Two instances were found in Adam's, both contracted forms (i.e., "I'm a broke"; "I'm a push"). For both children, the productions of this frame occurred in a relatively small time interval (between the ages of 34.05 months and 38.23 months for Sarah, and 34.01 months and 34.16 months for Adam). Their MLU during the time when they produced these frames ranged from 2.13 to 3.382 for Sarah and from 2.59 to 2.93 for Adam. The MLU of Sarah during the period in which she produces this frame is comparable to that of Audrey's (range = 2.242 to 3.446) and Adam's MLU range fell within a subset of Audrey's. So while it seems that the uses of the "I'm a verb" frame occur within similar MLU range among the three children, their frequency of use still differed, suggesting again that Audrey may not be typical in producing this frame.

In order to determine whether this difference in frequency of use emerged due to disparities in density among the children's corpora, the frequency of the use of the "I'm a verb" frame relative to the total number of utterances produced as well as the total number of future frames produced were calculated for each child, for the subset of the data in which all three children were comparable in MLU. With regards to Sarah, the "I'm a verb" frame accounted, on average, for 0.05% of the utterances and an average of 5.95% of future frames used per session. For Adam, the "I'm a verb" frame accounted for a mean of 0.02% utterances and 3.57% of future frames. For Audrey, a mean of 0.43% of all utterances and 21.99% of future frames within a session were of the "I'm a verb" type. We can, therefore, see that even when controlling for length of session and overall use of future frames, Audrey produced the "I'm a verb" frame at

higher rates than Sarah and Adam. This provides evidence that Audrey's use of this frame may not have been typical.

Parent/caregiver use. We next investigated whether differences in the frame's frequency of use were driven by the children's exposure to the frame by examining parent/caregiver use of the frame for the four children who produced it: Audrey, Cleo, Sarah, and Adam. We found that two occurrences of the "I'm a verb" frame were present in Cleo's input, and none were found in Audrey's, Adam's, or Sarah's. Exposure to this frame through caregiver use, therefore, does not appear to drive the differences in children's use of it.

In general then, we found that the "I'm a verb" frame was used more frequently by Audrey compared to the other children and that this was not driven by differences in their input. Thus, "I'm a verb" appears to be a novel frame, atypically created by Audrey. Why Audrey might have produced this form was further investigated. Our next questions included: a) was the "I'm a verb" a frozen form; b) were there differences in how the three future frames were used; and c) was the "I'm a verb" frame used as means to ease cognitive load.

New verbs over time. One proposed hypothesis for why Audrey was using this frame was that it was incorrectly acquired as a frozen form (e.g., mis-parsing of "I'm gonna" to I'm a"). Support for this hypothesis would be evidence demonstrating that this frame was used with only a subset of verbs. Moreover, it would be expected that these verbs would not be used in the other two future frames.

To investigate whether this was the case, the different verbs used in three frames over time were examined. Overall, the "going to verb" frame appeared with the most verb types (78; mean types per session = 2.17) and the "I'm a verb" appeared with the fewest (43; mean types per session = 1.19). However, there was also considerable overlap of the same verb types used

across and between the three frames. More specifically, nine verbs were used in all three frames and an additional nine verbs were shared between the "going to verb" and "I'm a verb" frames (Table 13). The "going to verb" frame gained new verb types at a rate of 1.11 words per session, while the "will verb" and "I'm a verb" frames gained new types at similar rates of 0.77 words per session and 0.74 words per session, respectively (Figure 6). This suggests that while the "I'm a verb" frame gained new types at a slower rate, there was some growth and thus, this frame was used productively. In addition, usage of the same types across the three frames demonstrates flexibility in Audrey's use of the frames and as such, suggests that these frames, in particular the "I'm a verb" frame, were not acquired as frozen forms.

Table 13

Verbs Used in Audrey's Future Frames

Verbs Used in all Three Frames	Verbs used in "Going to verb" and "I'm a verb"
do	*cut*
get	*draw*
go	*dump*
make	*eat*
play	*have*
put	*help*
sit	*pull*
take	*stay*
try	*walk*

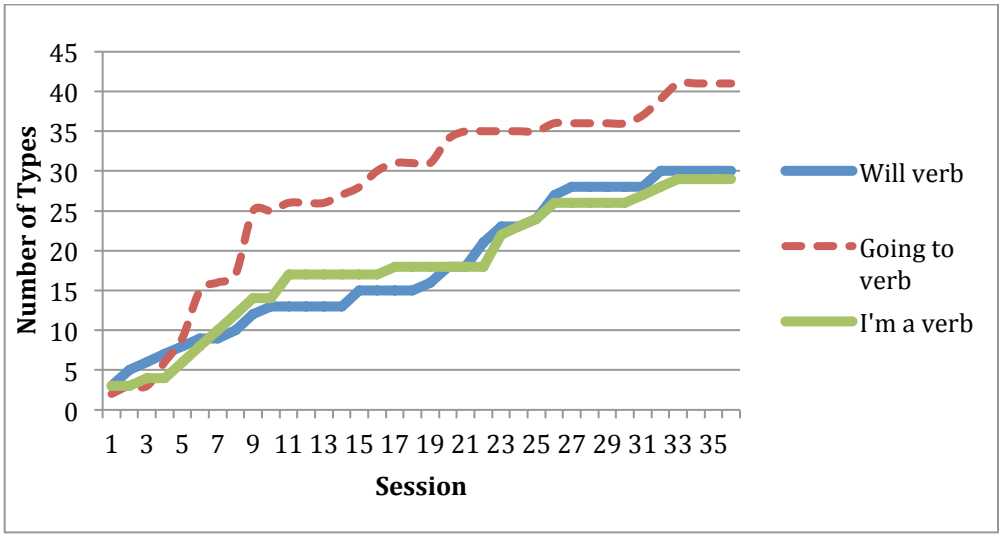

Figure 6. Cumulative growth of new verb types found with each of the three future frames.

Telicity. How the "I'm a verb" frame patterns in comparison to the other two frames would provide some insight into whether it was being treated as interchangeable with the "going to verb" or "will verb" frame. "Will" and "going to" is proposed here to be afforded with different telicities. "Going to verb," in containing a progressive element, and thus indicating an ongoing/imperfect aspect, may be expected to be more atelic in nature (Wagner, 2012). "Will" on the other hand, lacking a progressive term, may be associated with more telic verbs. Relatedly, Green (2002) proposed that in AAE, "I'm a verb" is a contracted form of "I'm gonna verb." Hence, if it is the case that telicity is driving differences in how the future frames are used, and if the "going to verb" frame is associated with atelic verbs, then "I'm a verb" should similarly appear with more with atelic verbs.

Indeed, "will verb" frames appeared more with telic verbs than atelic verbs, both across and within sessions ($M = 2.00$, $SD = 1.00$ and $M = 1.04$, $SD = 1.07$, respectively; Figure 7).

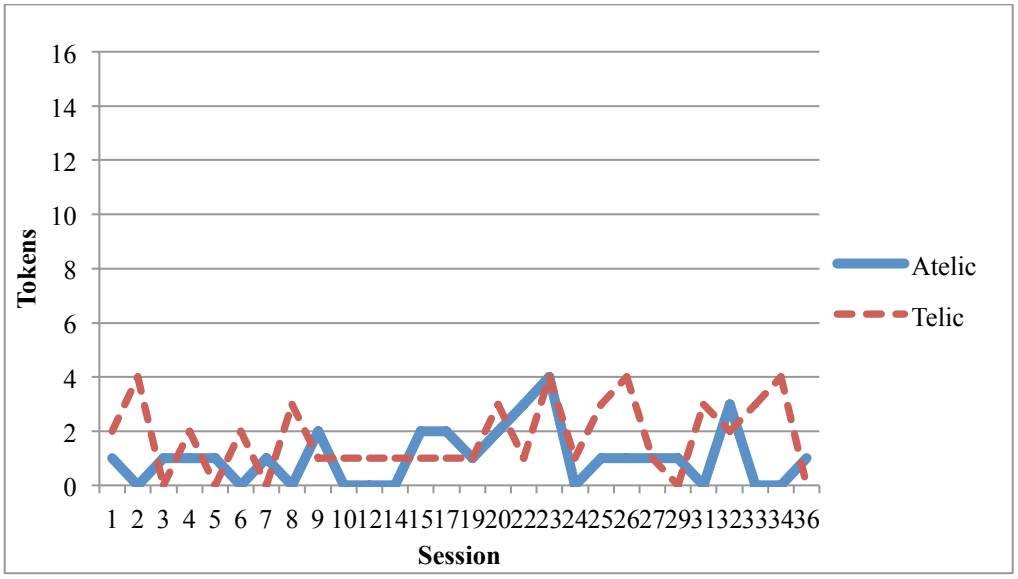

Figure 7. Number of atelic and telic verbs used with "will verb" frames.

"Going to verb" and "I'm a verb" frames, as expected, appeared with more atelic verbs than telic verbs (M_{atelic} = 2.48, SD_{atelic} = 3.12 and M_{atelic} = 2.5, SD_{atelic} = 3.65, respectively) across and within sessions (Figure 8 and 9), consistent with Green's (2002) proposed relationship between these two frames. This provides some support for the proposal that "I'm a verb" is a contracted form of "going to verb."

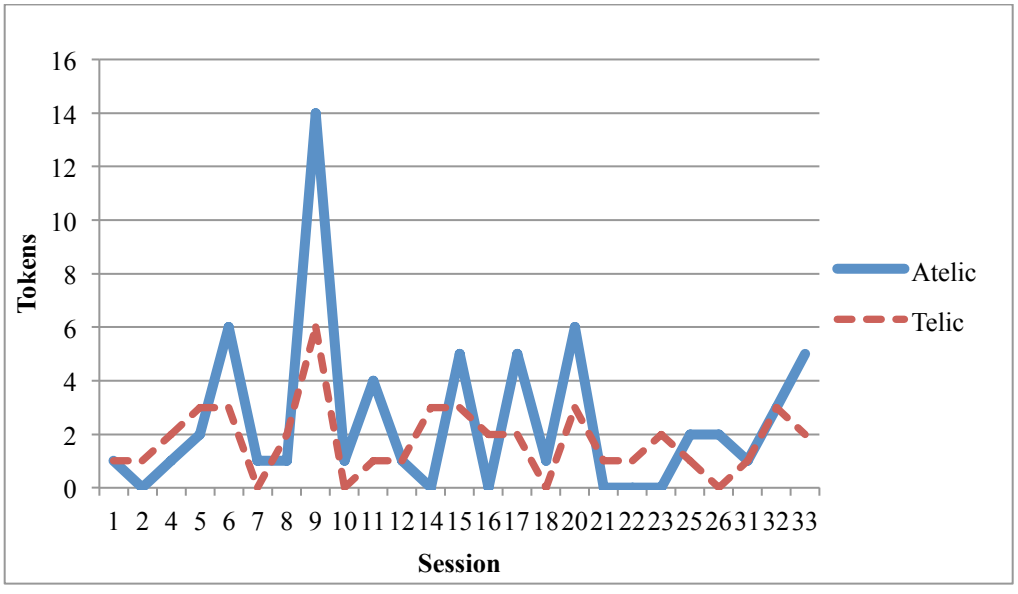

Figure 8. Number of atelic and telic verbs used with "going to verb" frames.

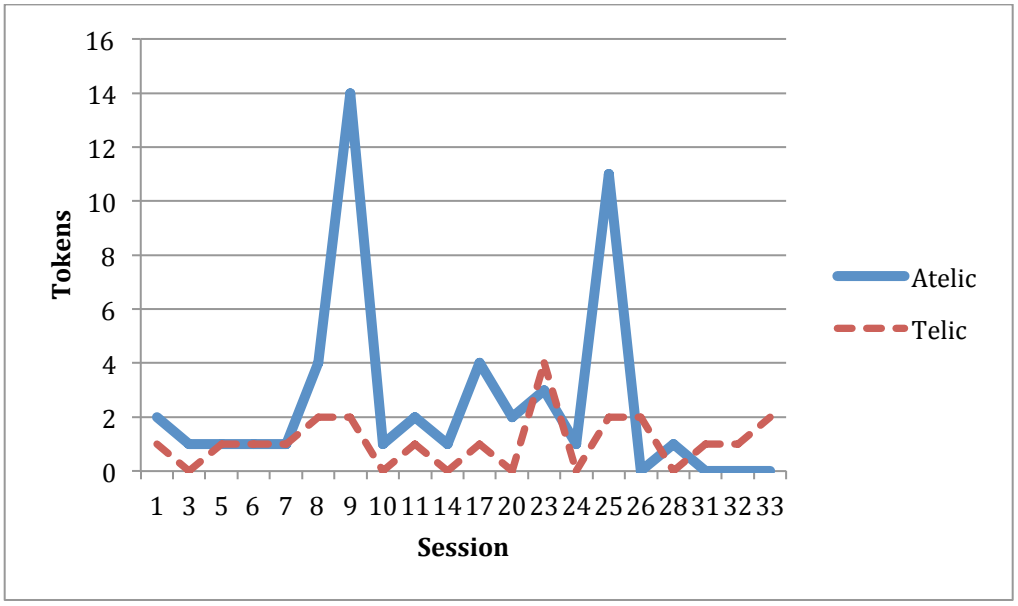

Figure 9. Number of atelic and telic verbs used with "I'm a verb" frames.

Length of Verb phrase. Another hypothesis for why Audrey used the "I'm a verb" frame is related to processing constraints. The proposal here is that longer utterances require more cognitive resources (Bloom, 1970; Bloom 1990) and thus production of a longer VP, which will take up cognitive resources, will require a shorter pre-verbal phrase. Indeed, there has been research suggesting that children may omit parts of utterances due to processing constraints (e.g., the null subject phenomenon in English speaking children; Bloom, 1990). Therefore, the average length of the verb phrase of the three future frames was examined. Under this account, it was hypothesized that because the "I'm a verb" frame has a longer unit preceding the main verb compared to the "will verb" frame in terms of containing an additional syllable. As "going to verb" has the most syllables preceding the main verb and therefore higher cognitive processing costs, the length of its verb phrase should be shorter than that of the "I'm a verb" frame. Therefore, if processing limitations do indeed govern the overall length of an utterance, they may impact the relationship between the pre-verbal phrase and the VP length. Therefore, we would

expect the following pattern, from longest VP to the shortest: "will verb," "I'm a verb," and "going to verb."

Collapsing across their respective contracted forms (e.g., "I'll" with "I will" and "I'm going to" with "I'm gonna"), we found that utterances with the "will verb" frame included more words following the main verb (M = 1.50 words, SD = 0.91) than utterances with the other two frames. However, the differences were not great: utterances with "I'm a verb" included, on average, 1.43 words after the main verb (SD = 0.92), and utterances with "going to verb" included, on average, 1.26 words after the main verb (SD = 1.34). While the general pattern was consistent with the hypothesized direction, the differences between the three frames were too small to determine whether a processing limitation was playing a role.

If the contracted forms are treated separately, the following pattern is expected under a processing limitation view (from longest to shortest VP): "I'll verb," "I will verb, " "I'm a verb," "I'm gonna verb," and "I'm going to verb." "I am a verb" and "I am going to/gonna verb" frames were not treated as a separate category in this analysis as there was only one occurrence of each. As such, they were grouped with "I'm a verb" and "I'm gonna verb" utterances, respectively.

The findings are presented in Table 14. This pattern was unexpected. Under the processing cost account, both "I'm going to verb" and "I'm gonna verb" should have the shortest verb phrase as the preceding units were longer compared to the rest. However, verb phrases of the "I'm going to verb" frame averaged the second longest, and thus was inconsistent with the predicted pattern.

Table 14

Length Ordering of Verb Phrases in Future Frames

Hypothesized Ordering of VP lengths (From longest to shortest)	Observed Ordering of VP lengths (From longest to shortest)
1. 'll verb	1. I'll verb (M = 1.62 words after main verb, S.D. = 0.90)
2. Will verb	2. I'm going to verb (M = 1.56 words after main verb, S.D. = 1.01),
3. I'm a verb	3. I'm a verb (M = 1.43 words after main verb, S.D. = .92),
4. I'm gonna verb	4. I will verb (1.24 words after main verb, S.D. = .88)
5. I'm going to verb	5. I/I'm gonna verb (M = 1.23 words, S.D. = 1.37).

In sum, "I'm a verb" patterned similarly to "going to verb" in that the verbs used in both these frames were more frequently atelic in nature. This provides support for the view that "I'm a verb" may be a contracted form of "going to verb" as well as the notion that telicity of verbs can have an effect on the particular frame type chosen to express future events. However, neither parental input nor processing constraints appeared to contribute to Audrey's use of this frame. Therefore, the use of this frame by Audrey still appears atypical, due to its higher frequency of use compared to typically developing children.

Atypical use in other domains

To investigate whether other areas of Audrey's language development might show deviance or delay, we examined two constructions shown to emerge within this age range: noun-noun compounds and verb-particle constructions (Snyder, 2001).

Noun-noun compounds. One hundred and seventeen uses of noun-noun compounds were produced throughout the duration of the study. Of the total, 10 types and 14 tokens of novel noun-noun compounds (e.g., *tooth necklace*) were found. The first production of a novel noun-noun compound occurred at 33.87 months while productions of lexicalized noun-noun

compounds were found from the first recording at 33.70 months. It should be noted that a novel noun-noun compound erroneously marked for the plural (i.e., *ears doctor*) was produced by Audrey at 34.03 months.

Verb-Particle constructions. A total of 304 verb-particle constructions were produced over the 36 sessions. Of the total occurrences, 35 (11.51%) were of the V-NP-P type (e.g., "have to take your hat off") and 14 (4.61%) were of V-P-NP type (e.g., "we clean up the book"). The former construction was first produced at 33.87 months and the latter at 33.97 months. The remaining tokens (255, 83.88%) consisted of the V-P construction type, appearing with only intransitive verbs (e.g., "he's waking up"). This type of construction was found starting from the first recording (Age = 33.70 months).

As predicted by Snyder (2001), verb-particle constructions preceded noun-noun compounds for typical children. Hence Audrey does not seem atypical here.

Interval testing analysis

The Speechome Recorder allows for more dense data collection than most previous methodologies used (Naigles, 2012). To investigate whether this provides a more informative understanding of the pattern of language development, we manipulated our dataset to reflect intervals comparable to previous studies on language acquisition**.** Audrey's acquisition of future forms was examined.

First, as previously discussed, when performing polynomial regression analysis on future tense use of Audrey's complete data set, a quadratic model best fit the "will verb" trajectory while "going to verb" and "I'm a verb" frames were best described with cubic models. Overall, each frame type's regression model was significant in accounting for the frame's shape ($p < 0.01$ for all three frames; Figure 10).

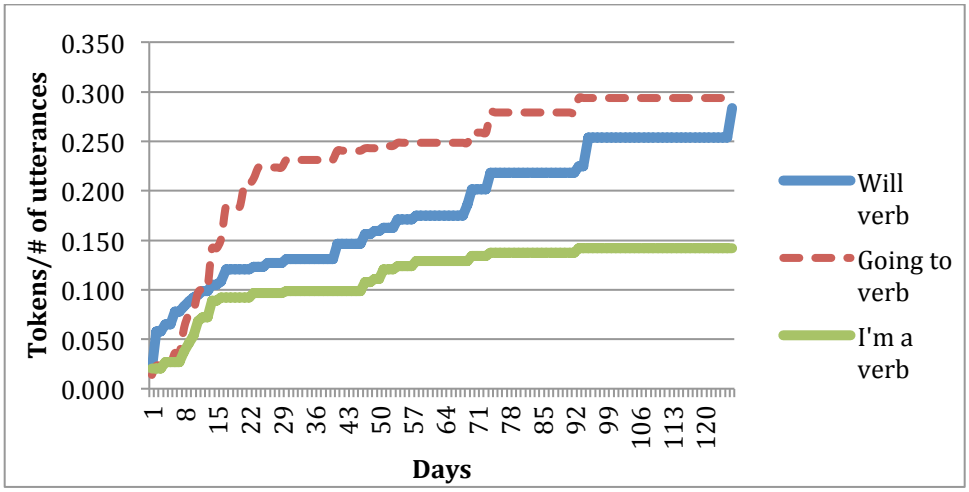

Figure 10. Developmental trajectories of Audrey's future frame use with the complete data set.

When sampling with a 3-day interval, little change was seen (Figure 11). A quadratic model again best fit the "will verb" trajectory (adjusted $R^2 = 0.98$) while a cubic model best fit "going to verb" and "I'm a verb" frames (adjusted $R^2 = 0.92$ and adjusted $R^2 = 0.93$, respectively). Similarly, all models remained highly significant in their fit ($p < 0.01$ for all three frames).

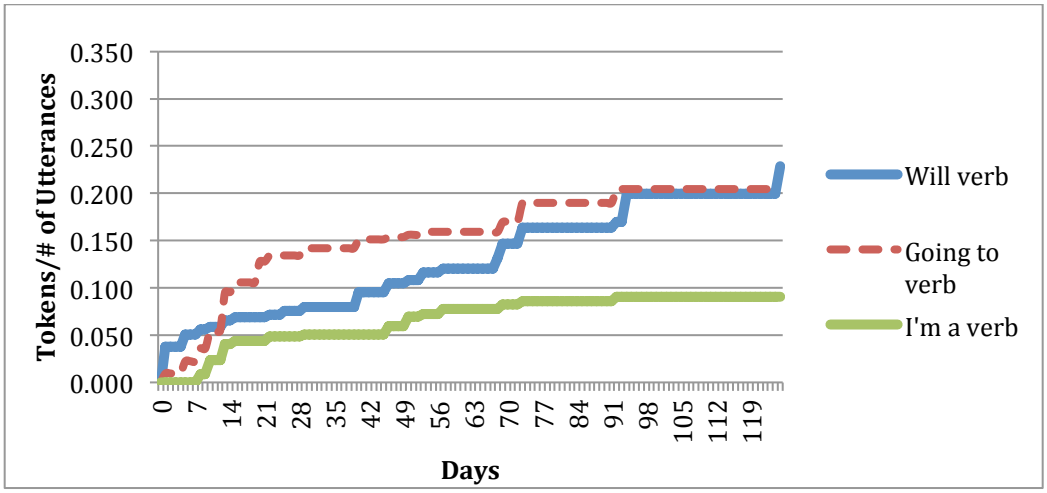

Figure 11. Developmental trajectories of Audrey's future frame use with three-day sampling.

With a weekly sampling interval, changes to the shape of the frames' trajectories emerged (Figure 12). The quadratic model was no longer a significantly better fit compared to a

linear model ($p = 0.90$) for the "will verb" frame. The best-fit line, therefore, was linear ($y = 0.005 + 0.001x$). Cubic models were also no longer significantly better than quadratic models in characterizing the shape of "going to verb" and "I'm a verb" frames ($p = 0.98$ and $p = 0.07$, respectively). As such, quadratic models were the best fit for the two frames ($y = 0.012 + 0.001x - 3.847X10^{-6}x^2$ and $y = 2.224X10^{-4} + 7.576X10^{-4}x - 2.834X10^{-6}x^2$, respectively)

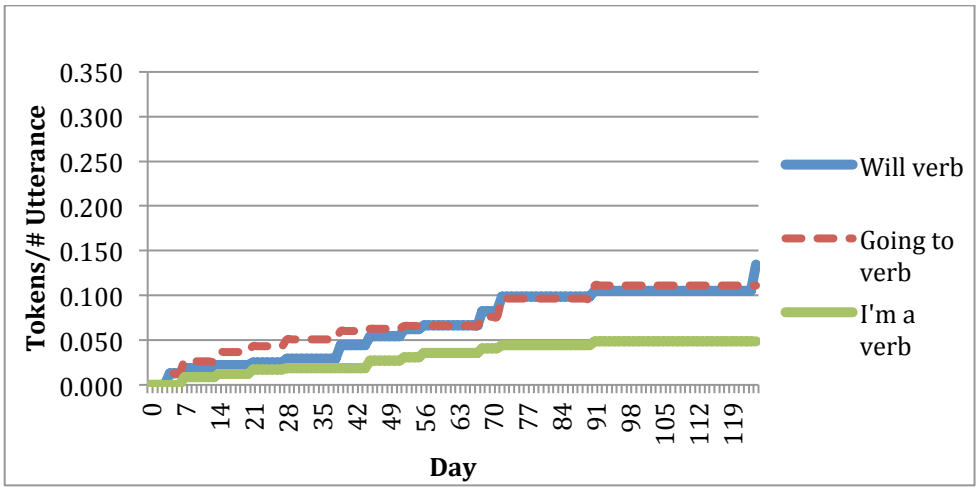

Figure 12. Developmental trajectories of Audrey's future frame use with weekly-day sampling.

Yet a different pattern was found with the bi-weekly interval sampling (Figure 13). While a quadratic model best fit the "will verb" frame ($y = 4.624X10^{-3} + 3.148X10^{-4}x + 2.620X10^{-6}x^2$, adjusted $R^2 = 0.98$, $p < 0.01$), consistent with the findings using the complete data set, "going to verb" and "I'm a verb" frames became best characterized with a linear model ($y = 0.014 + 4.99X10^{-4}x$, adjusted $R^2 = 0.89$, $p < .001$ and $y = 0.011 + 2.031X10^{-4}x$, adjusted $R^2 = 0.88$, $p < 0.001$, respectively).

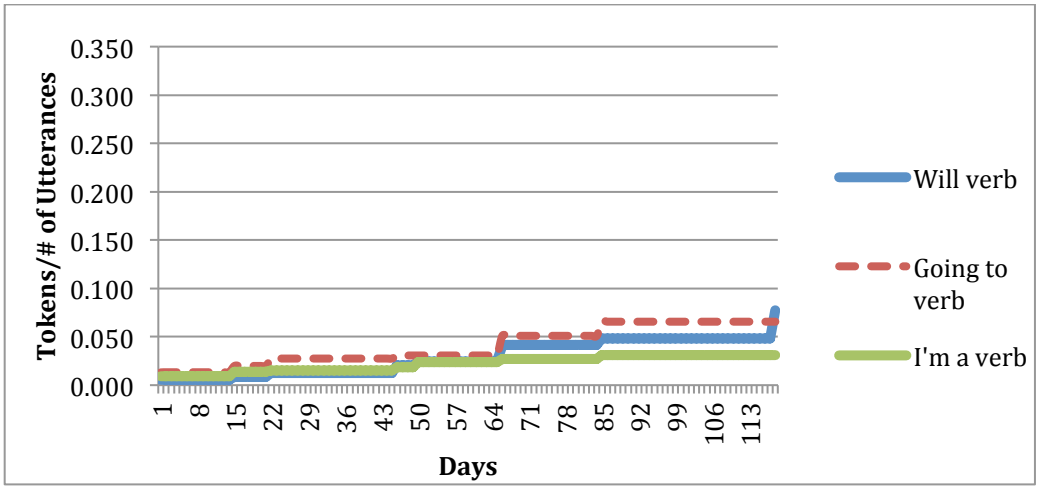

Figure 13. Developmental trajectories of Audrey's future frame use with bi-weekly sampling.

The most dramatic change occurred with the monthly sampling interval (Figure 14 and 15), with all three frames being best characterized with a linear model ($y = 0.002 + 3.697X10^{-4}x$ and $p = 0.02$ for "will verb", $y = 0.015 + 2.343X10^{-4}x$ and $p = 0.01$ for "going to verb", and $y = 9.580X10^{-3} + 8.276X10^{-5}x$ and $p = 0.01$ for "I'm a verb").

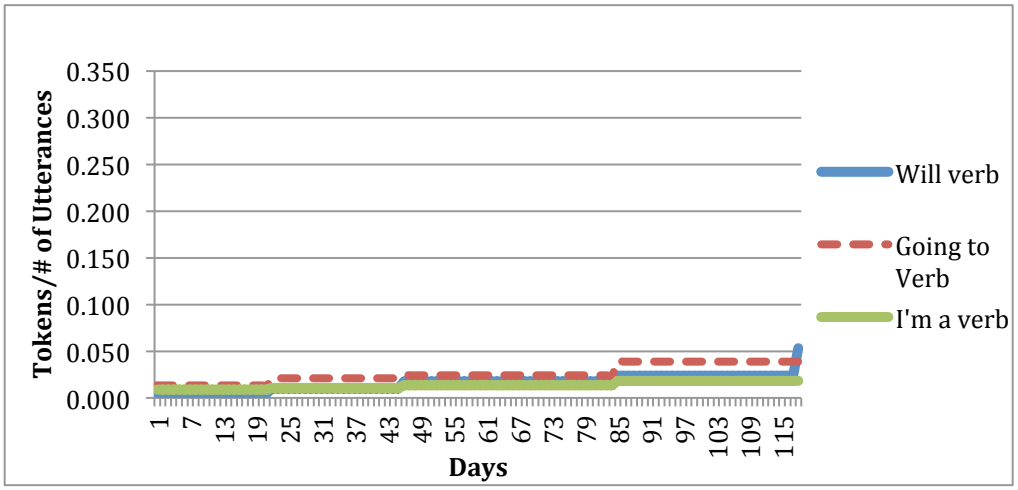

Figure 14. Developmental trajectories of Audrey's future frame use with monthly sampling.

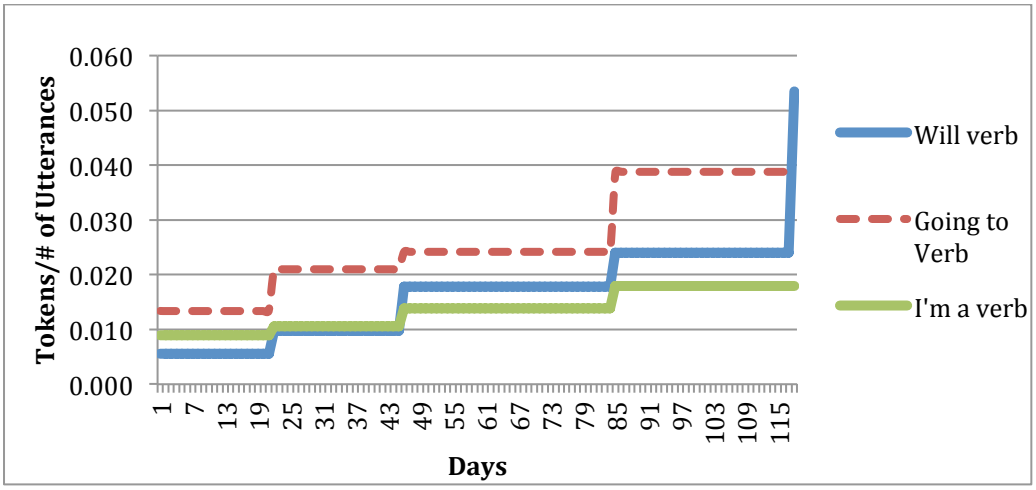

Figure 15. Developmental trajectories of Audrey's future frame use with monthly sampling (expanded view).

Discussion

The current thesis examined densely sampled, longitudinally collected, spontaneous speech productions from two children, one typically developing and one who had previous symptoms of ASD, with three aims. The first was to assess the development of the productive use of tense in atypical and typical populations through a novel device that allowed collection of dense recordings. We believed that utilizing a denser corpus would provide additional information concerning productive tense/aspect morphology use in TD children. This was motivated for a few reasons. First, a dense corpus allows us to track uses of tense/aspect markers across more sessions. With a sparser data set, we may miss occurrences in which an obligatory morpheme is supplied correctly or incorrectly omitted. As demonstrated by Rowland and Fletcher (2006), chances of over and underestimating a child's error rates increase with smaller sampling sizes. It is possible, then, that the smaller samples employed in previous studies investigating children's productive use of tense under- or over-estimated their ability. Second, with a dataset collected at smaller intervals, we can capture more minute changes in a child's

productivity with tense (e.g., average of new verbs marked with "-ed" per session, where sessions are typically collected between 1 to 3 days apart) rather than capturing gross changes in productivity. Relatedly, as productivity has not truly been assessed in prior studies in children with ASD, we hoped that a dense corpus would allow us to examine this question. Our second aim was to focus on the development of future tense as this has been relatively less studied in both TD children and children with ASD. Lastly, we aimed to evaluate the extent to which developmental patterns observed in language development research might be subject to distortions (i.e., misrepresentations of their trajectories) based on sampling rates. A discussion of our findings for the three aims follows.

Regarding productivity with present and past tense markers, the two children, Audrey and Cleo, were in many ways comparable. Both demonstrated use of present (i.e., third person singular and progressive "-ing") and past tense markers (i.e., "-ed" marking on regular verbs and suppletion or vowel change for irregular verbs) at similar rates. Across and within sessions, both utilized present and past tense markers on different verbs and incorporated new verbs throughout the study. In addition, Audrey made four overgeneralization errors (i.e., marking irregular verbs with "-ed") while Cleo made one in the subset of her data. Lastly, errors made by both Audrey and Cleo were mostly ones of omission and not commission, consistent with findings by Snyder (2011) with TD children.

Regarding future tense use, three future frames were observed in both children's productions: "will verb," "going to verb," and "I'm a verb." Both children used these frames in a productive manner. Different and new verbs were used with the three frames across and within sessions. Although frequency of the use of "will verb" and "going to verb" differed among Audrey and Cleo (with the former preferring the "going to verb" frame and the latter the "will

verb" frame), comparisons with other TD children from the CHILDES database suggest that there were no consistent patterning with regards to the use of the two future frames. More specifically, Audrey patterned similarly to Naomi while Cleo patterned similarly to Sarah and Adam. Parental input also did not seem to play a role, as all five parents produced "will verb" frames most frequently. Hence, it appears that the preference for "going to verb" or "will verb" as a future frame is driven by individual differences and as such, Audrey appears to be typical in her frequency of use of these two frames. With the "I'm a verb" frame, we again found differences in the frequency of use between the children. Audrey used this frame at a higher rate compared to Cleo. Comparisons with the TD children from the CHILDES database, however, suggest that unlike the two canonical future frames, the frequency of use of the "I'm a verb" frame was not driven by individual differences. Rather, we found that Audrey used the "I'm a verb" frame at a much higher frequency compared to all TD children, even when accounting for the total amount of utterances and future frames produced per session. Parental input also did not seem to play a role, as this frame was not found in Audrey's input. Audrey, therefore, appeared to be atypical in her use of this future frame.

These findings demonstrate that both Audrey and Cleo were utilizing tense/aspect markers in a productive manner. That is, use of these morphological markers and frames with a variety of verbs both within and across sessions suggests that their uses are not being restricted to a small set of verbs, but rather are being flexibly applied. Further evidence for productivity comes from their overgeneralization errors. Although both children incorrectly applied the "-ed" morpheme to irregular verbs, these errors demonstrate that they have extracted and acquired the "-ed" past tense rule. It should be noted that three of Audrey's four overgeneralization errors involved the application of the "ed" to an irregular verb that was already marked correctly for the

past (e.g., “drewed”) rather than applying the marker to the stem of the irregular verb (e.g., “drawed”). This rate was higher than reported in Marcus et al. (1992), where the latter type of error accounted for a mean of 3.9% of overgeneralization errors and the former accounted for 72.1%. It is difficult to claim whether this should be considered as evidence of atypicality in Audrey as the number of overgeneralizations produced by her was so low.

Stronger evidence of atypicality in Audrey emerged when examining differences in the children’s future frame use. While both children were using future frames productivity, Audrey’s high frequency of “I’m a verb” use compared to the other TD children suggests atypical development. In sum, then, it appears that a) both children have acquired these morphological markers for tense/aspect and are applying them in a rule-based way, rather then producing marked verbs as frozen forms and b) both are typical with respect to their use of present and past tense markings. However, Audrey appears atypical in her use of future frames, specifically, the “I’m a verb” frame.

The findings here are important for several reasons. They provide additional support through the use of a dense corpus in the typically developing literature that suggests early emergence of productivity with tense morphology (i.e., past and present). Regarding research on ASD, this would be among the few to demonstrate not only that a child who had previously exhibited symptoms with ASD can acquire and use tense markings comparably to a TD child, but also that she can use tense morphemes productively. Demonstrations of overgeneralizations from a child in this population are also among the first, as it is typically thought that they produce language in frozen forms (Tager-Flusberg & Calkins, 1990). Similarly, findings from Roberts et al. (2004) suggest that there are two subsets of children with ASD, those who made more omission errors than TD children (low-verbal) and those who are comparable to TD

children in their use of tense markers (high-verbal). Audrey's productivity with using morphological tense markers in obligatory contexts and overgeneralization errors suggests that she is similar to the latter category of children in Roberts et al. (2004), consistent with our prediction.

While the frequency with which these overgeneralizations were produced appeared to be slightly lower than was found in Marcus et al. (1992), (i.e., about 0.013% versus $M_{\text{per child}}$ = .042%, respectively), there may be a few reasons for this. In general, Marcus found that children varied greatly in their overgeneralization rate (i.e., range = 0% to 0.24%). It is possible, then, that Audrey was similar to the children in the lower ranges that simply did not overgeneralize as frequently in Marcus et al. (1992). A second possibility is that we had captured the wrong developmental period for which Audrey might be expected to produce these forms. Under this scenario, it is possible that Audrey produced these over-regularized forms at similar rates compared to TD children prior to the age of 33.70 months, when we began to collect her spontaneous speech productions. It is also possible, however, that Audrey's use of overgeneralizations reflect underlying differences in how she uses the "-ed" marker compared to TD children, which may be a remnant of her previous symptoms of ASD. This is not an unreasonable hypothesis to propose. While Audrey did not reach ASD criteria at the beginning of the study, it does not appear that she should be categorized as typically developing either, as we see some divergence in her future tense use.

When examining her use of the "I'm a verb" frame, we found that Audrey produced this frame at a much higher frequency compared to her TD counterparts, despite the lack of evidence for this frame in her input. Examination of verb types used with this frame suggested that this was not a frozen form used by Audrey. Similar to present and past tense markings, we found

that not only were different verb types being used with this frame within sessions, but also new verbs were being incorporated across sessions. Why, then, was Audrey using this frame when she had access to typical future frames, "will verb" and "going to verb?"

Three accounts were proposed. The first was that there were differences in the type of future events each frame conveyed (e.g., "I'm a verb" for immediate future events, "going to verb" for near future events, and "will verb" for distant future events). Evaluation of this hypothesis was attempted by calculating the timing difference between when Audrey produced an utterance and when the action was executed. However, as mentioned previously, due to technological issues, performing this analysis was not possible. We, therefore, attempted to determine at least whether "I'm a verb" was a shortened form of "going to verb," as some proposed for the use of "I'm a" in AAE (Green, 2002; Rickford, 1999). Analysis of the telicity of the verbs used in the three frames were performed in order to determine whether a) "going to verb" and "will verb" utterances were afforded different telicity due to the presence or absence of a progressive element and b) whether "I'm a verb" would pattern similarly to "going to verb," if the former is indeed a variant of "going to verb." We found support for our hypotheses. Both the "I'm a verb" and "going to verb" frames appeared more with atelic verbs while "will verb" appeared more often with telic verbs. This suggested that semantically, "I'm a verb" is similar to "going to verb." This, however, does not explain why Audrey would use "I'm a verb" despite having the "going to verb" frame. We, therefore, made our third proposal: the "I'm a verb" frame was used to alleviate processing load. More specifically, Audrey had limited processing capacities, which allow for only a limited utterance length. In order to produce a longer verb phrase, the pre-verbal phrase therefore needed to be shortened. The preverbal phrase in the "I'm a verb" frame is shorter in length (i.e., in terms of the number of syllables) compared to "I'm

going to verb" and as such, the former should allow for a longer verbal phrase. However, support for this hypothesis was not found. There were no consistent patterns found between the length of the pre-verbal phrase and the VP length. As such, it does not appear that Audrey was utilizing this phrase due to processing constraints.

Therefore, the question as to why Audrey used the "I'm a verb" frame despite having another frame that is typically used to describe the same type of future event remains unanswered. We can only speculate as to why Audrey used this frame in a productive manner, but a possible contributing factor could be her previous experience with symptoms of ASD. As previously reported, two TD children, Adam and Sarah, produced this frame a few times despite the lack of evidence for this frame in their input. It is possible, then, that all three children made an initial processing error (e.g., parsing "I'm going to/gonna" as "I'm a"). What possibly differentiates Audrey from Adam and Sarah, however, was that Audrey continued to utilize this frame due to difficulty with detecting and correcting errors while the TD children overcame this error more quickly. Indeed, problems with error detection have been previously found in individuals with ASD (Russell & Jarrold, 1998; Sokhadze et al., 2010). Sokhadze et al. (2010), for example, found that when event-related potential (ERP) responses were taken during an oddball paradigm, in which participants must respond (i.e., through a button press) when a target is presented serially among a series of more common and non-common stimuli, individuals with ASD differed in their response compared to age and IQ-matched TD individuals. More specifically, the amplitude and latency of two ERP components, ERN and Pe, typically associated with the detection of errors, were more reduced and prolonged in individuals with ASD compared to the TD group. This suggests that individuals with ASD may not be as efficient compared to TD individuals in their ability to detect errors. As ERN is associated with the

automatic detection of errors and Pe with the conscious "attribution of motivational significance" (Sokhadze et al., 2010, p. 81) of errors, differences found in both components suggest that there may be issues with both detecting errors as well as a attributing meaning or significance to errors in individuals with ASD. While the study used a non-language task and suggests a more domain-general issue, it may be possible that this difficulty in error detection can affect error detection in language in children with ASD as well. This differs from TD children, who have been shown to be somewhat sensitive to their own errors and parents' corrections (i.e., reformulations) of these errors (Chouinard & Clark, 2001). It is possible, then, that Audrey continued to use the "I'm a verb" frame due to her inability to realize that this was an erroneous frame and/or that erroneous forms need to be corrected. It is important to note, however, that parents and caregivers in our study did not appear to give direct, corrective feedback to the children, which is consistent with what has been previously found in TD literature (Brown and Hanlon, 1970).

Another possibility is that "going to verb" and "I'm a verb" are differentially used in such a way that was only distinct to Audrey (e.g., finer gradations of near future, with one frame referencing an event close to the near future and the other frame referencing an event further into the future, but still considered near-future). This is not inconceivable, as there are languages that do distinguish tense into finer categories (e.g., Mohawk). As we found a decrease in the use of "I'm a verb" in later sessions, it is possible that more experience with future frames use led to the diminishment of the differences between the two frames and as a result, "going to verb" superseding "I'm a verb." More densely collected speech productions are needed from both TD children and children with ASD to clarify this issue. It is possible that Abe or Sarah continued to use this form, or even that these forms were used at higher rates than that revealed through the speech samples collected, but were simply not captured due to the short duration of recordings

and the somewhat large interval size**.** Therefore, while it may be the case that TD children undergo a similar period of using this "I'm a verb" frame, we cannot determine if this is truly the case due to the limitations of the sparse data set from CHILDES.

Indeed, our analysis on the effects of interval size seems to suggest that studies that utilize sparse data collection intervals may not fully capture children's language abilities. More specifically, we found that despite utilizing the longest session for each sample, distortions in the shape of the developmental trajectory of Audrey's future tense use emerged when the collection interval was lengthened to weekly sampling. While the growth of "will verb" uses in the complete dataset was best described with a quadratic model and "going to verb" and "I'm a verb" uses with cubic models, models changed with the weekly sampling interval. In this dataset, the growth of "will verb" uses was best described with a linear model while the other two frames were best described with the quadratic. With our largest sampling interval, the monthly interval, all future frames were best modeled with linear models. This suggests that as sampling intervals are lengthened the ability to accurately model future tense development decreases. More specifically, as sampling became less dense, the models became more constrained in terms of the highest order of polynomial regression model that can be used to describe developmental change.

The interval at which distortion emerged differed from Adolph et al. (2008) in that distortions appeared in their dataset when intervals were extended from daily to 3-day intervals. However, it should be noted that measurements in Adolph et al. (2008) were binary in nature (e.g., whether standing behavior was demonstrated or not) while ours were continuous (e.g., number of instances of past tense "-ed" marking produced), which may account for our different findings. It may also be the case that if the longest session was not used for each data interval, distortions would have emerged earlier in our study. Lastly, it should be noted that the frequency

of "I'm a verb" appeared at a much smaller rate during larger intervals, even when taking into account the total number of utterances. That is, with the complete data set, this frame accounted for a cumulative of 0.142 tokens out of all utterances. However, when intervals were extended to weekly sampling, the ratio dropped to 0.048 tokens out of all utterances. Thus, without a densely collected corpus, Audrey's productive use of "I'm a verb" may be deemed as performance error. However, our analysis using the complete dataset suggests otherwise. This demonstrates that research in language development needs more microgenetic sampling methods in order to accurately represent patterns of acquisition and change.

Summary and Implications

When comparing the development of two children, one typically developing, Cleo, and one previously exhibiting symptoms of ASD, Audrey, we found similarities and differences. Both children demonstrated productive use of present and past tense markings. From this, we were also able to demonstrate that children with previous symptoms of ASD can acquire rule-based forms. We were also able to add to the future tense literature by demonstrating that with regards to the two canonical future frames "will verb" and "going to verb," there are individual differences in the preference for two future frames, regardless of parental input. As we found that the use of the "will verb" and "going to verb" frames are related to the type of verb being used (i.e., telic or atelic), it may be the case that this difference in the preference for the two future frames is similarly related to the type of events being talked about by the children (e.g., those using more "will verb" frames are talking about more telic events). Comparison of the productive use of these two frames along with effects of parental input have not been examined before, and as such, we provide some new insight into this area. What we have yet to explain, however, is Audrey's atypicality in her future tense use, namely her high frequency of producing

"I'm a verb." Analyses from the current study do not yet fully explain why this frame is used despite productive uses of the other canonical forms of future frames. Our findings suggest that "I'm a verb" and "going to verb" are semantically similar; however, whether more specific differences exist between the two frames is unclear. Lastly, the importance of using dense corpora should be noted. Developmental patterns were misrepresented (e.g., quadratic growth being fitted with linear line) starting from when the interval changed from daily to weekly sampling. As weekly sampling is typical in language development research (Lieven & Behrens, 2012), we suggest that previous studies examining children's developmental trajectories may not be accurately representing children's developing language profiles. As demonstrated with less dense data sampling, the models for the three future frames became more linear in nature. Therefore, there may be an over-estimation of the number of developmental trajectories that are fit with a linear model. This may have implications for what we judge to be typically developing, as well as the accounts proposed to explain these trajectories' shapes. As such, further investigation into use of microgenetic methods or dense sampling in language research is needed.

Limitations and Future Directions

While we were able to address our three aims in this study, there were also limitations that should be addressed for future research. First, we were somewhat limited in our ability to determine whether a verb was incorrectly unmarked for the past or for the present tense. While the context provided some information, often it was not enough to reliably establish the intended tense of the verb. As our methodology utilizes spontaneous speech, rather than test items controlled for and targeting specific tenses, it may be a limitation that is unfortunately inherent in the method and as such, difficult to remedy. However, future studies can use a combination of both spontaneous speech data and elicitation production or comprehension measures to

complement each other's findings. Another limitation in our study was the timing under which the study was executed. Under the microgenetic method proposed by Adolph et al. (2008), data collection should begin *prior* to the emergence of the particular phenomenon of interest. In our study, Audrey appears to have been relatively proficient with tense markers from the beginning of the study. As such, we were unable to capture the emergence of her ability to use tense. The two final limitations refer to the machinery of the SR itself. First, due to issues with the device's ability to synchronize audio and video recordings accurately, we were unable to perform analyses comparing timing differences among the three future frames between the production of an utterance and execution of the action. This issue may be resolved in the future with modifications to the hardware of the SR. Second, while we were able to record the children's speech in different contexts, with multiple speakers, the SR was situated in only one room of each of the families' homes, namely the playroom. As such, we may not be capturing the children's full abilities because the playroom setting may not promote the same type of language as other settings (e.g., dining room). A possible remedy may be to combine the SR with a LENA device (http://www.lenafoundation.org) which allows for portability and hence, ability to capture language use in more varied contexts.

In sum, through the use of densely collected spontaneous speech productions, we were able to demonstrate tense productivity in both atypical and TD children, suggesting that this methodology may become important in the future of language development research for providing more comprehensive and accurate descriptions of children's language abilities.

References

Adolph, K. E., & Robinson, S. R. (2011). Sampling Development. *Journal of Cognition and Development*, *12*(4), 411–423.

Adolph, K. E., Robinson, S. R., Young, J. W., & Gill-Alvarez, F. (2008). What is the shape of developmental change? *Psychological Review*, *115*(3), 527–43.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington: American Psychiatric Association.

Bartolucci, G., Pierce, S. J., & Streiner, D. (1980). Cross-sectional studies of grammatical morphemes in autistic and mentally retarded children. *Journal of Autism and Developmental Disorders, 10*, 39–50.

Bloom, L. (1970) *Language Development: Form and Function in Emerging Grammars*. Cambridge, MA: MIT Press.

Bloom, P. (1990). Subjectless sentences in child language. *Linguistic Inquiry, 21*(4), 491-504.

Broen, P. A., & Santema, S. A. (1983). Children's comprehension of six verb-tense forms.pdf. *Journal of Communication Disorders*, *16*, 85–97.

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

Brown, R., & Hanlon, C. (1970). Derivational complexity and order of acquisition on child speech. In J. Hayes (Ed.), *Cognition and the development of language* (pp. 11-53). New York: Wiley.

Cazden, C. B. (1968). The Acquisition of Noun and Verb Inflections. *Child Development*, *39*(2), 433–448.

Chouinard, M. M., & Clark, E. V. (2003). Adult reformulation of child errors as negative evidence. *Journal of Child Language, 30*(3), 637-669.

Comrie, B. (1985). *Tense*. Cambridge, UK: Cambridge University Press.

Davids, A., & Engen, T. (1975). *Introductory psychology*. Random House, Inc.

de Villiers, J. G., & de Villiers, P. A. (1973). A cross-sectional study of the acquisition of grammatical morphemes in child speech. *Journal of Psycholinguistic Research*, *2*(3), 267–278.

Dykstra, J., Sabatos-DeVito, M. G., Irvin, D. W., Boyd, B. A., Hume, K. A., Odom, S. L. (2012). Using the Language Environment Analysis (LENA) system in preschool classrooms with children with autism spectrum disorders. *Autism, 0*(0), 1-13.

Eigsti, I. M., Bennetto, L., Dadlani, M. B. (2007). Beyond pragmatics: Morphosyntactic development in autism. *Journal of Autism and Developmental Disorders, 37*, 1007-1023.

Eigsti, I. M., de Marchena, A., Schuh, J. M., & Kelley, E. (2011*).* Language acquisition in autism spectrum disorders: A developmental review. *Research in Autism Spectrum Disorders, 5*, 681-691.

Green, L. J. (2002*). African American English: A linguistic introduction*. Cambridge: Cambridge University Press.

Hohenstein, J., & Akhtar, N. (2007). Two-year-olds' productivity with verbal inflections. *Journal of Child Language*, *34*(4), 861–873.

Howlin, P. (1984). The acquisition of grammatical morphemes in autistic children: A critique and replication of the findings of Bartolucci, Pierce, and Streiner,1980. *Journal of Autism and Developmental Disorders, 14*, 127–136.

Kuczaj, S. (1976). *-ing, -s and -ed: A study of the acquisition of certain verb inflections.* Unpublished doctoral dissertation, University of Minnesota.

Lieven, E., & Behrens, H. (2012). Dense sampling. In E. Hoff (Ed.) *Research methods in child language: A practical guide* (pp. 226-239). Oxford, UK: Blackwell Publishing Ltd.

Lord, C., Rutter, M., DiLavore, P., & Risis, S. (1989). The autism diagnostic observation schedule-generic. Los Angeles: Western Psychological Service.

Marchman, V. A. (1997). Children's productivity in the English past tense: The role of frequency, phonology, and neighborhood structure. *Cognitive Science*, *21*(3), 283–304.

Marcus, G. F. (1996). Why do children say "breaked"? *Current Directions in Psychological Science*, *5*, 81-85.

Marcus, G. F., Pinker, S., Ullman, M., Hollander, M., Rosen, T. J., & Xu, F. (1992). Overregularization in language acquisition. *Monographs of the Society for Research in Child Development, 54*(4, Serial No. 228).

MacWhinney, B. (2000). *The CHILDES Project: Tools for Analyzing Talk*. 3rd Edition. Mahwah, NJ: Lawrence Erlbaum Associates.

MacWhinney, B., & Snow, C. (1990). The child language data exchange system: An update. *Journal of Child Language*, *17*, 457–72.

Mullen, E. (1994). The Mullen scales of infant development. Circle Pines, MN: American Guidance Service.

Naigles, L. R. (2012). Not sampling, getting it all. In E. Hoff (Ed.) *Guide to Research Methods in Child Language* (pp. 240-253). Oxford, UK: Blackwell Publishing Ltd.

Naigles, L. R., Chin, I., Vosoughi, S., Goodwin, M., & Roy, D. (2011). *Final Report for 3R01DC007428-04S1 Collaborative research supplement and infrastructure and research equipment for advancement of science*.

Naigles, L.R., Hoff, E. & Vear, D. (2009) Flexibility in early verb use: Evidence from a multiple-N diary study. *Monographs for the Society for Research in Child Development*, 74 (2).

Rickford, J. (1999). *African American Vernacular English*, Oxford, UK: Blackwell.

Rispoli, M., Hadley, P. A., & Holt, J. K. (2009). The growth of tense productivity. *Journal of speech, language, and hearing research*, *52*(4), 930–44.

Roberts, J. A, Rice, M. L., & Tager-Flusberg, H. (2004). Tense marking in children with autism. *Applied Psycholinguistics, 25*, 429–448.

Rowland, C. R., & Fletcher, S. L. (2006). The effect of sampling on estimates of lexical specificity and error rates. *Journal of Child Language, 33*(4), 859-877.

Roy, D., Patel, R., DeCamp, P., Kubat, R., Fleischman, M., Roy, B.,…Gorniak, P. (2006). The Human Speechome Project. In *Proceedings of the 28th Annual Cognitive Science Conference*. (pp. 2059–2064), Mahwah, NJ: Lawrence Earlbaum.

Russell, J., & Jarrold, C. (1998). Error-correction problems in autism: Evidence for a monitoring impairment? *Journal of Autism and Developmental Disorders, 28*(3), 177-188.

Rutter, M., LeCouteur, A. L., & Lord, C. (2003). *Autism Diagnostic Interview-Revised*. Los Angeles: Western Psychological Services.

Sachs, J. (1983). Talking about here and then: The emergence of displaced reference in parent-child discourse. In K. Nelson (Ed.) *Children's Language, vol.4* (pp. 1-28). Hillsdale, N.J.: Lawrence Erlbaum.

Salkie, R. (2010). Will: tense or modal or both? *English Language and Linguistics*, *14*(02), 187–215.

Siegler, R. S., & Crowley, K. (1991). The microgenetic method: A direct means for studying cognitive development. *The American Psychologist*, *46*(6), 606–20.

Sokhadze, E., Baruth, J., El-Baz, A., Horrell, T., Sokhadze, G., Carroll, T.,…Casanova, M. F. (2010). Impaired error monitoring and correction function in autism. *Journal of Neurotherapy, 14*, 79-95.

Sparrow, S.S., Balla, D.A., & Cicchetti, D.V. (1984). Vineland adaptive behavior scales. Circle Pines, MN: American Guidance Service.

Snyder, W. (2001) On the nature of syntactic variation: Evidence from complex predicates and complex word-formation. *Language*, *77*, 324-342.

Snyder, W. (2011). Children's Grammatical Conservatism: Implications for syntactic theory [Plenary Address]. In N. Danis, K. Mesh, and H. Sung (Eds.) *BUCLD 35: Proceedings of the 35th annual Boston University Conference on Language Development, Volume I* (pp. 1-20). Somerville, MA: Cascadilla Press.

Snyder, W., & Stromswold, K. (1997). The structure and acquisition of English dative constructions. *Linguistic Inquiry, 28*(2), 281-317.

Tager-Flusberg, H., & Calkins, S. (1990). Does imitation facilitate the acquisition of grammar? Evidence from a study of autistic, Down's syndrome, and normal children. *Journal of Child Language, 17*(3), 591-606.

Tek, S., Mesite, L., Fein, D., & Naigles, L. (2013). Longitudinal analyses of expressive language development reveal two distinct language profiles among young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*. Advance online publication.

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

Tovar, A. T., Fein, D., & Naigles, L. R. (2013). Grammatical aspect is a strength in the language comprehension of young children with autism. Manuscript submitted for publication.

Valian, V. (2006). Young children's understanding of present and past tense. *Language Learning and Development*, *2*(4), 251-276.

Vosoughi, S., Goodwin, M.S., Washabaugh, B., & Roy, D. (2012). A portable audio/video recorder for longitudinal study of child development. *In Proceedings of the 14th ACM International Conference on Multimodal Interaction (ICMI '12)* (pp. 193-200). New York, NY: ACM.

Wagner, L. (2001). Aspectual influences on early tense comprehension. *Journal of Child Language*, *28*(3), 661–81.

Wagner, L. (2012). First Language Acquisition. In R. Binnick (Ed.) *The Oxford Handbook of Tense and Aspect*. Oxford: Oxford University Press.

Wagner, L., Swensen, L., & Naigles, L.R. (2009). Children's early productivity with verbal morphology. *Cognitive Development*, *24*, 223–239.

Warren, S. F., Gilkerson, J., Richards, J. A., Oller, D. K., Xu, D., Yapanel, U, & Gray, S. (2010). What automated vocal analysis reveals about the vocal production and language learning environment of young children with autism. *Journal of Autism and Developmental Disorders, 40*(5), 555–569.

Waterhouse, L., & Fein, D. (1982). Language skills in developmentally disabled children. *Brain and Language, 15*, 307-333.

Weisleder, A. & Fernald, A. (in press). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science.*

Zimmerman, F., Gilkerson, J., Richards, J., et al. (2009) Teaching by listening: the importance of adult–child conversations to language development. *Pediatrics*, 124, 342–349.