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The Impact of Conversational Turn-Taking on Vocabulary Size in Children with Developmental Disabilities Using Augmentative and Alternative Communication

by

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Under the Direction of Rose Sevcik, PhD

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Arts

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ABSTRACT

Conversational turn-taking in families with children who are typically developing has been shown to positively impact their child's receptive and expressive vocabulary scores (Gilkerson et al., 2018). However, limited research analyzes whether this relationship exists in children with developmental disabilities and limited speech ability. Research suggests that augmentative and alternative communication (AAC) facilities a greater vocabulary size in children with developmental disabilities (Romski et al., 2010), but it is unknown if conversational turn-taking impacts its success. This study examined the growth trajectory of conversational turn-taking throughout the AAC intervention. Additionally, it examined the impact of conversational turn-taking on the effectiveness of a 12-week augmented language intervention. The findings indicate that when participating in an AAC intervention, children and their communicative partners showed differing growth trajectories in conversational turns. Moreover, these children made greater gains in vocabulary size when exposed to larger amounts of conversational turns than children in spoken intervention.

INDEX WORDS: Augmentative and alternative communication, Developmental disorders, Conversational turns

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The Impact of Conversational Turn-Taking on Vocabulary Size in Children with Developmental Disabilities Using Augmentative and Alternative Communication

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May 2023

DEDICATION

To my youngest sister, Yaya, may research like this help you in your communication journey. To my other siblings, Geo, Eli, Micah, and Addie, whose unique communication styles spurred my interest in studying language development in children. To my parents, Arrestonette and Hughes, for instilling in me the importance of education and teaching me to persevere through all circumstances. To my fiancé, Kudzai, who endured my incoherent rambles on my research and continues to support me in every endeavor. To Yah, because without him, none of this is possible.

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1 INTRODUCTION

Gaining proficiency in language is a defining achievement of childhood that affords children the ability to interact with the world around them through expressing their thoughts, feelings, and emotions. Language development is tightly linked to other hallmark aspects of child development, including Theory of Mind (ToM; Baillargeon et al., 2010; Ruffman et al., 2002). Therefore, it is unsurprising that deficits in language and communicative ability are closely related to adverse outcomes in overall child development, including emotional dysregulation, reduced literacy ability, and lowered academic success (Catts et al., 2001; Cirino et al., 2019; Foorman et al., 2015; Thompson et al., 2008). Moreover, it is common for children with developmental disabilities (DD) to have a secondary diagnosis of language impairment, hypothesized to cause delays in literacy achievement as they enter school (Justice, 2016). This impairment is concerning as early literacy skills have been predictive of later academic success, putting children with DD at risk for decreased academic achievement compared to their typically developing peers (Boudreau & Hedberg, 1999; Catts et al., 2001; Justice, 2016; Storch & Whitehurst, 2002).

A subpopulation of children with DD are those who are nonspeaking or minimally speaking who often exhibit slow expressive language development (SELD), categorized by less than 50 words by age two (Paul, 1996). These children encounter prolonged communicative difficulties compared to their vocal peers with DD and typically developing children. This trend is seen in children with cerebral palsy, where individuals with language impairments compounded with their motor impairments experience continuous delays in expressive language, reduced speech illegibility, shorter utterances and do not reach similar levels of language proficiency as their peers with reduced motor impairments without language impairments

(Hustad et al., 2010; 2012; 2014; 2020). The growing literature recommends augmentative and alternative communication (AAC) as an early language intervention to improve communicative skills in this population and minimize the risk of adverse long-term outcomes (Romski et al., 2015; Wright et al., 2013). Therefore, evaluating AAC language interventions and the components that improve its effectiveness will uncover the necessary factors needed to improve long term language outcomes for children with DD and complex communication needs.

1.1 Augmentative and Alternative Communication

In children who are typically developing, producing speech is a hallmark of child development, appearing as babbling at approximately at 6 months of age, developing into one-word utterances at 12 months, and combining words to sentences at 24 months (Rosenberg & Abbeduto, 1993). By contrast, individuals with DD often do not meet these milestones without intervention (Paul, 1996; Rosenberg & Abbeduto, 1993). Unfortunately, this leads to limited participation in communicative interactions needed to establish cognitive connections for symbolic representation and thought (Vygotsky, 1978). AAC intervention is designed to facilitate communicative interactions for individuals with limited speech ability as it uses nonstandard forms of communication (i.e., speech-generated devices, picture cards, sign language; Loncke, 2014). A systematic review of the AAC literature (70 total reports) conducted by Romski et al. (2015) supports that enrolling children with DD into early AAC intervention can mitigate adverse language outcomes by enhancing language skills and communication behaviors and promoting speech development. There is also a strong foundation of AAC's impact on expressive language growth in parent-child dyads (Romski et al., 2015; Wright et al., 2013) and its effectiveness over traditional speech intervention (Romski et al., 2010; Yoder & Stone, 2006).

Receptive language improvements during AAC intervention are notoriously challenging to assess and are often operationalized through targeted novel word gains post-intervention (e.g., Dada & Alant, 2009; Harris & Reichle, 2004). Nevertheless, AAC intervention has been linked to vocabulary gains in individuals with DD (Dada et al., 2021). Romski et al. (2010) evaluated the effectiveness of an AAC language intervention facilitated through a speech-generated device (SGD) against typical spoken communication in 62 children with varying developmental disabilities (i.e., Down's syndrome, cerebral palsy, and unknown conditions). They found that children exposed to the 12-week AAC language intervention gained a greater vocabulary size than those in the spoken intervention (Romski et al., 2010). Moreover, Dada and Alant (2009) examined the effect of a 3-week aided language stimulation program on 4 children with DD and little or no functional speech. They found that 3-weeks allotted enough time to teach all the children 24 novel vocabulary words. As a result of these findings and others like them (Babb et al., 2021; Light et al., 2021; Muttiah et al., 2022), AAC intervention has been encouraged for children with DD with emerging language skills.

There is a damaging assumption that access to AAC reduces motivation for spoken communication, which causes parents of children with DD to be hesitant to employ this intervention strategy (Romski, & Sevcik, 2005; Smith & Hustad, 2015). Although early implementation has been linked to improved spoken communication, these preconceived notions reduce AAC to a "last resort" intervention (Romski & Sevcik, 2005). Yoder and Stone (2006) evaluated the effectiveness of Responsive Education and Prelinguistic Milieu Teaching (RPMT), a spoken intervention, against Picture Exchange Communication System (PECS), an AAC intervention, on spoken communication output in 36 minimally speaking children with autism spectrum disorder (ASD). After 24 hours of intervention over six months, children in the PECS group exhibited a greater number of nonimitative spoken communication acts and different nonimitative words posttreatment than those in the RPMT group. Moreover, Walters et al. (2021) examined the spoken output of 45 children enrolled in a 12-week language intervention via AAC or traditional spoken modalities. They found that participants in the AAC intervention produced more spoken words than those in the spoken intervention, and both groups produced a similar amount of speech sound errors. These findings support that AAC can dually encourage improvements in aided and spoken communication in young children with DD and should not be considered a last resort intervention.

As with other forms of communication, AAC requires a conversational partner to reciprocate the interaction. For all young children, their first communicative partner is typically their parents. For children with DD, the ability to communicate with their primary caregiver becomes a necessary skill to express their needs. Therefore, research has focused on the generalizability of AAC interventions in the home environment. Wright et al. (2013) evaluated the generalizability of the Enhanced Milieu Teaching (EMT; Hancock & Kaiser, 2006) combined with Joint Attention, Symbolic Play, and Emotional Regulation (JASPER; Kasari, Freeman, & Paparella, 2006) techniques to teach signs and spoken words in 4 children diagnosed with Down’s syndrome. Their results showed that without formal instruction on signing, parents increased their sign use with their child after the intervention, and the child generalized the majority of the words they learned through intervention to the home environment. Moreover, Adamson et al. (2010) evaluating three different parent-coached language interventions (two of which used AAC) found that all interventions improved symbol-infused joint engagement for the children, and these gains generalized to the children's joint engagement with the parent outside of the intervention. These results indicate that language interventions facilitated through AAC have implications for communicative practices outside the intervention context, and parents play a crucial role in these outcomes.

1.2 Role of Parent-Child Interaction in Language Development

Considering AAC as a modality to communicate language, broader theories of language development established in populations who are typically developing are useful in understanding how AAC increases vocabulary in children with complex communication needs. The socio-pragmatic approach to language development suggests that through social interaction, children receive the first-hand experience needed to develop language proficiency and master the linguistic nuances in their community (Bruner, 1983; Kuhl, 2007; Tomasello et al., 2005; Vygotsky, 1978). From birth, typically developing children are active participants in social interaction, maturing from nonverbal (i.e., pointing, gestures, joint attention, etc.) to vocal contributions (Carpenter et al., 1998; Levinson, 2016; Lizkowski et al., 2012; Tomasello et al., 2007). Within this framework, features of parent-talk have been overwhelmingly linked with their children's language development starting as early as infancy (Bruner, 1981; Dilley et al., 2014; Nelson et al., 1989; Snow, 1977, 1984).

Prior understanding of social interaction has associated larger vocabulary size with overall more parent-talk, indicating that early and repeated exposure to the lexicon in the home environment allows the child sufficient opportunity to retain the meaning of novel words (Hart & Risley, 1992, 1995). Additionally, parents tend to alter their speech (dubbed parentese) when directed toward children categorized by being slower, higher pitch, present-forced, referring to the object of the child's attention, and having a lack of grammatical errors (Rosenberg, & Abbeduto, 1993). Previous research indicates that though fathers produce less parentese than mothers, both mothers' total words and fathers' total parentese significantly predicted their child's vocalizations from 6-24 months (Tachikawa Shapiro et al., 2021). Subsequent analyses in typically developing populations have highlighted the importance of the quality of parent-talk, such that a larger vocabulary size is associated with parent-talk that is more diverse and complex with limited directive utterances (Rowe, 2008). More recently, Hirsh-Pasek et al. (2015) evaluated the quality of input in 60 low-income families of typically developing children. They found that at 24 months, the quality of communication interactions (evaluated by the occurrence of symbol-infused joint engagement, routines, and fluent and connected communication) accounted for 27% of the variance in expressive language one year later (Hirsh-Pasek et al., 2015).

Assertion of this association between parent and child language has led some to believe that language acquisition delays found in individuals with DD are a result of a poor language environment provided by parents. Previous work by Buium et al. (1974) compared the mean length of utterance (MLU) for mothers with children who had Down’s syndrome and mothers of typically developing children matched by chronological age (mean age 24 months). They found that the mothers who had children with Down’s syndrome had shorter utterances than those who did not have children with Down’s syndrome. Buium et al. (1974) asserted that these results support their hypothesis that mothers of children with developmental disabilities create a language environment that limits their child's linguistic development. However, Rondal et al. (1978) conducted a similar experiment matching the groups by MLU. They found that there was no difference in speech patterns for mothers with and without children with Down’s syndrome. Therefore, parents utilize the same techniques they would if their child did not have a DD. Commentary on these findings by Rosenberg and Abbeduto (1993) suggests that mothers are not limiting the linguistic environment but rather matching the child's linguistic competence to improve the communicative experience. Thus, they assert that research should move away from placing blame on parents for their child's language delay. Instead, research should examine ways in which parents can contribute to the quality of the linguistic environment and encourage language development for their children.

1.3 Quality Interactions: The Contribution of Conversational Turn-Taking

An integral part of social interaction is communication connectedness facilitated through conversational turn-taking, in which each speaker tunes in to what the other is saying during conversational turns and contributes to the dialogue during their turn (Dunn & Brophy, 2005). Conversational turn-taking has been well-documented in its relation to cognitive-linguistic development in typically developing populations. Ramírez et al. (2020) evaluated parent-child interactions at 6, 10, 14, and 18 months in 71 typically developing dyads. Half of the adult participants were exposed to parent coaching after the 6-, 10-, and 14-month observations. The coaching sessions included linguistic feedback on age-appropriate activities to promote language growth. They found that exposure to coaching improved parentese and conversational turns, which were both correlated with enhanced growth in child vocalizations at 18 months (Ramírez et al., 2020). Furthermore, Gilkerson et al. (2018) collected monthly daylong audio recordings from typically developing children ages 2-36 months over 6 months. They found that conversational turn-taking between 18 and 24 months accounted for 14% to 27% of the variance in receptive and expressive vocabulary, IQ, and verbal comprehension scores 10 years later after controlling for SES (Gilkerson et al., 2018).

Additionally, Donnelly and Kidd (2021) obtained daylong audio recordings every 3 months for 122 typically developing children between 9-24 months old. They analyze several characteristics of the language environment, including the adult word count (AWC), conversational turn count (CTC), and child vocalization count (CVC). They found that after controlling for adult words heard in the environment, there was a bidirectional relationship between conversational turns and vocabulary growth, such that increases in conversational turns predicted increases in vocabulary growth and vice versa. Moreover, Wang et al. (2020) conducted a meta-analysis including 17 studies to evaluate the automated conversation measures (i.e., AWC, CTC, and CVC) through the Language ENvironment Analysis (LENA) software and their relation to language skills (measured through expressive or receptive language ability) in children younger than 48 months old. They found robust results of medium correlations between CTC, CVC, and language skills, while AWC had a small to medium association with language skills. These findings support that quantity of parent talk is associated with language outcomes as previously understood, but that conversational turn count is also a indicator for quality interactions and a significant component affecting growth in vocabulary size.

Limited research has been done to evaluate whether the association between conversational turns and vocabulary size holds true in atypically developing populations. VanDam et al. (2012) collected day-long audio recordings of 30 families (22 hard-of-hearing (HH) and 8 typical hearing (TH) children at age 2) and compared them to a normative sample of TH children. Their results indicated that the HH children and TH children had similar amounts of AWC and CTC. Additionally, AWC and CTC were correlated with auditory characteristics (i.e., speech intelligibility and pure tone average), but only CTC was correlated with receptive language ability. Similar results were found in a later study, in which 28 children with mild to severe hearing impairment participated in day-long audio recordings of their home linguistic environment within 6 months following their second birthday (Ambrose et al., 2014). Ambrose et al. (2014) found that a greater number of conversational turns at 2 years old predicted increased communicative abilities (measured using the Comprehensive Assessment of Spoken Language) at 3 years old. However, this trend was not seen for AWC. These results include a limited sample of atypically developing children, but they indicate that a different trend might exist for children with DD. Though AWC and CTC might work in tandem to encourage language development in typically developing populations, those with DD may benefit only from an increased number of conversational turns.

Regardless of these findings, limited studies link vocabulary to conversational turn-taking in children with DD (Ambrose et al., 2014; VanDam et al., 2012). Moreover, no research has been published on this connection in minimally speaking children using AAC. The current study strives to broaden the existing literature by evaluating whether the relationship between CTC and vocabulary size appears in children with DD using AAC. Additionally, it is also vital to address the trajectory of conversational turn-taking throughout the intervention as an indicator of growth in connectedness over time, which is directly tied to greater social interactions and improved academic outcomes (Dunn & Brophy, 2005). Ultimately, the goal of this study is to advocate for conversational turn-taking as an indicator of both quantity and quality of parental input for children using AAC, as supported by previous research in typically developing populations.

1.4 The Current Study

This study used archival data from 109 parent-child dyads who participated in a 24-session (12-week) language intervention for children with DD. The language intervention compared AAC against typically spoken communication modalities in children with limited functional speech. **This study first aimed to examine the growth trajectory of conversational turn-takings throughout the intervention**. Based on work done in typically developing populations that shows increasing conversational turns throughout development (Donnelly &

Kidd, 2021), it is predicted that the general trajectory of conversational turns will show increases in conversational turns throughout the AAC intervention. However, it is unknown what the shape of the growth of conversational turns may look like.

The second aim was to examine whether AAC exposure moderates the relationship between conversational turn-taking and vocabulary size in children with developmental disabilities and limited speech. Previous research indicates that the SES of the parents influences the vocabulary size of children and the amount of parent talk the research (Hart & Risley, 1992, 1995). Rowe (2008) elaborated that these differences in SES appear to correspond to the parent's educational level and knowledge of child development. Therefore, it is predicted that AAC exposure will moderate the relationship between conversational turn-taking and vocabulary size after controlling for race and parent education. Moreover, previous research has supported that AAC increases vocabulary size in children with emerging language skills. Coupled with previous research that vocabulary size is closely linked to conversational turns, it is hypothesized that the nature of the interaction will appear such that more conversational turns will predict greater vocabulary size but only in the AAC condition.

2 METHODS

2.1 Participants

109 parent-child dyads were recruited from 45 different sources in the metropolitan Atlanta area, such as pediatric offices and early intervention services. None of the dyads had participated in a parent-led intervention before this study. To be included in the study, the child had to be between 24-36 months old, have less than ten spoken words, a score of fewer than 12 months on the *Expressive Language Scale of the Mullen Scales of Early Learning* (MSEL;

Mullen, 1995), motor capabilities to use an SGD, and a primary diagnosis other than delayed speech and language impairment, deafness/hearing impairment, or autism.

At the onset of the study, the children were assessed using the MSEL (Mullen, 1995), a 15–60-minute assessment to evaluate early cognitive development and school readiness for children ages 0-68 months. This assessment provided an MSEL composite score and preliminary scores on visual reception, fine motor skills, and receptive and expressive language. As a precautionary measure, children were also assessed on three additional assessments of receptive and expressive language, including (1) *The Sequenced Inventory of Communication Development* (SICD-R; Hendrick et al., 1984) providing the expressive and receptive language scores in months; (2) *The MacArthur Communicative Development Inventories* (MCDI; Fenson et al., 1993) providing the size of expressive and receptive vocabulary, and (3) the *Clinical Assessment of Language Comprehension* (CALC; Paul & Miller, 1995) evaluating emerging language skills with a raw score out of 9.

2.2 Intervention

The data are sourced from two datasets evaluating a 24-session (12-week) language intervention comparing AAC and spoken communication modalities. The first dataset included 62 parent-child dyads who were randomly assigned to either augmented communication input (AC-I), augmented communication output (AC-O), or spoken communication (SC). In the AC-I group, the interventionalist used an SGD to label target words but did not prompt the child to use the device. The AC-O group used an SGD to label target words and prompted the children to use the SGD to respond. The SC condition acted as a comparison group as the interventionalists prompted the children to verbally produce the target words. The second dataset differed from the first dataset as it included 47 participants randomly assigned to AC-I, AC-O, or a combination of the augmented communication input and output conditions (ACIO).

All groups across the two datasets included an individualized list of target words for each participant categorized by being unfamiliar to the child, motivating to learning, and useful during home routines. The vocabulary intervention consisted of three typical 10-minute activities (playing with blocks, book reading, and snacks) to incorporate the target words naturally. In each session, the interventionist prompted the child to use each word on the list as specified by the intervention assignment. After the majority mastery of vocabulary items, additional terms were included.

The first 18 sessions (9 weeks) occurred in the lab and transitioned to the home in the last six sessions (3 weeks) to encourage generalizability of the new vocabulary. In the first eight sessions (4 weeks), the parents observed the technique of the trained Speech-Language Pathologist (SLP) and then gradually increased their involvement from sessions 9-14, until they were fully equipped to lead the sessions for the remaining sessions of the intervention (see *Table 1* for details on the intervention sequence). The parents received an Intervention Protocol Manual (Romski & Cheslock, 2000) detailing weekly goals for the parents, SLPs, and child. Throughout the intervention, the SLP conducted parent coaching in which they instructed parents on how to implement each mode of intervention (AC-I, AC-O, SC) to ensure adequate implementation. The interventionists were trained to implement each condition of the intervention and were randomly assigned to deliver each condition with equal frequency. As a result, they could not be masked to the treatment groups but were masked from the research question to prevent evaluation biases.

Table 1 Intervention sequence including the role of the parent and interventionist

Setting	Sessions	Interventionist Role	Parent Role
In Lab	Sessions1-8	Facilitated the entire session (i.e., Snack, play, and reading)	Observed in the observation room with SLP
	Sessions 9 & 10	Led session for 20 minutes including reading and play	Entered the last 10 minutes of the session leading snack time.
	Sessions 11 & 12	Led play activities (10 minutes)	Led session for 20 minutes including reading and snacks
	Sessions 13 & 14	Coached the parents and provide resources	Facilitated the entire session (i.e., Snack, play, and reading)
	Sessions 15-18	In room for support, but not actively coaching	Facilitated the entire session (i.e., Snack, play, and reading)
At Home	Sessions 19-24	In room for support, but not actively coaching	Facilitated the entire session (i.e., Snack, play, and reading)

Note. SLP=Speech-Language Pathologist;

2.3 Data Collection

In both datasets, baseline, sessions 18, and session 24 were video recorded, and the *Systematic Analysis of Language Transcripts* (SALT; Miller & Chapman, 1985) program was used to transcribe each session. The second dataset included additional video recordings and transcriptions for sessions 6 and 12. Using conventions outlined in the SALT manual (Miller & Chapman, 1985), trained transcribers detailed the speakers, utterances, spontaneous vocabulary words use, and conversational turns. An analysis of reliability consisted of three independent reviews of each language transcript. Two of the checks focused on the accuracy of overall session transcription. A separate check focused on the accuracy of the codes assigned to targeted augmented and spoken vocabulary words.

Spontaneous (nonpromoted) spoken and augmented vocabulary words used during session 24 were recorded and summed to determine *vocabulary size* at the end of the intervention. *Conversational turns* are defined by SALT (1985) as consecutive utterances by a single speaker contingent upon the speaker's previous turn, as this is the most accurate approach supported by Leech & Rowe (2020). Therefore, the *conversation turn count* (CTC) was determined by summing the turns of all conversational partners (child and the designated communicative partner). Parent demographics such as race and parent education were recorded from parent self-report at intake.

2.4 Data Analysis

For this study, the three AAC groups (AC-I, AC-O, and ACIO) were combined into one group to represent exposure to AAC. Preliminary Analyses were run using an ANOVA to determine the equivalence of groups on all the inclusionary criteria (i.e., *Mullen's Scale of Early Learning: Visual reception, Fine Motor Skills, Expressive and Receptive Language*).

2.4.1 Aim 1

2.4.1.1 Statistical Test

Analysis of Aim 1 was exclusively analyzed using the second dataset (47 parent-child dyads exposed to the AAC intervention) because their data include language transcripts for sessions 6 and 12 not found in the first dataset. Including these additional sessions elucidates the full growth trajectory throughout the intervention. A linear mixed model was used to evaluate the growth trajectory of CTC within the AAC intervention using five time points spaced evenly across 12 weeks (i.e., baseline, session 6, session 12, session 18, and session 24). Model 1 evaluated no growth in CTC throughout the intervention. Models 2 and 3 assessed the presence of linear or quadratic growth, respectively, across the intervention. Using multilevel modeling with SPSS detailed by Heck et al. (2014), each model was fitted to the data and compared against each other to determine the model with the best fit for the growth trajectory of total CTC throughout the intervention

2.4.1.2 Power Analysis

A power analysis was run on General Linear Mixed Model Power and Sample Size (GLIMMPSE; Kreidler et al., 2013) determined that a sample size of 47 was adequate to detect a small to large effect of a linear mixed model with one level at an alpha level of .05. Additionally, variance components were estimated using the restricted maximum likelihood estimate (REML) to reduce the likelihood of a type 1 error as instructed by Heck et al. (2014).

2.4.2 Aim 2

2.4.2.1 Statistical Test

Analysis of Aim 2 included the full dataset (109 participants) in an OLS linear regression to assess AAC exposure as a moderator for the relationship between CTC and vocabulary size (depicted in Figure 3). The predictors will include the covariates (race and parent education) as indicators of SES, the intervention type (AAC or SC), CTC, and the interaction term between intervention groups and CTC. Vocabulary size at session 24 was the outcome variable.

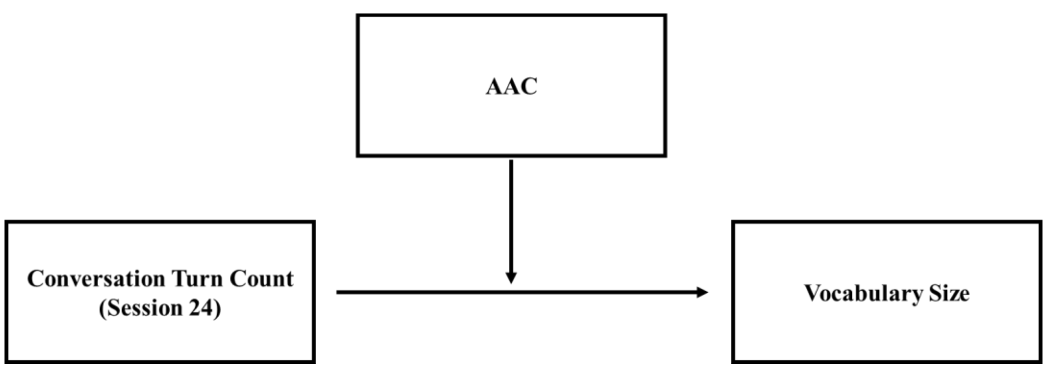

Figure 1 Moderation Model evaluating exposure to AAC as a moderator between the conversational turn count and vocabulary size

2.4.2.2 Power Analysis

A G*Power 3.1.9.4 analysis (Faul et al., 2007) determined that a sample size of 109 was adequate to use on a multiple linear regression with two predictors (conversational turns and AAC), two covariates (race and parent education), and the interaction term. The study is adequately powered at .8 to detect a medium effect size of .15 at an alpha level of .05.

3 RESULTS

3.1 What is the growth trajectory of conversational turns throughout the AAC intervention?

47 children (33 male and 14 female) and their conversational partners were included in the analysis, with an average chronological age of 34.34 months (SD=4.46). Total CTC was compared across sessions using a one-way analysis of variance (ANOVA) which revealed that there was a significant change in CTC throughout the intervention, $F(4,230)= 8.37$, $p<.001$). Post-Hoc comparison using Tukey HSD reveals that there is a significant increase from baseline to session 6 (p= .009), session 18 (p=.001), and session 24 (p<.001), but there is no change from baseline to session 12 (p= 1.00). Unexpectedly, there was a significant decrease in CTC from session 6 to session 12 (p= .014). However, increasing trends reappear between session 12 to session 18 (p= .002) but level out from session 18 to session 24 (p= 1.00) (shown in *Figure 2*).

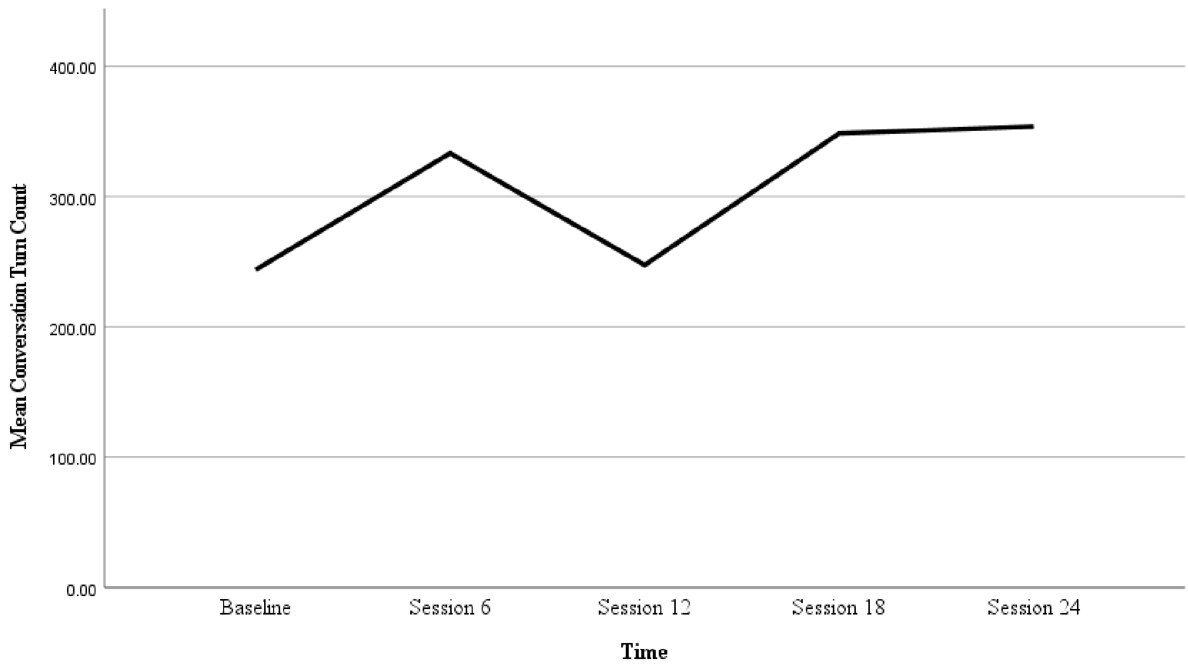

Figure 2 Longitudinal growth of total conversational turns count during a language intervention facilitated through AAC

The shape of the growth in CTC was analyzed using a mixed model linear regression comparing no growth, linear growth, and quadratic growth trends. The linear and quadratic growth models were found to be nonsignificant (p=.41 and p=.80, respectively), while no growth was found to be significant (p<.001). Low CTC totals in session 12 prompted further exploration of the data to elucidate the nature of the growth trajectory. Therefore, total CTC were separated by speaker including the child turns, interventionist turns (at baseline and session 6) and parent turns (at session 12, 18, and 24) to analyze the unique growth trajectories. In each session, the child's conversational turns were statistically equivalent to their conversational partner's turn turns except for in session 12, where parents had a significantly lower CTC (p<.001) as shown in *Table 2*. Further analysis of CTC for each speaker indicated that the children and their conversational partners had an incongruous growth trend (shown in *Figure 3*). The growth model of child CTC showed that the children followed a quadratic growth trend in which they continued to increase in CTC throughout the intervention but slowed as they reached the end of the intervention, $F(1,46)= 8.00$, p.007. However, their conversational partners appear to follow a quartic growth trend $F(1,46)=171.13$, $p=.001$. The interventionist's CTC increase from baseline to session 6, but there is a sharp decline at session 12 as parents take over the sessions, followed by increases in CTC from session 12 onward.

Table 2 Mean Conversational Turns by Session

	Baseline (I)	Session 6 (I)	Session 12 (P)	Session 18 (P)	Session 24 (P)
Total CTC	243.89 (155.52)	333.34 (112.00)	247.53 (102.60)	348.55 (136.59)	353.79 (138.17)
Child CTC	123.70 (82.36)	170.40 (59.33)	177.40 (68.39)	181.59 (74.16)	181.68 (73.76)
Partner CTC	120.19 (73.65)	162.94 (53.07)	70.13** (42.02)	166.96 ** (63.40)	172.11 ** (64.87)
Mean difference	3.51	7.47	107.28*	14.64	9.57

Note. *= significant predictor; I= Sessions where the interventionist was the communication partners; P=Sessions where parents were the communication partner; CTC= Conversational turn count; In parentheses= standard deviation.

Table 3 Growth model fitted to total, child, and parent conversational turn counts

Variable	Model	*F*	*p*-value
Total CTC			
	Intercept*	198.85	<.001
	Linear Growth	.692	.41
	Quadratic Growth	.063	.80
Child CTC			
	Intercept*	168.44	<.001
	Linear Growth*	15.48	<.001
	Quadratic Growth*	7.99	.01
Partner CTC			
	Intercept*	125.18	<.001
	Linear Growth*	160.96	<.001
	Quadratic Growth*	194.13	<.001
	Cubic Growth*	185.86	<.001
	Quartic Growth*	171.13	<.001

Note. *= significant predictor; CTC= Conversational turn count.

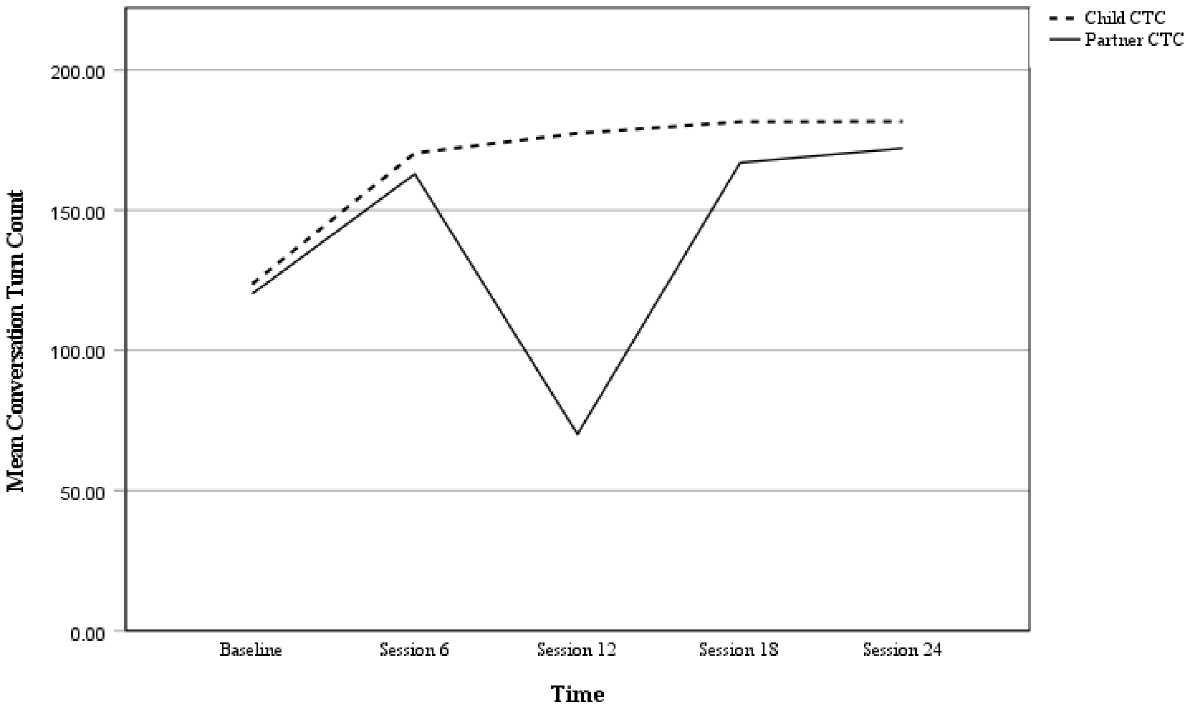

Figure 3 Growth of conversational turn account across the language intervention facilitated via AAC separated by parent and child turns

3.2 Aim 2: What roles does Conversational Turn-Taking Have on Vocabulary Size for Children Participating in AAC intervention?

The second question in this study evaluated the relationship between CTC and AAC exposure on the vocabulary size of children with developmental disabilities. 109 parents (M_{age}= 37.52 years) and children (M_{age}= 30.36 months) were included in the analysis of aim 2. Demographics consisted of parents self-identified their race (65 white and 42 identified as other races) and level of education (83 with a college or post-college education, and 24 with less than a college education).

Using a One-Way ANOVA, the four intervention groups (AAC-I, AAC-O, AAC-IO, and SC) were found to be equivalent on baseline Mullen receptive language scores, F(3,104)= -.23, *p*=.88 and Mullens expressive language score, *F*(3,104)= -.07, *p*=.98 (means shown in *Table 4*). After consolidating the two AAC groups, correlations were run between the predictor variables (i.e., AAC, total turns, parent education, and parent race) and the outcome variable (vocabulary size), as seen in *Table 5*. Parents' self-identification of race significantly correlated with total turns at session 24 (*r*=.22, *p*=.02), indicating that white parents typically had more total turns at session 24. Additionally, vocabulary size at session 24 was strongly correlated with total turns at session 24 (*r*=.50, *p*<.001) and AAC exposure (*r*=.56, *p*<.001). These results imply that larger vocabulary size is associated with greater conversational turns and exposure to AAC.

Table 4 Descriptive Statistics of inclusionary criteria and outcome variables by intervention group

	N	Chronological Age (in months)	Receptive Language	Expressive Language	Total CTC	Vocabulary Size
AAC	88	29.53 (4.60)	16.75 (8.56)	11.30 (3.13)	254.81 (169.00)	.76 (1.64)
Speech	21	30.53 (5.15)	16.27 (7.00)	11.27 (4.11)	313.99 (144.32)	16.50 (10.24)
Mean Δ		3.55	.48	.027	59.18	15.74
SE Δ		1.28	1.81	.83	36.25	1.19
p		.43	.79	.98	.11	.001*

Note. *=significant mean difference; Respective Language= Raw receptive language score from MSEL (Mullen, 1995); Expressively Language= Raw expressive. language score from MSEL (Mullen, 1995); In parentheses= standard deviation.

Table 5 Correlations of predictors with the outcome variable.

Variable	1	2	3	4
1. Parent Education				
2. Parent Race	.12			
3. AAC	-.04	-.08		
4. CTC	-.19*	-.22*	.16	
5. Vocabulary Size	-.074	-.12	.56**	.50**

Note. *= significant predictor, p <.05; **= significant predictor, p<.001;

A multiple OLS linear regression was run, including the covariates (parent race and education), predictors (AAC exposure and total turns at session 24), and the interaction term between AAC and total turns (Shown in *Table 6*). The overall model significantly predicted vocabulary size at session 24, F(5,101)= 21.75, p<.001, R^2=.72. The data indicates a main effect of both AAC exposure t=7.31, p<.001, in which children in the AAC condition had a larger vocabulary size by session 24. Additionally, there is a main effect of CTC at session 24 t=6.19, p<.001, indicating that increases in CTC predicted greater vocabulary size. Most importantly, there is an interaction between AAC exposure and CTC on vocabulary size t=2.96, p=.004. Probing the interaction further elucidated the nature of this interaction. As depicted in *Figure 4,* increases in total conversational turns predicted greater vocabulary size, but only in children who were exposed to AAC.

Table 6 Results of linear regression analysis for AAC exposure and CTC on vocabulary size at Session 24 including parent race and education as covariates.

Factors	Standardized Coefficient	Standard Error	Unique R^2	*p*
Parent Race	-.032	1.63	.001	.66
Parent Education	-.035	1.87	.001	.62
AAC*	.521	2.05	.25	<.001
CTC*	.449	.01	.18	<.001
AAC X CTC*	.214	.01	.04	.004

Note. *=significant predictor; AAC is separated by intervention groups with and without AAC; CTC= sum of parent and child conversational turns; Race= is separated by white and other races; Education= categorized by parents with less than a college education and above a college education.

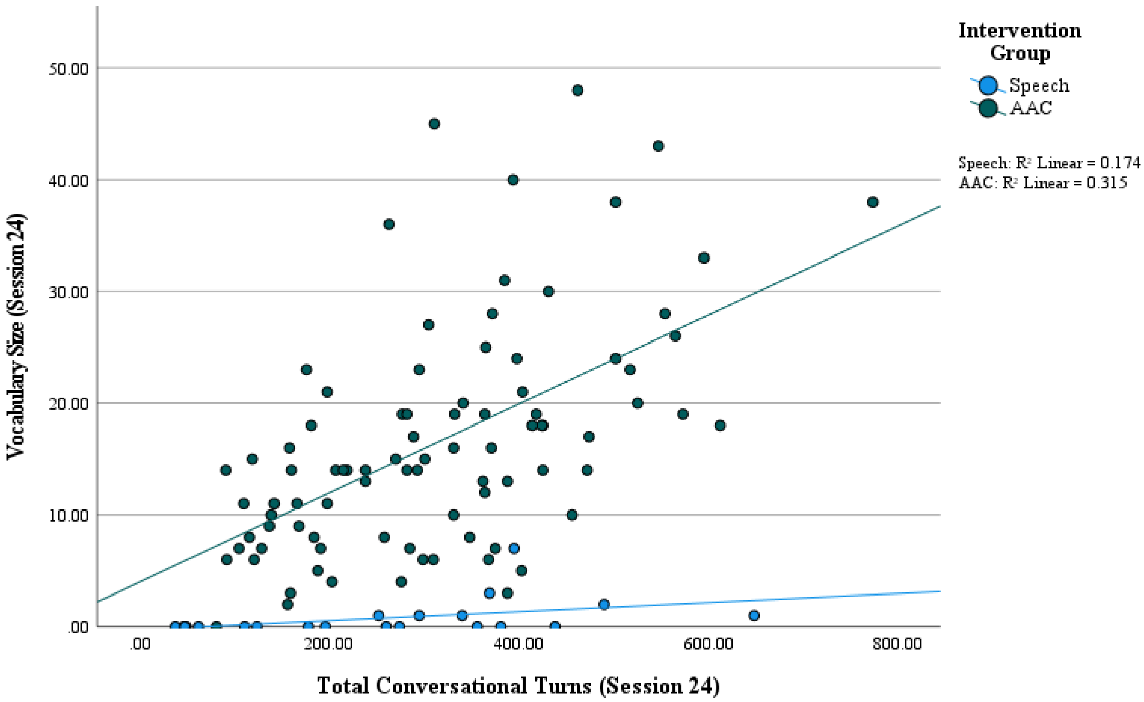

Figure 4 Graph of the relationship between conversational turn count and vocabulary size separated by intervention group.

4 DISCUSSION

In this study, we examined the growth trajectory of conversational turns throughout an augmented language intervention for children with DD who are minimally speaking. Moreover, we uncovered the effect of total conversational turns and AAC exposure on vocabulary size at the end of the intervention. The combined results of these aims elucidated the impact of the socio-pragmatic experience quantified through conversational turn-taking during individualized AAC intervention for children with DD.

The first aim analyzed the growth trajectory of total conversational turns, child conversational turns, and their communication partner's conversational turns. The results support an increase in total conversational turns from baseline to session 24. However, there is an unexpected decrease in total CTC in session 12, causing growth trajectory models of total CTC to be inconclusive. Further inspection revealed that child CTC and their partner's CTC over the course of intervention differ substantially. The children exhibit a quadratic growth trend in which they increase in CTC throughout the intervention, with the largest increase in CTC occurring between baseline and session 6, but the growth slows nearing the end of the intervention.

Considering conversational turns as a measure of connectedness, the model implies that as the children progress through the intervention, they become more connected and engaged with their conversational partners. This growth in connectedness slows after a sharp increase from baseline to session 6, implying that these children might reach a ceiling on their ability to connect with their conversational partners. The intervention focuses on novel word learning but does not emphasize other aspects of language such as multiple-word utterances, phonological awareness, and syntax structure. Therefore, the growth in connectedness may plateau because the children do not have adequate skills to increase their input. Another likely explanation is that the length of the intervention does not capture the full extent of growth in connectedness between these dyads. It is possible that as these children improve their cognitive-linguistic abilities through development, they may increase conversational turns after this plateau.

Interestingly, there is evidence that their conversational partners’ exhibit a quartic growth trend in which they increase in CTC from baseline to session 6 and session 18 to session 24, but a large decrease in CTC during session 12. On par with other findings (Rosenberg & Abbeduto, 1993), parents typically matched their child's participation indicating that they are also engaging with and responding to the child's input. However, the dip in parent CTC in session 12 illustrates an atypical phenomenon. This trend is explained by the gradual shift in communicative partners that occurs between session 9-13 in which parents begin to take over as the primary interventionist. In session 12 parents are not entirely leading the session and must also take on the role of a student as they learn to implement the intervention with their children. Therefore, it is hypothesized they reduce their input as they focus on acquiring these skills. Fortunately, within three weeks parents have conversational turn equivalent to that of the interventionist before the shift and continue to match the input of their child for the remainder of the intervention.

The second aim examined the relationship between AAC exposure, CTC, and vocabulary size after controlling for parent race and education. The results indicate that AAC exposure moderates the relationship between CTC and vocabulary size, such that increases in CTC predicted increases in vocabulary size, but only in parent-child dyads that participated the AAC intervention. In other words, parents with a child with DD enrolled in AAC interventions follow similar trends as their typically developing counterparts (Donnelly & Kidd, 2021), where increases in communicative connectedness between parent-child dyads are associated with improvements in language outcomes. However, the same is not true for parents with a child who has DD enrolled using a speech-only intervention. It is hypothesized that this difference manifests because AAC allows children with complex communication needs to adequately communicate their thoughts, making interactions with communicative partners more meaningful than if they were required to vocalize utterances.

4.1 Clinical Implications

The findings add to the existing literature that AAC is more effective than traditional intervention as it predicts larger vocabulary sizes in children with developmental disabilities (Romski et al., 2010; Yoder & Stone, 2006). Additionally, the results suggest that when employing AAC intervention, interventionists should also encourage more conversational turns as it predicts a larger vocabulary size, but such tactics will be ineffective in traditional language intervention using spoken communication. One possible explanation of these results is that using

AAC, which includes visual symbols, limits cognitive strain, and aids memory for the target vocabulary. In other words, the AAC device may give children more chances to use a set list of words while reducing the cognitive cost of auditorily retrieving those words, which facilitates the development of the novel word's meaning.

Moreover, this study elucidates the nature of the growth trajectory of CTC throughout the intervention. The results revealed differences in the CTC trajectory of children using AAC and their conversational partners. These findings suggest that when shifting to parent-led sessions, parents may reduce their input as they work to gain competency in implementing the intervention. This tendency to reduce input may have rippling effects as it reduces total conversational turns that we now know is related to the child's vocabulary size at the end of the intervention. Language interventions typically record the communicative gains of the child, but these results suggest that when parents are trained to act as interventionist, they uniquely alter their communicative practices over the course of the intervention. Therefore, these results support that language interventions using AAC should employ a family-centered approach (McCollum et al., 2001). This type of intervention includes goals and outcome measures to address changes in the parents' communicative practices, as the changes in the child's communicative practices may not always mirror changes in the overall language environment. Additionally, parents might benefit from opportunities to practice implementing the strategies outside of the scheduled sessions (i.e., role-play activities with SLP or interventionist) in conjunction with access to the Intervention Protocol Manual (Romski & Cheslock, 2000) to prevent the reduction in their input.

4.2 Limitations and Future Directions

Some limitations lie in the conclusions that can be drawn from this study. Firstly, the exclusionary criteria apply the results to a specific subset of children with developmental disabilities and cannot be generalized to children with a primary diagnosis of autism, specific language impairment, or hearing loss. Additionally, this study examines the growth trajectory in conversational turn-taking during AAC intervention but does not compare it to children who were not in the AAC group. Therefore, it cannot assert that exposure to AAC impacts the growth trajectory of conversational turns. Lastly, causal claims cannot be made on the effect of conversational turns because the number of turns was not manipulated.

Future studies would benefit from addressing these limitations. Firstly, they should include a larger sample size with representation for several developmental disabilities to assess whether the growth trajectory of CTC differs according to diagnosis. Additionally, the growth curve should be compared against children who participated in spoken language intervention as it will reveal the effect of AAC on conversational turn-taking. Lastly, analyses also should manipulate the number of turns by encouraging a subset of parents to take more turns to determine the causal effects CTC has on vocabulary size. Future research inquiries should also analyze other aspects of conversational turns (e.g., content in turns, length of pauses between turns, interruptions, etc.) for unique effects on vocabulary size within this population as it will uncover the complete picture of interconnectedness between parent-child dyads throughout the intervention.

4.3 Conclusion

Overall, these results strengthen the literature that AAC language intervention effectively increases vocabulary size while illuminating conversational turns as a factor interacting with these variables. This study also disentangles the growth trajectories of interventionist, parents, and child CTC resulting in a unique understanding of these parent-child communicative interactions throughout the intervention. The combination of these results creates the foundation for a new line of research evaluating the communicative connectedness of parents who have children with DD and complex communicative needs.

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