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Prevalance of Frozen Forms in Children With Autism Spectrum Disorder

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Abstract

Autism Spectrum Disorder (ASD) has been implicated with a wide variety of language impairments and developmental delays in the acquisition of language in young children. A number of unique impairments in the speech of children with ASD have been proposed. The current study empirically investigates one such proposed language error; namely, that children with ASD produce large numbers of frozen, or unanalyzed language forms. Frozen language forms refer to multi-word phrases that are produced by rote and across both appropriate and inappropriate contexts. The children's speech was recorded in a supervised play session with a caregiver, and was coded using an adaptation of Pine et. al. (1993)'s coding scheme. The children with ASD produced frozen forms significantly more frequently than the TD children; additionally, the ASD group produced repetitive, "non-frozen" language forms significantly more frequently than the TD group. However, the actual prevalence of these language errors within the ASD group was fairly low (< 12% of all utterances), and the frequency of these errors tended to decrease over time. Thus the existence of forms may not be appropriate indicators of Autism Spectrum Disorder. Additionally, the speech of children with ASD appeared to match the developmental trends of TD children over time, but at a slower pace.

Introduction

Autism Spectrum Disorder (ASD) refers to a group of developmental disorders most commonly marked by impairments in social interaction, communication, stereotyped behavior or interests, and manifestation of these symptoms before the age of three (DSM IV-TR, APA 2000). Accompanying the impairments in communication of those children with ASD are deficits in language acquisition. These symptoms are nearly universal across diagnoses of ASD and have been the subject of study in the past (Tek, Mesite, Fein & Naigles 2013). Previous research has revealed that children with ASD demonstrate remarkable strength at grammatical comprehension of language, but suffer from difficulties with the pragmatic aspects of communication (Naigles & Chin 2015). These pragmatic difficulties further manifest themselves as difficulties with abstraction of conceptual language across contexts (Kelley, Paul, Fein, & Naigles 2006). Additionally, children with ASD often fail to demonstrate word learning biases that enable typically developing (TD) children to learn language at an exponentially rapid rate (Naigles, Kelley, Troyb, & Fein 2013). All of these general deficits in autistic language acquisition are well documented, but the prevalence of specific, disordered manifestations of language are not. With the exception of Naigles, Cheng, Rattanasone, Tek, Khetrapal, Fein, & Demuth (2016), very little research has focused on exactly how children with ASD manifest language differently from their TD counterparts in terms of specific errors and learning differences. The purpose of this study was to empirically investigate a specific form of possible language deficit in children with ASD using an original coding paradigm, and to compare it to the speech of TD children.

ASD refers to a spectrum of disorders ranging in severity from mild to severe (Landa 2008). Exact symptoms can vary, however social impairments and delayed language acquisition are common to nearly all diagnoses. Deficits with attention and lack of interest in

other people are common symptoms as well. These symptoms can take many forms, ranging from difficulties maintaining conversation, lacking a "theory of mind," the ability to attribute mental states to others, and even total withdrawal from social interactions in the most severe cases (White, Keonig, & Scahill 2007). Additionally, assessing children under 12-24 months for autism spectrum disorder can be very difficult as both comprehension and production are very hard to observe in natural settings in both children with ASD and TD children (Charman, Drew, Baird, & Baird 2003). Many standardized language measures are often not effective until later ages, at around two to five years of age, at which point gaps in language development between a child with ASD and their TD peers become evident. In particular, children with ASD frequently demonstrate fundamental impairments in nonverbal, pragmatic communication, which most often manifest as difficulties with joint attention (Sigman & Ruskin 1999). TD children can typically be seen demonstrating competence in these nonverbal communication abilities before the age of five. However, the delays in language production in ASD do not necessarily indicate that there is a comprehension deficit.

Delays in language production in ASD often do not necessarily reflect underlying deficiencies in linguistic abilities. Goodwin, Fein, and Naigles (2012) examined whether delays in the production of "wh-questions," which are interrogative questions where "wh-words" take the place of missing information, in children with ASD was the result of grammatical or pragmatic impairments. In a longitudinal study comparing both children with ASD and TD children using the Intermodal Preferential Looking paradigm (IPL), it was found that both groups demonstrated comprehension of wh-questions well before their production. The ASD and TD groups were able to consistently comprehend questions involving both subjects ("What hit the apple?") and objects/themes("What did the apple hit?), although the ASD group did so at a later age than the TD group.

However, Goodwin, Fein, and Naigles (2015) examined the children's wh-question comprehension in relation to their mother's input, and reported that children with ASD seemed to often memorize wh-questions in unanalyzed "frozen chunks" before using them in a more productive form. The researchers found a positive correlation between maternal usage of wh-questions with verbs, which typically occur in the context of complete sentences, and the children with ASD's later comprehension of wh-questions in an IPL paradigm test. The authors suspected that this was due to the fact that wh-questions that occur in the context of complete sentences, ("Where are you going?"), carry useful information about morphosyntax, as well as the different pragmatic uses for wh-questions. However, excessive maternal uses of more fragmentary wh-question forms, ("What else?"), were actually correlated with worse performance on wh-question comprehension tests in ASD children. The authors believed this was because these sorts of wh-questions are homogenous in their syntactic form, making them very easy to memorize by rote. These relatively simple language forms can easily be memorized and used by a child with ASD without understanding its intent or parsing it for meaning. Furthermore, if these fragmentary wh-question forms are often utilized by caregivers, the more the child with ASD will treat as them as routine sayings, without the need for further analysis. Instead of understanding the pragmatic meaning of a phrase such as "What's that," it is used by the child with ASD as a simple cue to name an indicated item. However, while the authors noted the presence of these "frozen chunks," or unanalyzed language forms, they did not examine the actual prevalence of this phenomena.

However, while both children with ASD and TD children are similar in many ways in their capacity for language acquisition, there may still be learning differences between the two groups. This is most evident in the unique language errors found in children with ASD. For example, Naigles et. al. (2016) investigated the prevalence of pronoun reversals in

children with ASD. Pronoun reversal refers to using the incorrect pronoun in a sentence ("You want some milk" instead of "I want some milk") and is an often-cited phenomena in the speech of children with autism. Using a pronoun correctly is a complex, linguistic and pragmatic process, requiring knowledge of the number, case, and person of a sentence. As children with ASD's language comprehension often outpaces their social development, this error is likely to result due to difficulties with perspective-taking. The results found that the ASD group did produce significantly greater numbers of pronoun reversals than the TD group (p=.001).

Of the total utterances produced by the children with ASD , approximately 6.42% were pronoun reversals at visits 1-3, and 4.15% of their utterances were pronoun reversals in visits 4-6. This is in comparison to the TD children, whose total usage of pronoun reversals comprised 1.67% of their total utterances in visits 1-3, and 0.68% of their total utterances in visits 4-6. However, while the children with ASD produced greater numbers of pronoun reversals than their TD counterparts, their actual prevalence was quite low. Additionally, their usage decreased over time in both groups, and did not occur with any sort of consistency within the ASD group. This is likely an indication that further research is required to determine whether such errors truly occur consistently in ASD. The topic of the current study was an attempt to fill this gap for a particular language error also frequently cited in descriptions of language use in children with ASD, "frozen" language forms.

Frozen, or unanalyzed, language forms are essentially words and phrases that are memorized "verbatim" and used across multiple contexts. For example, when requesting a desired item from a caregiver, a TD child might use such diverse forms as "Can I have that," "Give me that," "Are you using that," or "Please, may I have that?" The diversity in forms indicates an understanding that each form has an equivalent meaning, and that each form

would be appropriate in the given situation. However, a child with ASD may, for example, use the form "I want that" in every situation. Although there is an understanding that the phrase is used to request something, it is not learned in variable chunks that can be applied in multiple contexts, but as a single, static unit. Such language forms are not limited to children with ASD or even the English language. Newport (1988) examined adult learners of American Sign Language (ASL) and noticed a similar phenomenon. Late learners of ASL who had not been exposed to the language until late childhood or adulthood exhibited significantly large amounts of these frozen language forms, especially in the context of verbs. Verbs in ASL often contain "modifier motions," which can further describe a verb's path of motion, or identify the tense that it occurred in. These modifiers occurred frequently in early/ child ASL learners, but were seldom used by late learners. Instead, adult learners of ASL typically relied on a limited catalogue of "stock" phrases that they used across most contexts. Modifiers were either not utilized, or were used inappropriately. However, frozen language forms are not limited to late learners or children with ASD as they can be found in the speech of TD children as well.

Typically developing language learners most often utilize one of two distinct strategies for language acquisition. The first combines known single words into new configurations, forming phrases and eventually complete sentences. The second strategy involves "slotting" new words and phrases into existing "semi-frozen" templates to form new phrases (Pine & Lieven 1993). These frozen phrases do not tend to represent deficits in language acquisition when found in TD children. For example, Lieven, Pine, & Barnes (1992) developed a coding scheme to classify multi-word phrases into different categories, and analyzed these in longitudinal transcripts of recorded play sessions and maternal diary entries. Frozen phrases showed the greatest variance in prevalence across children, with

values ranging from as low as 2% of all utterances to as high as 42% of all utterances. However, the prevalence of frozen forms decreased steadily over time, and those children who produced large numbers of frozen phrases, when just begging to exhibit multi-word speech, tended to be more productive speakers later on. Additionally, strong positive correlations were observed between common nouns and frozen phrases, with both steadily decreasing over time. The authors concluded that those TD children who acquired large numbers of frozen phrases in their early speech were adopting a "non-referential" strategy of language acquisition in which new words were incorporated into existing frozen phrases. The content of these frozen phrases would indicate what parts of speech the child is attending to most closely, and their speech would begin to rely on these frozen forms less as they matured and began to utilize more productive language forms. Lieven, Pine, and Barnes (1992) surmised that frozen forms, when found in TD children, represented an early language acquisition strategy and did not indicate an underlying deficit.

However, it is unclear if such a pattern would hold in the language of children with ASD. It seems unlikely that frozen language forms would predict later language productivity in autism, especially given that the tendency of children with this order disorder to manifest as stereotyped and limited behaviors. These behaviors can take many forms, ranging from repetitive motions, object manipulations, limited interests, resistance to change, and repetitive language use (Watt, Wetherby, Barber, & Morgan 2008). These types of behaviors typically begin to emerge at approximately the second year of age, and Wetherby, Woods, Allen, Cleary, Dickinson, and Lord (2004) found significant differences between TD and ASD groups for instances of stereotyped movements at approximately twenty-one months of age. They reported that 72% of the ASD group showed repetitive object manipulations, while 0% of the TD group demonstrated these behaviors. Additionally, 50% of the ASD group

demonstrated stereotyped, bodily movements with no member of the TD group exhibiting similar stereotyped behaviors (Wetherby et. al. 2004). The findings of Watt et. al. (2008) indicated that these stereotyped behaviors were found less often in higher-functioning children with ASD who tended to resemble their TD counterparts more closely in language acquisition and nonverbal communication. However, Zandt, Prior, and Kyrios (2007) found a significant difference in repetitive movements and language measures between a high-functioning ASD group and a TD group, indicating the presence of these behaviors across the range of ASD severity.

Considering the repetitive nature of frozen forms, combined with the resistance to change often found in ASD, frozen forms would seem to act as an effective tool for a speaker with ASD; one language form that could be used across all contexts to accomplish communicative goals, bypassing the pragmatic and grammatical difficulties of learning multiple language forms for different situations.

Frozen language forms are very similar in their functions to the restricted and repetitive behaviors (RRB) so common to ASD diagnoses. Although widely recognized as a homogenous symptom of ASD, the actual form of RRBs can vary greatly (Szatmari, Georgiades, Bryson, Zwaigenbaum, Roberts, Mahoney, Goldberg, & Tuff 2006). RRBs refers to a wide variety of behaviors, ranging from resistance to change, compulsions and rituals, unusual attachment to objects, repetitive hand and finger mannerisms, and repetitive manipulations of objects. These behaviors are most evident in children with developmental delays; the more severe the diagnosis of ASD, the more common these behaviors are (Szatmari et. al 2006). Szatmari et. al. (2006) also noted that the greatest number of RRBs and the most resistance to change occured in children with ASD who had the greatest delays in language acquisition. Taken together, this would suggest that RRBs are positively

correlated with difficulties in language acquisition, and thus frequency of language errors in children with ASD. RRBs are typically used as a buffer for pragmatic interactions in children with ASD, acting as a repertoire of limited behaviors for use in social situations. As suggested by Goodwin, Fein, and Naigles (2015), frozen language forms appear to be used in a similar fashion, as a shortcut for dealing with pragmatic and social difficulties in children with ASD by having access to a repertoire of acceptable phrases for use across contexts. While Lieven, Pine, and Barnes (1992) suggested that frozen language forms were a type of language acquisition strategy for TD children, and thus did not represent a deficit in learning, this does not appear to hold true for children with ASD. Frozen language forms constitute a language error in children with ASD as they are used in the place of language forms, rather than as a strategy to acquire them.

While studies such as Naigles (2013) and Naigles and Fein (2015) have acknowledged the presence of frozen language forms in the speech of children with ASD, they have not been examined in any great detail, nor was a coding scheme for classifying an utterance as being "frozen" provided. In general, there has not been much in the way of specific research involving specific phenomena of language acquisition in children with ASD, barring Naigles et. al. (2016). Moreover, the focus of that study was on language acquisition errors, rather than on possible language acquisition strategies or adaptations. Newport's (1988) work with adult language learners of ASL was in many ways similar to this specific language acquisition phenomenon exhibited by children with ASD. However, Newport's coding scheme was tailored for American Sign Language, and was thus inappropriate for the present study. The coding scheme utilized by both Pine and Lieven (1992) and Lieven et. al. (1993) was much more appropriate for the present study as it was designed for English-speaking children and contained specific criteria for classifying

multi-word utterances. Despite its advantages, their method of coding was not completely appropriate in its current state because its criteria for classifying utterances was designed for older TD children who had a much more advanced grasp of language. The coding scheme was therefore modified to accommodate a sample of children with ASD.

Pine and Lieven (1992) utilized the following coding scheme for classifying multi-word phrases: First, a lexicon was constructed for each child by recording each word that appeared on its own to build a rough approximation of that child's vocabulary. All multi-word phrases were in one of the following categories: Frozen phrases were defined as multi-word phrases which contained two or more words which have not occurred previously in the child's vocabulary, or one such word that had not previously appeared anywhere in the transcript. Intermediate utterances were defined as multi-word phrases which contained only words that have appeared independently in the child's previous vocabulary, but have only appeared once. Multi-word utterances containing one word that has only appeared in the child's previous vocabulary once, with the rest of the vocabulary in the phrase having appeared previously, were also coded as being intermediate. Constructed, or productive, utterances were defined as multi-word phrases made up entirely of known words and phrases that have independently occurred at least twice in the child's vocabulary.

The coding scheme used in the present study was adapted from the principles found in Pine and Lieven (1992), but several key changes were made in order to accommodate its use for with children with ASD. The first was that frozen phrases were classified as only those phrases containing no known words, or which were clearly repetitions of phrases spoken by caregivers. Second, the intermediate category was made more lenient to include all multi-word phrases which consisted of one or more words found previously, or concurrently, in the child's lexicon. Finally, productive phrases were those multi-word phrases which

consisted entirely of known words. These types of phrases were further subdivided into three categories: “pure” productive phrases which consist entirely of known words found elsewhere in the lexicon, repetitive productive phrases which are phrases that consist entirely of words found elsewhere in the lexicon, but appear unmodified three or more times in a transcript, and numerical phrases which consist of simple counting strings. These modifications were made to accommodate the delays present in language acquisition in children with ASD, as well as the stereotyped speech and behaviors often observed in children with ASD. These categories are explained in greater detail in the Methods section below.

The aim of the present study was threefold: First, to develop an empirical coding paradigm tailored to the unique speech of children with ASD adapted from the coding scheme employed in Pine & Lieven (1993). Modifications to the paradigm would include additional categories to accommodate the repetitive and stereotyped speech patterns often exhibited by children with ASD. Second, this modified coding scheme was used to analyze longitudinal transcripts of the speech of autistic children. Lastly, the results were compared to an analogous sample of TD children to determine the ways in which their usage of language differed. Based on the results of Goodwin, Fein, & Naigles (2012) and Goodwin, Fein, & Naigles (2015), it was predicted that the overall measures of language acquisition and productivity would not differ greatly between the ASD and TD groups. Both would exhibit reasonably strong language production, although the ASD group would do so later. However, the ASD group would demonstrate significantly larger numbers of frozen forms than the TD group (Newport 1988). These frozen forms would manifest in some manner across all children with ASD, but due to the varied nature of autistic symptoms, these frozen forms would not occur with any sort of regularity or pattern across time (Naigles et. al. 2016).

Method

Participants

For this study, transcripts of 17 children previously diagnosed with ASD by their physician based on their ADOS scores were obtained from a longitudinal study of children with ASD.The group was composed sixteen boys and one girl. Their ages ranged from 26 to 37 months at the beginning of the study (Mean Age=32.765 months SD=3.6;). The ASD group had been previously recruited through schools and treatment facilities in the northeastern United States as part of the Longitudinal Study of Early Language (LSEL) (Goodwin, Fein & Naigles 2012; Tek, et. al 2013)**.** All children in this group had been professionally diagnosed prior to the study. Their diagnosis was confirmed using both the Autism Diagnostic Observation Schedule (ADOS) (Mean Score=13.823, SD=4.405) and the Childhood Autism Rating Scale (CARS) (Mean Score=34.341, SD=7.009). Both tests were conducted at visit one and visit five, though only CARS scores were reported for visit five in order to account for differences in functioning and overall verbal expression (Mean Score=34.235, SD=8.394). Although the transcripts usually spanned seven visits, seven of the children in the ASD group were missing visit 7, two children were missing visit 4, one child was missing visit 2, and one child was missing visit 5. Moreover, due to the heterogenous nature of ASD whose symptoms can range from mild to severe, only the transcripts of twelve children were fully considered for analysis for the purpose of this study. The other five children were essentially "non verbal," typically with MLUs of 1.0 and often fewer than ten "codeable" utterances. Although their transcripts were fully coded, they were not included in the final analysis in order to prevent the skewing of the results.

For comparison purposes, transcripts were obtained from a group of typically developing (TD) children as well.The TD group had been recruited through the database of

the lab at the University of Connecticut. Their ages ranged from 19 to 24 months of age at the beginning of the study. (Mean Age=21.55 months, SD=2.51). The TD group consisted of eleven boys and one girl. These children were also administered the ADOS (Mean=0 SD=0) and CARS (Mean=15.143, SD=.378) tests at visit one, and none had elevated scores (See *Table 1*). This group did not have any missing transcripts, though not all were analyzed for the purpose of this study.

Procedure

For both the TD and ASD groups, data was gathered through a series of half-hour, in-home visits with each child and a caregiver, usually their mother. Visits were separated by a period of four months. Play sessions were semi-structured, toys and puzzles were provided to stimulate pretend play and joint interaction (joint attention, pointing, reaching, communicating etc.). These portions of the sessions usually lasted for about fifteen minutes, although some children played with these toys for the entire session. The second fifteen minutes of each session was usually a "free-play" portion where the child and caregiver played as they would normally at home. These sessions were video-recorded and transcripts of each visit were created by trained transcribers.

Standardized Test Measures

Autism Diagnostic Observation Schedule (ADOS)

ADOS (Lord, et. al. 1999) is an assessment of communication, social interaction, and play using a semi-structured play session and interviews in order to diagnose autism spectrum disorders. This assessment was utilized at visits 1 and visit 5.

Childhood Autism Rating Scale (CARS)

The CARS scale (Schopler, Reichier, & Renner. 1980) is an alternative rating scale used to indicate autism severity. The scale includes fifteen subscales measuring aspects of communication, emotional expression, and social interaction using structured play and interviews.

Coding

Coding Procedure

Using the transcripts, each child's speech was analyzed line-by-line. Each utterance was coded under one of the following categories using a modified form of the speech analysis paradigm employed in Pine and Lieven (1993). First, individual lexicons were created for each child using all isolated, single-word utterances across visits to construct a rough approximation of each child's vocabulary. Inaudible, or repetitive phrases were noted, but not coded for the purposes of the current study. All multi-word utterances were classified as being frozen, intermediate, or productive in accordance with the modifications made to the coding scheme utilized by Pine and Lieven (1993) to accommodate its use for children with ASD. All productive phrases were then subdivided into "pure" productive, repetitive productive, and numerical phrases. The criteria for each classification is explained in greater detail below.

Mean Length of Utterance (MLU)

MLU is a measure of overall sentence complexity, reflecting a relative level of language development. It is calculated by dividing the number of morphemes by the total number of utterances.

Single Word Vocabulary

These utterances are isolated utterances containing common nouns, proper names, verbs, adjectives, pronouns etc. They also consist of "interactive words," such as "bye" or "booboo" that pertain to a specific situation, but who lack a formal definition (Lieven, Pine, & Barnes 1992). Onomatopoeic words were coded in this way as well (See *Figure 1*, highlighted in green). Although each utterance was coded as it appeared in the transcript, only unique utterances were included in the dataset in order to build a rough approximation of each child's vocabulary (see *Table 2*). Repetitions of the same word within the transcript were noted, but not included in the dataset. Vocabulary content was maintained between transcripts; for example, if "fish" appears on its own in Visit 1, it was still considered a part of the child's vocabulary in Visit 7.

Repetitive Utterances

Utterances consisting solely of repetitions of the same word, for example, "*go go go*," were highlighted in blue (see *Figure 1*) and were coded separately, not as multi-word utterances. Although productive and consisting of more than one word, these utterances provided no information about productivity under this paradigm, and were thus coded separately. Each repetitive utterance found in the transcript was coded as well to provide information about overall verbal activity.

Inaudible Utterances

These utterances, coded as "xxx" in the transcript and highlighted in red (see *Figure 1*), represented utterances that were either inaudible in the original recording due to noise, mumbling, interruptions etc. or utterances that otherwise did not seem to map to formal words or other interactive verbal expressions. Both individual words and entire phrases were coded in this fashion if even one inaudible utterance was detected. Longer phrases containing at least one inaudible utterance were coded separately and were not used for analysis of productivity. Each inaudible phrase located in the transcript was nonetheless coded to allow for a general evaluation of that child's verbal activity in that session.

Multiword Utterances

Multiword utterances consisted of all utterances containing two or more formal words or interactive phrases. All utterances fitting this description were initially coded in the same way (highlighted in yellow, see *Figure 1*). However, after the original coding, each utterance was further subdivided into one of the following groups based on the specified criteria:

A. *Frozen Forms*- Phrases that contained two or more words that had not occurred previously in the child's single-word vocabulary or one new word that had not previously occurred in that position in a previous utterance. Frozen phrases could still contain function words (*the, and, this, etc.*) or words present in the child's single-word vocabulary so long as they were present in different positions. Also consisted of "stock" phrases and expressions. See *Table 2* for examples; all phrases classified as "frozen" in this sample contained no words found in the single word lexicon.

B. *Intermediate Forms*- Contained words or phrases that had appeared previously in the child's single word vocabulary in the same position, but also contained new words that may or may not have occurred previously in that same position. For example, in the sample shown in *Table 2*, the phrase "I wanna try" is classified as intermediate as both "I" and "wanna" appeared in the single word lexicon, but "try" did not.

C. *Productive Forms*- Contained words or phrases consisting entirely of words found in the child's single word vocabulary. This category could also contain new words that had occurred independently in the transcript. For example, in *Table 2,* "Doggy more go" was classified as productive as it consisted entirely of words found in the single word lexicon. "True" productive phrases, in the current coding scheme, were those productive, multi-word phrases which did not also fall into the following two subcategories:

    a. *Repeated Productive Forms*- Productive phrases that were found in the same configuration more than three times, or those phrases which contained the same "head" appearing more than three times. As shown in *Table 2*, "wanna cookie" and "wanna more" were both classified as repetitive. Although they consisted of words found in the single word lexicon, their structure was repetitive. "Wanna" was always followed by the desired object, and this phrasal form appeared across contexts. Though these phrases did fit the criteria of being productive, they also re-occurred a significant number of times, and were, in a way, "frozen" themselves. Thus, they were considered separately from "True" productive forms.

    b. *Numerical Forms*- Consisted of "counting" phrases. Examples of numerical forms most often consisted of simple sequences of counting forward or

backward (see *Table 2*). Although numbers, usually one through ten, almost always occurred in the single-word vocabulary of both TD and children with ASD, counting was unique as the numbers always occurred in the same sequence. Demonstrating an ability to count did not demonstrate true production as these sequences could be learned by rote as well. Although technically productive, they were also a "frozen" form.

After all utterances were coded according to the following criteria, they were transferred into an Excel spreadsheet. From there, all multi-word utterances that were classified as frozen, intermediate, or productive were then tallied. The percentage of each type of utterance was then calculated, based on the total number of coded phrases. Percentages were compared both within the ASD group across visits, as well as between the ASD and TD groups. Cohen's Kappa was then performed to determine the agreement between two raters' judgements of utterance types across seven transcripts for two children with ASD (one rater was the author, the other was trained by the author in the coding scheme). There was weak, albeit significant, agreement between the two raters' judgements, $\kappa=.263$ (95% CI, .093 to .122) $p < .0005$. This will be considered in more detail in the Discussion section.

Results

The results for the dependent measures were presented in *Table 3*. Both the TD and ASD groups exhibited similar percentages of frozen utterances in their speech. Additionally, both groups' largest percentage of utterances fell into the "intermediate" category. While the ASD group had a larger total percentage of productive statements, they exhibited much larger amounts of repeated productive phrases as well. Additionally, for both the ASD and TD groups, "numerical" utterances were very low, both within individual visits and overall.

An independent samples t-test was conducted to compare the percentage of each utterance type across the ASD and TD groups at each visit. A significant difference was found in visit 6 between frozen utterances in the TD and ASD groups $t(22)=-2.345$, $p=.028$ Additionally, a marginally significant difference was found in visit 6 for repetitive productive utterances between the TD and ASD groups $t(22)=-1.954$, $p=.059$

A repeated measures analysis of variance (ANOVA) was used to analyze change in utterance frequency across visits for the ASD group. Utterance frequency was calculated by dividing each utterance type by the total number of coded utterances. The percentage of repeated productive utterances tended to decrease from visit to visit, however these decreases were not statistically significant $F(6,2)=7.253$, $p=.126$ "Pure" productive utterances also tended to increase in number across visits, but again, the increases were not statistically significant $F(6,2)=3.480$, $p=.240$

The modal utterance type of each transcript was compared for both visits 1 and 6. Modality referred to the utterance type that was found most often in each transcript. As can be seen in *Table 4,* for both the ASD and TD groups across visits, intermediate utterances were the modal utterance type. The ASD group, however, had two children that had frozen phrases as their modal utterance type and two children with repeated productive phrases as their modal utterance type at visit 1; the TD group exhibited neither category as their modal

utterance type. Additionally, one child in the ASD group had frozen phrases as their modal utterance type at visit 6, and one child had repetitive productive phrases as their modal utterance type at visit 6. Neither of these utterance types were modal for the TD group at visit 6. Discrepancies in the number of children were due to missing transcripts as well as "non-verbal" transcripts in both the ASD and TD groups. To test the differences between the number of relevant children in the ASD and TD groups, a Chi-Square analysis was conducted. The analysis did not detect a significant difference in the percentage of frozen, intermediate, "pure" productive, repeated productive, and numerical utterances between the ASD and TD groups at both visits 1, $\chi^2(4, N=18)=1.6, p=.808$ and visits 6, χ^2 (4, $N=24)=3.429, p=.488$

Discussion

The purpose of the current study was to investigate the prevalence of frozen and repetitive language in the speech of children with ASD. The ASD and TD groups did not differ significantly in their prevalence of frozen forms at visit 1. Both groups displayed similar frequencies of frozen, intermediate, and productive utterance types. As the groups had been matched according to verbal development, this was an expected result. However, by visit 6, the ASD group had begun to lag behind in their verbal expressions. The ASD group displayed significantly larger numbers of frozen and repetitive productive utterances as compared to the TD group at visit 6. This would seem to indicate that the ASD group maintained use of these utterance types for substantially longer than their TD counterparts. However, the ASD group did display a limited evolution in their linguistic development as seen by their marginally significant decrease in repetitive productive forms across visits, as well as an increase in "pure" productive forms. These results would seem to indicate that the

ASD group demonstrated noticeable language development across visits, but not to the same extent as the TD group.

The TD and ASD groups were most similar in their prevalence of intermediate utterance types. Intermediate utterance types were the most common utterances across visits, usually consisting of >40% of all coded multi-word utterances. As intermediate forms represented a combination of existing vocabulary and new language forms, and based on the assumption that comprehension precedes production and most words found in a child's vocabulary would not be directly expressed, this result was expected (Goodwin, Fein, & Naigles 2012). However, in addition to differing in the prevalence of frozen and repetitive productive forms, the TD and ASD groups also differed in their prevalence of "pure" productive forms. While the differences were not statistically significant, the TD group did appear to demonstrate a more "productive" understanding of language overall. The significant differences in the prevalence of frozen and repetitive productive phrases would seem to indicate that the TD group relied upon these language forms less as time went on. These results seemed to match the conclusions of Lieven, Pine, and Barnes (1992), who suggested that frozen forms in TD children represented an alternative language learning strategy and would decrease steadily with time. As frozen and repetitive utterance types gradually began to be replaced with intermediate forms, which contained combinations of known and new vocabulary, and productive forms, which consisted entirely of known vocabulary, it appeared that frozen language forms were no longer being relied upon as a language acquisition strategy in TD children as their linguistic skills matured.

Although the ASD group demonstrated significantly larger proportions of frozen and repetitive forms as compared to their TD counterparts, the prevalence of these language forms was not noticeably high. Additionally, although the ASD group demonstrated a more

repetitive language structure than the TD group, they did not make these sorts of language errors markedly often or with any sort of consistency, with the overall percentages of frozen forms decreasing slightly in later visits. This result was similar to that of Naigles et. al. (2016) who found that although children with ASD made language errors more often than TD children, these errors did not make up a significant portion of their overall speech. For example, the percentage of frozen forms, compared to the total number of multiword utterances, was approximately 21% for the ASD group at visit 1, and approximately 15.5% for the TD group. By visit 6, these percentages had dropped to 18.3% for the ASD group, and as low as 8.9% for the TD group (see *Table 3*). While the ASD group appeared not to improve significantly in their percentage of frozen forms, these were group averages. Individual differences were significantly larger, with one particular child with ASD having 20.5% of their utterances frozen at visit 1, but only 7.6% of their utterances classified as frozen by visit 6. More striking differences can be observed in the percentage of repetitive productive forms in both the ASD and TD groups. At visit 1, the TD group's percentage of repetitive productive forms compared to their total number of utterances was only 5.2%, while the ASD group's utterances were at 11.4%. At visit 6, the TD group's percentages of repetitive productive utterances had dropped to 3.1%, the ASD group had hardly decreased at all, with their prevalence of repetitive productive forms at 10.3%.

While the ASD group's prevalence of frozen language errors dropped over time, the fact remained that the ASD group maintained higher percentages of frozen forms for a longer period of time. Additionally, the prevalence of repetitive productive language forms remained at nearly identical levels across all visits in the ASD group. From these findings, it was concluded that the use of frozen language forms did demonstrate an alternative language acquisition strategy among children with ASD. Although, the ASD group demonstrated

higher prevalence of frozen language forms than the TD group, these results may have been a reflection of the stereotyped behaviors and speech patterns often observed in children with ASD (Watt, Wetherby, Barber, & Morgan 2008). In other words, although the TD and ASD groups demonstrated similar language acquisition strategies, the ASD group was noticeably affected by RRBs, resulting in delays in language acquisition and greater prevalence of frozen and repetitive language forms. While frozen language forms decreased noticeably over time, repetitive productive language forms did not share this pattern. What appeared to be happening is that unanalyzed language forms were steadily replaced with a limited repertoire of known phrases that functioned in much the same way as the frozen language forms at earlier visits.

However, while the ASD group did demonstrate significantly higher percentages of frozen and repetitive productive utterances as compared to the TD group, these utterance types were rarely the modal utterance type for the ASD group, with only one child at visits 1 and 6 displaying frozen forms as their most common utterance type and one child displaying repetitive productive forms as their most modal utterance type at visit 6. For the majority of the ASD group, intermediate language forms were the most common utterance type, and these utterance types displayed some elements of productive speech as they consisted of both known vocabulary and new words. Thus, while their language acquisition fell behind their TD counterparts in some aspects, the ASD group still displayed significant language comprehension and production. These results stand in opposition to Newport (1988), which concluded that frozen language forms were a semi-permanent fixture of late language learners' vocabularies, with significant language comprehension not occurring until much later in life. However, the participants in Newport (1988) were all adult learners of American Sign Language, so such delayed language acquisition among their participants was an

expected result. While still displaying some deficits in language acquisition and production, the ASD group appeared to maintain a permanent vocabulary across visits and produced large numbers of productive and semi-productive utterance types in their speech.

The primary limitation of this study was the limited time available for data collection. Although the ASD sample was fully analyzed and coded across all visits, the TD group was only fully analyzed at visit 1 and visit 6. Although this provided general trends of language development in the TD group and was useful for comparison purposes, a more nuanced picture of how the ASD and TD groups differed in their utterance types, as well as how their use of language changed over time, may have emerged if both groups were analyzed with the same amount of depth.

Shortcomings with the coding scheme became evident over the course of the experiment, most notably in its classification of intermediate utterance types. The only criteria for an utterance type to be classified as intermediate was that it contained both words found previously in the child's single word vocabulary and new words not previously found in the vocabulary. However, these utterance types varied wildly, with some phrases being almost entirely frozen, but containing a single known word, and others being almost entirely productive, but containing a single new word. The coding scheme grouped all of these utterances together under a single category, thus neglecting to account for the internal variety found within these utterances. A revised coding scheme with sub-categories for intermediate types, similar to the ones used for productive utterances, would likely reveal a more detailed picture of language use in both ASD and TD children.

Additionally, as the interrater reliability of the coding scheme utilized was only moderate, more stringent and specific criteria of what utterances apply to each category that rely less upon the judgement of individual analysts would help to correct this issue. The

primary interrater disagreements tended to focus on the classifications of intermediate and frozen language forms. These disagreements most often focused on function words such as "the," "and," "if" etc. Confusion arose in the classification of these phrases as part of a child's single-word vocabulary, as these language forms rarely appeared on their own. The presence, or absence, of these function words in a child's vocabulary often determined if a multi-word phrase was classified as frozen or intermediate, so a revised coding scheme should have specific parameters for resolving similar conflicts. Finally, the limited sample size, further reduced by eliminating several "non-verbal" children in the ASD group from analysis, may have contributed to the relative insignificance of most of the results. A larger sample size may produce more definitive differences both within the ASD group and between the ASD and TD groups.

Although the results were not definitive, they did indicate clear differences in how ASD and TD children develop and use language in the first years of life. While the TD group performed in accordance with Pine, Lieven, and Barnes (1992), with the prevalence of frozen and repetitive forms steadily decreasing over time, the ASD group maintained the use of these forms for much longer. However, while the ASD group demonstrated a greater frequency of frozen and repetitive forms, and overall lagged behind their TD counterparts, these language errors did not occur with significant regularity or frequency, and the ASD group demonstrated limited language progression between visits. Therefore, it can be concluded that while frozen language forms appeared to be an aspect of language use in ASD, they did not appear with enough frequency or regularity to be a reliable indicator of ASD in young children.

Therefore, it can be concluded that children with ASD acquire language similarly to TD children, albeit at a slower pace and with a significantly greater reliance on a limited

number of language forms. These results fall roughly in line with Goodwin et. al. (2012) and Tovar et. al. (2015) where children with ASD demonstrated strong language comprehension, but impaired pragmatic usage of language in social situations. However, while Naigles et. al. (2016) concluded that language errors, such as pronoun reversals, did not make up a significant portion children with ASD's language production and tended to decrease steadily over time, the prevalence of repetitive productive language forms in the current study, and their relative stability over time, did not corroborate this pattern. Finally, while the prevalence of frozen forms in children with ASD was greater than their TD counterparts, the number of frozen language forms did drop over time, which did not follow the pattern of RRBs outlined in Szatmari et. al. (2006), which concluded that repetitive behaviors would remain highly resistant to change and would not see significant decreases in their prevalence over time. While the prevalence of repetitive productive language forms seemed to fit this pattern, the decrease of frozen language forms seemed to indicate a willingness to experiment with new linguistic categories. The relative stability of the repetitive productive forms seemed to indicate that these language forms were utilitarian in nature. Repetitive language forms seemed to be used across many social contexts because they served the child's social purposes, not because of an underlying deficit in language acquisition or due to a resistance to change. This phenomena can be succinctly summarized with the vernacular expression "If it ain't broke, don't fix it."

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Table 1: ADOS and CARS Scores for both the TD and ASD groups.

Child's Designation	Group	ADOS Visit 1	CARS Visit 1	CARS Visit 5
A1	ASD	13	27.5	24.5
A2	ASD	8	27	31
A3	ASD	9	31	31
A4	ASD	15	34	37
B1	ASD	7	19.5	15
D1	ASD	11	38	39
J1	ASD	20	43	46.5
J2	ASD	11	27	22.5
K1	ASD	10	27	30.5
L1	ASD	11	35	33.5
R1	ASD	17	40.5	35.5
T1	ASD	15	36	29
CH	TD	0	15	15
DK	TD	0	15	15
JB	TD	0	16	15
RR	TD	0	15	15
SB	TD	0	15	15
SE	TD	0	15	15
ST	TD	1	15	15

Table 2: Sample lexicon with examples of each type of multi-word utterance.

Child's Name	Single Word Lexicon	Frozen Forms	Intermediate Forms	Productive Forms	Repeated Productive Forms	Numerics
J. Doe	I	Oh god!	I wanna try	One cookie	Wanna cookie	One two three
	mommy	Way to go	It's a cookie	I wanna do	Wanna cookie	Three two one
	three	Super duper	No more play	What I do	Wanna more	
	wanna	Land ahoy	Big doggy	Doggy more go		
	one	Over the top	Mommy go now			
	do	Climb up	No kitty			
	two					
	what					
	yes					
	no					
	cookie					
	doggy					
	more					

Table 3: Means and SD of utterances for the ASD and TD groups

Visit 1	Frozen (SD)	Intermediate (SD)	"Pure" Productive (SD)
TD	.155 (.133)	.323 (.249)	.136 (.132)
ASD	.209 (.170)	.472 (.253)	.204 (.126)
Visit 6			
TD	.089 (.041)	.590 (.193)	.233 (.081)
ASD	.183 (.132)	.469 (.123)	.224 (.114)
Overall			
TD	.122 (.086)	.457 (.249)	.184 (.099)
ASD	.144 (.105)	.387 (.215)	.203 (.078)

Table 4: The number of children in each group producing each utterance type as their modal category at visits 1 and 6.

Group (Visit)	TD (Visit 1)	ASD (Visit 1)	TD (Visit 6)	ASD (Visit 6)
Frozen	1	2	0	1
Intermediate	6	7	12	9
Productive	0	0	0	1
Repeated Productive	0	2	0	1
Numerical	0	0	0	0
“Uncodable” Transcripts	5	1	0	0

Figure 1: Transcript sample demonstrating the coding procedure and examples of each utterance type.