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Initiation of Communication in Preschool Children with Autism:

Temporal Development and Contextual Inconsistencies

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Abstract

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication and restricted or repetitive interests or behaviors (CDC, 2021). Some children with ASD begin to show symptoms at 12 months, and a diagnosis can be reliably made at 18-24 months, when the social communication profiles of a child with ASD becomes distinctly different from their neurotypical peers (Wetherby et al., 2007). Early/preschool inclusive classrooms have been shown to promote development of social communicative skills (Stahmer & Ingersoll, 2004). The Marcus Autism Center hosts an inclusive Preschool with three classrooms (2/3/4 year old), and tracks student development using active engagement measures. One of the variables of active engagement, initiation of communication (IC) measures purposeful, directed acts of communication in children with ASD. The present study incorporates IC data from an eligibility observation (EO) and five classroom recordings for 19 children to study the effects of contexts, time, as well as demographic and developmental data, on the development of communication within the Preschool. We hypothesized that the sampled children would demonstrate within-individual temporal and contextual consistency in IC, and that their developmental baseline data (gathered from clinicians-administered ADOS and parent-reported CDIs) and demographic data would lead to between-groups differences in classroom IC. Our analyses yielded mixed result overall: for the sampled children, time spent at the Preschool was significantly correlated with classroom IC ($F = 7.13$, $p = .009$). Moreover, the overall trajectory of classroom IC followed a positive trend line (*slope* = 0.84), suggesting overall improvement in communication rates. On the other hand, IC at EO was not significantly correlated with IC across the five classroom dates. The null result should inspire further examination of how context/ environment affects social communication within an individual. In addition, analyses of demographic and developmental data provided mixed results regarding their relations with IC at EO and in class. Certain developmental variables, such as calibrated ADOS score and number of words understood in CDIs, were correlated with higher IC, whereas other variables in developmental measures did not show statistically significant correlations. Interaction effects between race and sex, as well as collection year and class level, were also found to be significant. An important consideration for this study is the constraint on sample size given the limited number of children within the Preschool.

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Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that affects 1 in 44 American children (Maenner et al., 2018). Social communication delay is one of the most prominent defining features of ASD (CDC, 2021). This deficit is observed on multiple levels, including lack of attention to the eyes of others, weaknesses in following gaze/point, limited joint attention, and language deficits (American Psychiatric Association, 2013). From as early as two years of age, these behavioral differences in social communication profiles can be observed when compared to typically developing or even developmentally delayed peers (Wetherby et al., 2007). Research has shown that early diagnosis, intervention, and inclusive education improve social communication outcomes for children with ASD (Zwaigenbaum et al., 2015; Christoforos et al., 2021). The classroom is an optimal environment for children with autism to interact with other people daily for an extended period of time and develop a functional communication system (Stahmer, Akshoomoff, & Cunningham, 2011). Set in the Preschool Program at Marcus Autism Center, the present study aims to examine the temporal development of social communication for children at the Preschool, and to evaluate the utility of the Eligibility Observation (EO), a part of the admission process, in capturing communicative behaviors that would predict classroom outcomes. The present study measures Initiation of Communication (IC), a variable within the larger construct of Active Engagement (Sparapani et al., 2016), as an indicator of social communication development. We seek to answer the question of whether IC across two different social contexts and multiple time points show internal consistency for children with ASD in the Preschool.

Communication

Atypical social communication is one of the two domains of behaviors that define ASD (American Psychiatric Association, 2013). From as early as age two, children with ASD show significant deficits in communicative behaviors including social referencing, joint attention, and language (Wetherby et al., 2007). In addition, rates of communication have been found to be significantly lower in preschool-age children with ASD compared to children who are developmentally delayed but not autistic (Wetherby et al., 2007), leading to diminished comprehension and learning opportunities. Delehanty and Wetherby (2021) observed that higher communication rates for children with ASD between the ages of 18-24 months were significantly correlated with better communication skills and less red flags for ASD at 20 months, and better language abilities at 3 years. Conversely, diminished frequency in communicative behaviors is often accompanied by lack of initiation of interaction and a deficiency in the content of communication (Engelstad, Holingue & Landa, 2020). These trends are concerning because indicators such as language fluency before the age of five are strong predictors of cognitive and academic outcomes in adolescence (Arnold et al., 2012).

Classroom

For children with ASD who display communication challenges, NDBIs (naturalistic developmental behavioral interventions) are strongly advised to promote language development and learning outcomes (Schreibman et al., 2015). However, the accessibility of ASD-specific treatment programs for children is scarce and varied across the country (Cantor et al., 2020).

Assessment of communication rates and interventions targeting communicative behaviors should be made available to children with ASD and their families to ensure better developmental outcomes. An alternative to intensive therapy, classroom-based interventions demonstrate promise by supporting social communication development in a more efficient manner (Engelstad, Holingue & Landa, 2020). The classroom environment affords daily interaction opportunities with multiple social beings that are embedded within the child's natural surroundings. Given that children with autism often display behaviors such as emotional dysregulation and resistance to change, successful inclusive education programs recruit teachers who understand the disorder and implement appropriate teaching methods that are grounded in research (Engelstad, Holingue & Landa, 2020). Early inclusive education where all students, including children with disabilities, have the opportunity to learn in the same classroom with their peers, has been proven to significantly promote the development of social skills such as social interaction, spontaneous vocalization, and imitation (Vivanti et al., 2019; Eldar et al., 2010; Kurth et al., 2018). Toddlers with autism who attended an inclusive program for one year showed significantly higher development in communication skills compared to the expected developmental trajectories (Stahmer, Akshoomoff, & Cunningham, 2011).

Active Engagement

To reliably study communication in children with autism in the classroom, an appropriate quantitative measure is needed. One good measure of social developmental outcome is active engagement (AE) (Sparapani et al., 2016), defined by self-motivated involvement in shared activities and directed communicative behaviors (Siller, Morgan, & Fuhrmeister, 2020). The National Research Council recommends that students with ASD engage in a minimum of 25 hours of AE each day to promote better learning and social skills outcomes (NRC, 2001). AE in students with ASD has been found to be better achieved in preschool classrooms where the social and academic demands of school life are lower than when the children reach secondary-school age (Christoforos et al., 2021). A study on friendships in school-age boys with ASD found that even though children with ASD do make friends, their self-reported and perceived friendship qualities were poorer than children who are typically developing (TD) (Mendelson, Gates, & Lerner, 2016). The study found that, despite having a desire for friends, children with ASD struggle to stay actively engaged with classmates and activities in the classroom. With deficits in joint attention and social orientation (American Psychiatric Association, 2013), children with ASD often fail to attend to the communicative bids of others in the classroom. Partially consequent of attentional deficits, children with ASD demonstrate lower rates of communication, which invariably lead to neglect and isolation in the classroom (Christoforos et al., 2021). To investigate the social-communicative aspect of active engagement, the present study measured and analyzed Initiation of Communication rates across time and contexts in children with autism at the Marcus Autism Center Preschool. Initiation of communication (IC), a variable of AE, is an act of communication that primarily serves the purpose of sharing information with other individuals (Bottema-Beutel, 2020; Wetherby et al., 2007). Given the importance of early communication behaviors and the benefits of early inclusion programs, the present study seeks to investigate the longitudinal trajectory of IC in children with ASD in inclusive classrooms across contexts.

Variability and generalizability of communication rates across contexts

It is well established that communicative behaviors show extensive variability across individuals with ASD, from mild impairment to profound disability (CDC, 2021). A study by Franchini and colleagues used a parent-report questionnaire to show considerable variability in early language and gesture acquisition during the first two years of life in 482 infant siblings at high risk for ASD (2018).

Compared to longitudinal development of communication, the consistency of communicative behaviors across contexts is less well studied in children with autism. Research has shown that individuals with ASD experience difficulties generalizing skills and past knowledge to new challenges, and that the generalization weakness is associated with underlying language skills (de Marchena, Eigsti, & Yerys, 2015). Relatedly, a recent study in Norway studied expressive language in 2-4 year-old children with ASD across the home and preschool contexts. The study found no significant difference in the number of words the children used in the two contexts. Instead, there was a significant difference in the vocabulary employed in the two contexts, with one-third of words said both at home and in the preschool, and two-third of words selectively spoken in only one of the two environments (Sánchez Pérez, Nordahl-Hansen, & Kaale, 2020). The generalized adaptation theory of autism centers around a lower ability of the individual to adapt to the environment and their internal changing states (Gernert, Falkai, & Falter-Wagner, 2020). Combined with the fact that context-degeneralized language (talking about non-present individuals or events) is a strong predictor of academic proficiency in typically developing children (Uccelli et al., 2019), the drastic difference in language content across contexts may suggest that children with ASD have weaknesses in adapting pre-existing communication skills to new environments. A recent meta-analysis article on social communication intervention outcomes yielded significantly larger effect sizes in studies with context-bound outcome measures, where the setting, communication partners, materials, and interaction styles are highly similar to the treatment context (Fuller & Kaiser, 2020). This result shows that for children with ASD, advanced social communication skills observed in one context does not necessarily imply success in other environments. It also points to the importance of communication partners and their support in facilitating a child's communicative frequencies. For children with ASD at the Marcus Preschool Program, we were interested in whether communication rates in a clinical observation are predictive of communication rates in the classroom. Ergo, the present study examined whether communication behaviors in a controlled setting from interactions with parents and clinicians persist into the classroom environment.

Marcus Autism Center Preschool Program

The Preschool Program at Marcus Autism Center serves as a model for the study of early inclusive education for children with autism and typically developing children. Classroom sizes range from ten to twenty children, of which six have received diagnoses of ASD. Three teachers who are regularly trained and supported by a classroom coach support the students through their daily activities. The Program was developed as an early inclusive education model preschool that would generate guidance for community-viable preschool programs (Siller et al., 2021).

Admission to the preschool program involves a two-fold process that includes parental report and EO, where a child's ability to communicate and other developmental considerations are evaluated for fit with the program (Siller, Morgan, & Fuhrmeister, 2020). Previous research emerging from this lab school has shown that parent-reported early gestures were the strongest predictor of the preschool's decision to invite a child for an EO, whereas parent reported number of words produced by the child were the strongest predictor of whether we invited the child to enroll following the EO (Siller, Morgan, & Fuhrmeister, 2020). However, limited research has been conducted on whether rates of IC in the EO is predictive of IC rates in the classroom. Given that whether a child is admitted is partially determined based on his/her initiation of communication in the EO, it is essential to investigate the strength of the selection process to ensure maximum developmental gains from the preschool program.

The environmental context of the EO (small room with clinician, guardian, and child) and the classroom (early childhood classroom with 12-18 children and three teachers) at the Marcus Preschool are significantly distinct. The frequency at which a child communicates with family members may not be representative of their communicative rates with classmates and teachers. In fact, crowds and social overstimulation are some of the most frequently reported barriers to managing anxiety suffered by children with ASD (Francke & Geist, 2003). Therefore, children with autism could exhibit divergent social behaviors in the EO and the classroom. There is a gap in the literature with regard to how children with autism interact in varying social environments. This present research assessed social aspects of active engagement by measuring the initiation of communication in children with ASD at the preschool. This study examined the question of whether communicative behaviors exhibited by the children in EO with parents and clinicians were correlated with communication rates in the classroom with classmates and teachers. Furthermore, given that benefits of inclusive education in ASD includes increases in social communication skills (Stahmer & Ingersoll, 2004), the study assessed the classroom IC development trajectory longitudinally.

Method

Participants

A total of 19 students with ASD enrolled at the Marcus Preschool Program over two years — 2019-2020 (Wave 1) and 2020-2021 (Wave 2) – were included in this study. Study inclusion criteria were based on diagnosis of ASD, presence of an initial EO and classroom video collected on a minimum of three days. Six children (31.6% of the sample) were enrolled in the Preschool Program for both Waves of data collection, whereas the remaining 13 children were only enrolled during one Wave of data collection. The students who attended both Waves were counted as two separate entries where Time in school was being accounted for by the analyses, amounting to a total of 25 entries.

Sample demographics are summarized in Table 1. The mean chronological age of the study sample ($N = 25$) at the time of entry to the Preschool was 44.44 months ($SD = 14.57$). The preschool program hosts three classrooms that are organized by age. Over the two Waves, the sample included 10 entries in the two-year-old classroom, 8 in the three-year-old classroom, and 7 in the four-year-old classroom. 68.4% of the sample population was male ($N = 13$), which is reflective of the unbalanced, sex-based epidemiology of ASD (Ratto et al., 2018). In addition, the racial makeup of the sample is moderately representative of the city of Atlanta, with 52.6% of the sample being African American/Black, 26.3% White, and 21.1% Mixed or others. SES was evenly distributed within the sample, whereas the education level achieved by the parent completing the questionnaire suggests that most parents received graduate level of training or higher (57.9%). Single parents who make up 26.3% of the sample may partially explain the lower household income level.

Developmental characteristics of the student sample are presented in Table 2. Out of the 19 children, 12 had Autism Diagnostic Observation Schedule (ADOS) data on file, whereas all 19 had baseline MacArthur Communicative Development Inventories (CDIs) results were collected from parental questionnaires upon entry. Five children (41.7%) received the Toddler module of the ADOS, four (33.3%) received Module 1, 2 (16.7%) received Module 2, and one (8.3%) received Module 3. The mean age at which the ADOS was administered was 35.50 months (*SD* = 14.73). The Calibrated Severity Score of ADOS for this sample had a mean of 7.08 (*SD* = 2.31), which is consistent with their autism diagnosis (Gotham, Pickles, & Lord, 2009). The CDI scores on the sample show delayed receptive and expressive language, as well as lower nonverbal communication, compared to typically developing peers (Luyster, Lopez, & Lord, 2007; Feldman et al., 2000). These ADOS and CDI scores were used in secondary analyses as predictors of classroom IC.

At the time of the first classroom video recording used to code IC, an average of 13.08 (*SD = 8.13*) months have passed since the EO session. Given that time spent in the classroom prior to IC collection might have an impact on a child's comfort in initiating communication, a secondary analysis was performed on the time between EO session and the classroom collection date.

Measures

REDCap Intake

Upon initial application to the Preschool, parents provided information on demographic , baseline social and communicative skills, as well as behavioral challenges of the child. The background questionnaire included information on parent age, ethnicity, income and education level, as well as marital status.

The *MacArthur-Bates Communicative Development Inventories* (MB-CDIs; Hutchins, 2013) are a set of parent report instruments that capture information about children's developing language abilities, including variables like Early Gestures, Late Gestures, Words Produced, and Words Understood. Baseline data from the MB-CDIs were used to first describe the participants and then as secondary predictors contributing to the model.

Autism Diagnostic Observation Schedule

The *Autism Diagnostic Observation Schedule (*ADOS-2; Lord et al. 2002) was used to determine severity of autistic symptoms and as secondary predictors to the model. The ADOS is a standardized, semi-structured interview observation designed to assess behaviors related to autism or autistic spectrum disorders including communication, social interaction, and play or imaginative use of materials. The ADOS-2 is designed for individuals who are at least 12 months of age, and reliably yields three standardized scores: social affect, restricted and repetitive behavior, and a combined total score. The ADOS-2 is comprised of five modules: the Toddler module (for children between 12 and 30 months of age who do not consistently use phrase speech), Module 1 (for children 31 months and older who do not consistently use phrase speech), Module 2 (for children with any age who use phrase speech but are not verbally fluent), Module 3 (for verbally fluent children and young adolescents), Module 4 (for verbally fluent older adolescents and adults). The clinician selected and administered one module based on each individual child's expressive language level and chronological age.

Initiation of Communication

Initiation of Communication (IC) rates were coded from the initial EO session and at five additional timepoints in the classroom for each participant, over a three month period. IC is defined as the purposeful and directed communicative act by the child (adapted from Wetherby & Prizant, 2002). IC rate measures the number of times a child either gestures or vocally signals for communication with another individual. An IC is purposeful when it is acted with the intention of communicating a message, whereas it is directed when the act is clearly conducted to address another individual. Four undergraduate research assistants were trained to code for directed, purposeful IC.

Procedures:

Eligibility Observations

During the admission process, an EO was conducted by either a speech-language pathologist or a developmental psychologist, with both the family and the child. IC attempts in an initial EO session were coded for each child in the sample. The EO consists of a semi-structured observation and a structured parent interview (Siller, Morgan, & Fuhrmeister, 2020). During the semi-structured observation, the clinician tries to engage the child in joint play using toys such as dolls, cars, and bubbles. The clinician also invites the family to interact naturally with the child. Due to the constraints of the study, the EO were coded separately and independently. A typical EO session lasts from 25 minutes to 50 minutes. From each child's EO recordings, three 5-minute intervals were selected, where possible, to capture the child's communication rates during parent-clinician talk, clinician prompted communication, and interaction with parent(s). IC were coded from these selections. The mean IC was calculated for each child and used for further analyses.

Classroom Observations

Five full-day Classroom Observations (CO) were collected over a three-month period within each classroom. Trained undergraduate research assistants coded classroom recordings to first identify categories of activities in the classroom. Categories included Center time (children distributed to play at multiple stations in the classroom), Circle time (children gathered at one place for a classroom-wide event), Unorganized time (no clear directions or activity in the classroom), Meal time, and Transition time (e.g., transition between Circle and Center). For the purposes of this study, videos from Center time were selected for coding. Compared to teacher-led, whole-class activities, the dispersed yet focused nature of Center time allowed children to engage and initiate communication with others freely and was consequently exclusively examined. After the Center times were identified, for each child at each data collection date, a 5-min sample of the data where the child was present and observable was systematically selected by the lab coordinator for further coding of IC. The lab coordinators the distributed these selected videos segments to undergraduate research assistants for coding. For this study, only data from children with an ASD diagnosis were included. Undergraduate research assistants performing the coding procedures were blind to children's diagnostic status.

Inter-rater Reliability

An initial training period within each coding group was marked complete as student coders achieved 80% agreement. Reliability training consisted of undergraduate research assistants coding the same video segments by the criteria separately and meeting to discuss discrepancies. Once coders achieved adequate levels of reliability, CO videos were distributed by the lab coordinator to each student individually. 20% of CO assignments overlapped between student coders, allowing for consistent reliability check-ups throughout the coding process. Two undergraduate interns coded the Wave 1 videos, and three undergraduate interns coded for Wave 2. Inter-rater reliability was calculated for 20% of the coded sample, yielding average high percent agreement (75%) across the two Waves, with the range of percent agreement spanning from 12.5% to 100%.

Data Analysis:

Data Preparation:

A total of 34 ASD entries from the two Waves were initially coded in this study. Out of these entries, five had more than two out of five missing CO data points due absences or late enrollment. These entries were removed from the analysis. Moreover, three students (4 entries given that one student continued from Wave 1 to Wave 2) did not have their EO sessions in the system. We excluded these data list-wise. Furthermore, six children continued attending the Preschool from Wave 1 to Wave 2. For analyses where time spent at the Preschool were accounted for, the six children who had two sets of CO data points were treated as two separate entries. Where time as a confounding variable was not being accounted for through statistical modeling, only the first Wave data were included for analyses. After excluding entries with more than two missing CO data, we ran primary and secondary analyses using 25 entries from the two consecutive years.

Preliminary Analyses

Sample demographics were examined for each classroom across the two waves using descriptive statistics and visual examination of histograms. We also visualized the distribution of IC from the EO session and CO recordings for each individual child using scatterplots.

Distribution properties of IC, demographic data, and developmental data were examined using statistical indicators of skewness and kurtosis as well as visual inspection of histograms and scatterplots.

Primary Analyses

Analyses were conducted using the statistical program SPSS (IBM SPSS Statistics, IBM Corporation, Version 28.0.0.0). We were interested in studying the predictive value of the EO session on the child's IC in the classroom, as well as the temporal constancy of IC. To study these relations, 1) we first ran the Univariate General Linear Model on how Time as an independent variable relates to IC across the 5 CO. Time between EO session date and each CO collection date was calculated and correlated with each IC data point with respect to the student. Since time between EO and CO was accounted for, we treated the children who continued across the two Waves as separate entries with five data points each.; 2) then, we performed Pearson bivariate correlations test to examine the linear intercorrelations between IC at the six collection dates. Since the time between EO session and the first CO collection date could be a potential confound in children who continued across from Wave 1 to Wave 2, only the data from the first Wave that a child was present for was included; 3) given that the repeated-measures GLM is not resistant to missing data, we extracted the 10 entries that had complete data and performed repeated-measures GLM with CO number as the repeated measure and IC as the dependent variable to determine whether individual students differ in their trajectories; 4) finally, individual trajectories were plotted for the six children who continued to attend the Preschool Program over the two years. Each of the six children had one EO session and 10 CO recordings of IC across the two waves of data collection.

Secondary Analyses

Multivariate GLMs were performed to study whether demographics, ADOS scores, CDI scores, Class (2/3/4 years old) and Wave (1 vs. 2) predicted IC at both the EO session and from CO 1-5. Entries from children's second year at the program were not included in this analysis to minimize potential confounds.

Results

Relations between Time, IC at EO, and IC in Classes

Details on IC at each data collection date are summarized and presented in Table 3. On average, the sampled children displayed more IC during EO (*Mean* = 27.40) than on any of the CO dates (*Mean* = 6.38~7.86). As expected, Time (between EO session and first CO IC collection) was a significant predictor of CO IC rates ($F = 7.13$, $p = .009$), with IC rates increasing as the Time a child has been in the classroom increases. Time and the identity of the student combined also produced a strong model that predicted IC rates in CO ($F = 3.21$, $p < .001$), such that each student demonstrated a fairly consistent rate of IC across time. In addition, age upon entry (in months) was also a significant independent predictor of all classroom IC ($F = 4.12$, $p = .045$), regardless of time. Children who were older upon entering the Preschool demonstrated more IC behaviors.

Contrary to our original hypothesis, EO IC was not a significant predictor of IC at CO in the univariate GLM analysis. To follow-up, Pearson bivariate correlations were calculated for an analysis of intercorrelations between all IC collection dates. These correlations are presented in Table 4. Significant ($p < .05$) intercorrelations were found between IC at Time 2 and Time 3, as well as Time 1 and Time 4. However, once again, no significant correlation between IC at EO and IC at any CO were present. To eliminate the effect of absences in the data, we performed repeated-measures GLM with the ten entries that had complete data points across six instances. The repeated-measures GLM once again yielded no significance for EO-CO correlation.

Finally, a trendline of IC over Time was plotted for the six children who continued from Wave 1 to Wave 2 and shown in Figure 1. A bar graph was also plotted for mean IC on the five CO instances, which yielded no significant difference (Figure 2).

Effects of Demographic and Developmental Status on IC

Secondary tests examining the effects of sex and/or ethnicity on the IC rates at EO and the mean IC rates over five Times showed no overall significance. However, race*sex did have a significant interaction effect on IC at EO session ($F = 3.952$, $p = .048$), such that in Black/ African American participants, children who are male showed lower IC rates at EO session, whereas for participants who are White or Other or Mixed, the female children showed lower IC rates at EO session. Household SES was not a significant predictor for either mean IC in Classes or IC at EO. On the other hand, the Wave from which the data were collected was a significant predictor of IC at EO, but not of mean Classroom IC ($F = 4.25$, $p = .038$; $F = 17.27$, $p = .001$). Specifically, children in Wave 2 produced significantly more IC at EO session compared to children in Wave 1 ($F = 5.99$, $p = .026$). In addition, based on pairwise comparisons, children in the 3 and 4-year-old Classroom in Wave 2 demonstrated significantly higher IC than 3 and 4-year-olds in Wave 1 ($MD = -41.33$, $p = .006$; $MD = -25.83$, $p = .024$). Detailed data on Class and Wave interaction and Sex and Race interaction are presented in Table 5.

Calibrated ADOS score had a significant effect on mean IC over the five collection dates ($F = 8.13$, $p = .036$). All other ADOS variables (module administered, Repetitive and Restricted

Behaviors, Social Affect) were not significantly predictive of IC. From the CDIs completed by parents upon entry, the number of words understood has a significant effect on predicting IC at EO ($F = 5.97$, $p = .031$), whereas other variables (words pronounced, early and late gestures) did not.

Discussion

By studying IC in 19 children with autism at the Marcus Preschool across two years, we studied the effect of time and context on communication rates. Overall, the length of time a child has spent in the Preschool is associated with their IC rates. Their IC at EO, which was collected before their entry to the Preschool, was not associated with classroom IC. Social communication challenges in autism including lower communication rates have been shown in multiple settings, such as naturalistic home environments, classroom settings, and clinical scenarios (Mamas et al., 2021; Delehanty & Wetherby, 2021; Engelstad, Holingue, & Landa, 2020). However, limited research has examined the consistency of IC across settings and the innate factors contributing to rates of IC. This study was significant in that it analyzed the internal consistency (or inconsistency) of communication rates for children with autism across time and contexts.

Overall, the study found internal temporal consistency of IC across time for preschool children with ASD, specifically within individual consistency and temporal increase. In addition, children initiated more communication after spending more days in the classrooms, which could be indicative of increased familiarity with the classroom environments and/or improved social skills. It is promising to see an increase in IC by children with ASD in the classrooms as it could be reflective of social learning (Stahmer, Akshoomoff, & Cunningham, 2011).

On the other hand, in contrast to our original hypothesis, the IC rates demonstrated by the child during the initial EO session were not significantly predictive of IC rates in CO. This lack of correlation could be indicative of several underlying causes or complications: 1) Prompting by the clinician during EO could serve as a confounding variable that contributed to demonstrated IC. Given that part of the purpose of the EO was to evaluate a child's language and play skills, as well as to probe for classroom readiness (Siller, Morgan, & Fuhrmeister, 2020), clinicians purposefully engaged the child with toys and verbal cues to encourage communication. Because the EO is so facilitating and supportive, it might provide us with a varied and richer observation of IC for a given child than during CO. Prompting by the clinician could increase a child's likelihood to communicate to varying degrees, which needs to be taken into account for future studies; 2) The difference in contexts could lead to varying communicative behaviors by the child since the CO and the EO sessions provide relatively different affordances (Hellendoorn, 2014). The EO is a semi-structured interview with the child's family and the clinician. The child might feel more at ease communicating with their parents and a sole stranger (trained clinician). There are significantly more people in the classrooms compared to in the EO, which could potentially overwhelm the child and decrease their IC; 3) The method through which we collected data across the five CO timepoints could also be an interfering factor. Given that the children were recorded for a full day at school during collection dates, practicality mandated random selection of segments of the recording to be coded. Despite preliminary coding of the videos based on classroom activity, there may still be variation between the individual activities that the child was performing. However, given that we did see a general upward trend of IC over time, and with time being a significant predictor of classroom IC, the effects of the variability in activities partaken by the individual child could have been accounted for across the sample.

The dyadic nature of communication should be taken into account in future studies. Children from a young age display intergroup biases which remains stable throughout the human lifespan (Dunham, Baron, & Banaji, 2008). This rapid social learning has been shown to be intact in adults with ASD with no association between autistic traits and Implicit Association Test effects (Birmingham et al., 2015). Implicit biases has been less studied in young children with ASD. Future studies could examine who the preschool children are directing their IC's toward (e.g. peers, teachers) to further identify consistencies or inconsistencies within the contexts.

The present study is significant in that it measured an established variable (IC) in a novel manner to evaluate the current preschool admission process. By understanding the correlations between IC during the EO and classroom outcome, we can begin to analyze its value in the admission selection process more accurately and consciously. By suggesting contextual inconsistency of IC, the study findings put into question the practicality of using the measure of IC, as well as the interpretation of EO sessions. Other measures of Active Engagement besides IC, including joint attention, shared positive affect, and gaze/point following, should also be analyzed for their predictability (Wetherby et al., 2007). Future studies could examine whether other measures of Active Engagement carry across contexts.

The interaction effect between race and sex on IC at EO was unexpected. Literatures have identified gender-racial effects in the misidentification and lack of ASD treatments for certain student populations (Golson et al., 2021; Werling & Geschwind, 2013). Phenotypic differences were previously documented, with Black/African American children displaying more echolalia, stereotypical words or phrases, and unusual eye contact (Harrison et al., 2017), and White children displaying more adherence to inflexible routines and persistent preoccupations with parts of objects (Sell et al., 2012). Gender-racial differences in ASD expressions emphasize the importance of including multiple dimensions and variables in the study of Active Engagement across contexts, as well as the need for a larger, more representative sample size.

A 2021 paper by Delehanty and Wetherby identified the relative distribution of different types of communicative acts: vocalizations account for 60% of all communicative acts across ASD, TD, DD populations; deictic gestures (pointing, showing, giving, and reaching) ⅓ of time, followed by iconic, conventional, and contact gestures. Vocalization, deictic gestures, and conventional gestures were significantly correlated with communication and early learning measures. The differential strengths of correlation between various types of communication could be studied longitudinally and across contexts in the future.

It is important to note that in Delehanty and Wetherby's study, there was no significant correlation between rate of communicative acts and the Calibrated Severity Score (CSS) of ADOS. This result, upon first glance, appears to be in conflict with our significant finding between IC at EO and CSS. A potential reconciliation may come from the disparate observation context: Delehanty and Wetherby observed children with ASD in a naturalistic home setting, whereas in our study, children were observed in a clinical setting with a clinician and their family. Notably, the ADOS observation is also typically carried out by a clinician in a clinical facility, and involves prompting the child with various toys and questions. Future study should examine more in-depth the relation between context and ADOS scores. More importantly, if ADOS outcomes correlate with communication rates in a clinical setting yet not in a naturalistic setting, then clinicians need to be careful when interpreting ADOS results as it may not perfectly represent a child's behavior outside of the testing room. Furthermore, it could also explain why in our study, mean IC from all CO collection dates did not correlate with any of the ADOS scores. Compared to the EO session, the classrooms are more naturalistic social environments.

An important limitation to consider when interpreting the results of this study is the small sample size. The size of the sample was constrained by the number of children who attended the Marcus Preschool in 2019-2020 and 2020-2021, during which CO and EO sessions were collected. It was further reduced as a result of student absences on multiple dates. The small sample size may have limited our abilities to observe a consistent effect of certain demographic variables on IC rates. It is possible that certain outcomes are partially masked by the small sample size and type II errors might have occurred. On the other hand, it is also possible to introduce type I errors that biased our results from this sample. As previously stated, the sample captured a demographic representation of Atlanta in terms of race, and it did include more male participants, as expected given the skewed gender prevalence (Werling & Geschwind, 2013). Despite the demographic representation, a small sample size still could have reported skewed results, such that our findings would not be generalizable to the entire autistic population. Future study should attempt replication on a larger scale.

In conclusion, IC in CO showed within-subject relation in their development over time. However, neither overall nor individual IC showed correlation across the EO and CO contexts. The temporal consistency and contextual inconsistency of IC trajectory for children with ASD should prompt future research on developing measures of social communication that achieve consistency across contexts. Relatedly, the generalizability of clinical observations to behavior in one’s natural social environment needs to be addressed and evaluated for measures of social communication.

Tables and Figures

Table 1 Demographic characteristics of the sample upon acceptance to the Preschool.

Variable	***N***	***M (SD) or %***	***Range***
Chronological age (months)	25	44.44 (14.57)	21-71
Age at each classroom level (months)			
2 year-old	10	32.50 (9.41)	21-50
3 year-old	8	44.13 (8.90)	28-54
4 year-old	7	61.86 (5.64)	54-71
Sex			
Male	13	68.4%	
Female	6	31.6%	
Clinical diagnosis of ASD upon entry			
Yes	17	89.5%	
No*	2	10.5%	
Age at ASD diagnosis (months)	12	30.58 (11.33)	18-54
Race			
Black/African American	10	52.6%	
White	5	26.3%	

Hispanic	1	20%
Non Hispanic	4	80%
Other or mixed	4	21.1%
Household Income		
Below $20,000	2	10.5%
Between $20,001 and $50,000	3	15.8%
Between $50,001 and $80,000	3	15.8%
Between $80,001 and $120,000	1	5.3%
Above $120,000	6	31.6%
Missing	4	21.1%
Marital Status		
Single	5	26.3%
Married	12	63.2%
Other	1	5.3%
Missing	1	5.3%
Guardian answering the questionnaire		
Mother	15	78.9%

Father	3	15.8%	
Parent	1	5.3%	
Highest level of education of the guardian			
Graduate professional training (graduate degree completed)	11	57.9%	
Standard college or university graduate	4	21.1%	
Partial College (at least one year completed); or has completed specialized training	3	15.8%	
Missing	1	5.3%	
Guardian age (years)	17	37.18 (5.01)	29-47
Collection year			
Wave 1	11	44.0%	
Wave 2	14	56.0%	

Note. EO = Eligibility Observation; IC = Initiation of Communication; * these children did receive an ASD diagnosis at a later time point

Table 2 Developmental characteristics of the sample.

Autism Diagnostic Observation Schedule measures	*N*	***Mean or %***	***Range***
Module	12		
Toddler	5	41.7%	
1	4	33.3%	
2	2	16.7%	
3	1	8.3%	
Age at evaluation (months)	12	35.50 (14.73)	14-68
Social Affect	12	4.33 (2.71)	0-9
Restricted and Repetitive Behavior	12	11.33 (3.89)	518
Calibrated Severity Score	12	7.08 (2.31)	2-9
Missing	7		
Mac-Arthur-Bates CDI (Words and Gestures form)			
Early Gestures	19	12.89 (3.54)	8-10
Late Gestures	19	26.32 (12.48)	6-38
Total Gestures	19	39.21 (15.51)	14-62
Words Understood (of 396)	19	235.63 (134.59)	0-396

Words Produced (of 396)	19	169.11 (152.51)	0-396
Phrases Understood (of 28)	19	18.79 (7.428)	0-26

Note. ADOS = Autism Diagnostic Observation Schedule; CDI = Communication Development Inventories

Table 3 IC in Eligibility Observation session and 5 Classroom Observations

Session Name	***N***	***Mean***	***SD***	***Range***
Eligibility Observation	19	27.40	15.81	3-68
CO 1	24	6.38	4.98	0-16
CO 2	22	5.59	4.65	0-15
CO 3	19	7.84	6.16	1-23
CO 4	22	7.86	6.08	0-19
CO 5	20	7.35	5.39	1-21
Time between EO collection and first CO collection (months)	25	13.08	8.13	3-29

Note. EO = Eligibility Observation; CO = Classroom Observation

Table 4 Pearson bivariate intercorrelations between IC measures across six instances

IC measures	EO	CO 1	CO 2	CO 3	CO 4
EO					
CO 1	-.186				
CO 2	.942	.520			
CO 3	.694	.359	.754*		
CO 4	.791	.701*	.532	.481	
CO 5	.672	.977	-.076	.320	.068

Note. * Correlation is significant at the .05 level (2-tailed); EO = Eligibility Observation; CO = Classroom Observation

Table 5 Pairwise Comparisons for Demographics and Class-Wave Interactions

	Mean Difference	**Significance**
Class	Wave 1- Wave 2	
2	-6.400	.376
3	-41.33*	.006
4	-25.833*	.024
Race	Male-Female	
Black or African American	-24.500*	.050

White	21.833	.100
Other of Mixed	2.000	.884

Note. * The Mean Difference is significant at the .05 level.

Figure 1 IC plotted over CO number for the six children who continued from Wave 1 to Wave 2 (ten classes). Positive overall trajectory observed.

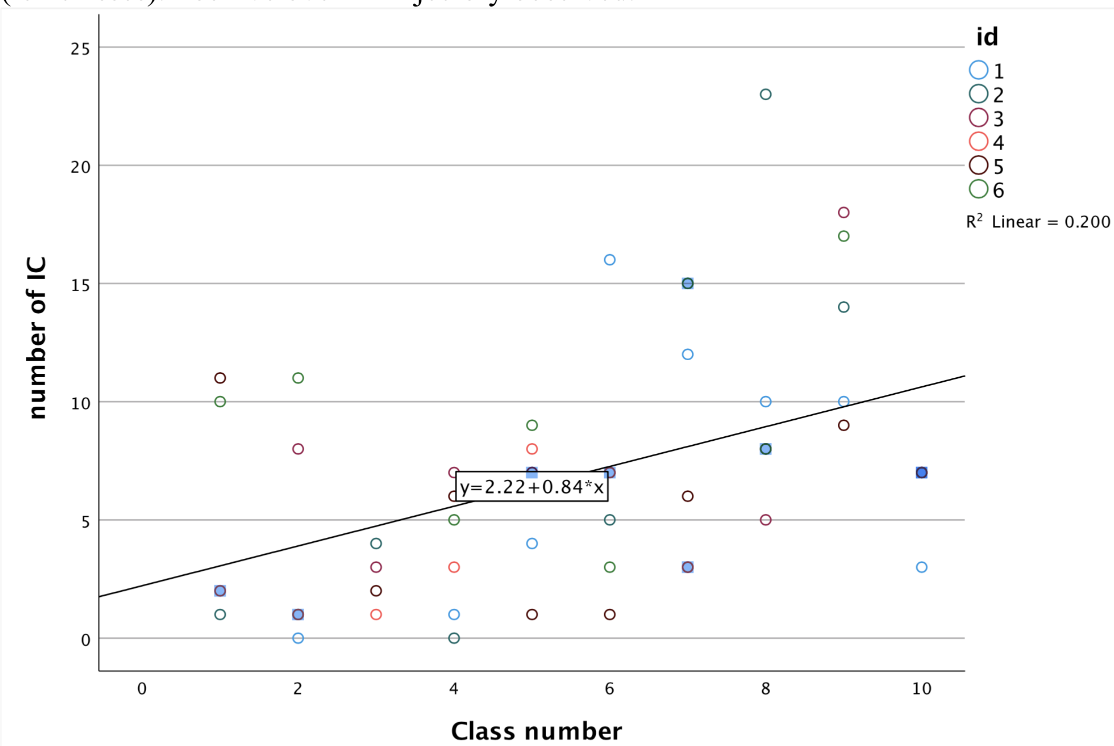
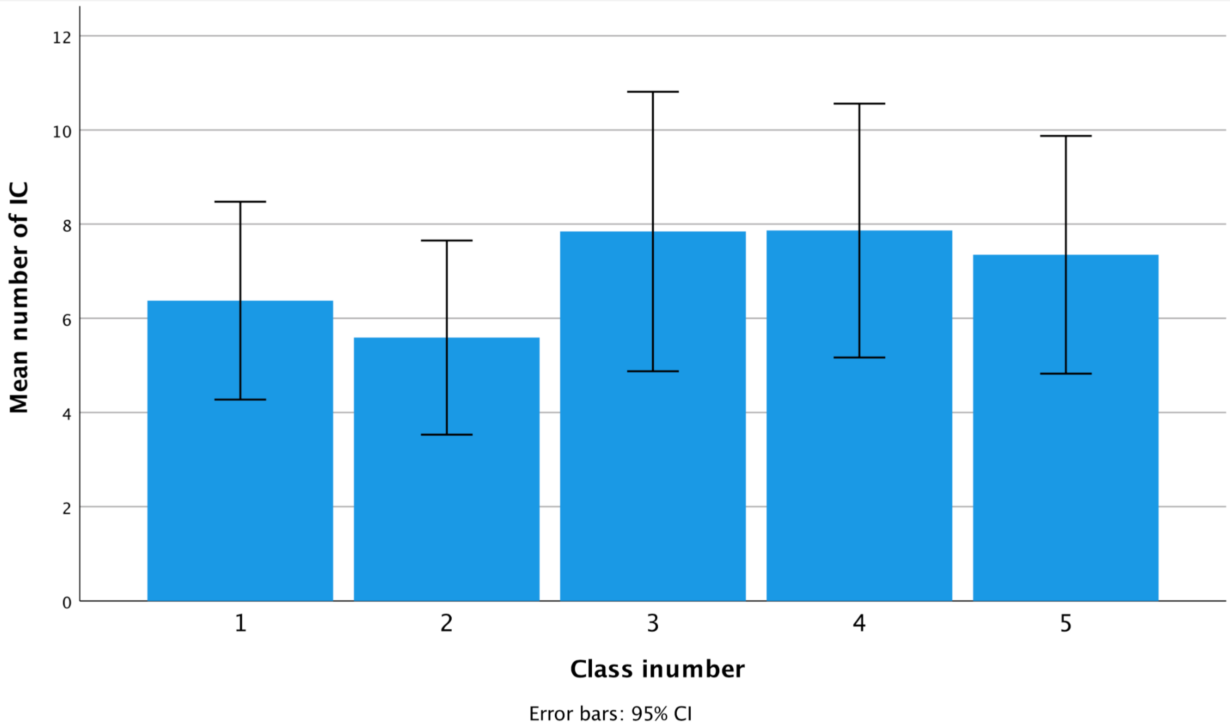


Figure 2 Bar graph of IC averages at the five CO instances. No significant difference.



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