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ORIGINAL PAPER

Comparing the Pragmatic Speech Profiles of Minimally Verbal and Verbally Fluent Individuals with Autism Spectrum Disorder

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Abstract
Although pragmatic speech impairments have been found across the autism spectrum, how these manifest in minimally verbal (MV) individuals with autism spectrum disorder (ASD) has not been studied. We compared the pragmatic speech profiles of MV ($n=50$) and verbally fluent (VF) individuals with ASD ($n=50$; 6–21 years-old) based on natural language sampling during the Autism Diagnostic Observation Schedule-2. MV individuals with ASD primarily used their speech to agree/acknowledge/disagree, respond to a question, and request. In contrast, the primary pragmatic function used by VF individuals was commenting. Out of the total non-echolalic speech, groups did not differ proportionally in labeling and response to questions. Findings highlight the importance of investigating multiple aspects of pragmatic communication across different conversational partners and contexts.

Keywords Autism spectrum disorder · Minimally verbal · Pragmatic speech · Social development · Natural language sampling

Introduction

Within the field of autism spectrum disorder (ASD) research, most studies on pragmatic speech functioning have focused either on young toddlers and preschoolers or on older verbally fluent (VF) individuals (Capps et al. 1998; Koning and Magill-Evans 2001; Loveland et al. 1988; Paul et al. 2008; Shriberg et al. 2001; Tager-Flusberg and Kasari 2013). While fluency and flexibility in the use of spoken language clearly underlie the distinction between minimally verbal (MV) and verbally fluent individuals (VF) with ASD, impairments in pragmatic speech appear across the autism spectrum (Lam and Yeung 2012; Tager-Flusberg et al. 2005). However, no studies have investigated how MV children and adolescents with ASD use their limited speech to communicate with others. Here, we present the first study that investigates the pragmatic functions of spoken language used by MV individuals with ASD, when compared to age-peers with fluent language, based on natural language sampling. Other aspects of communication, such as how they use other vocal behaviors besides speech or other communication modalities (e.g., gestures) are not considered here. This study, informed by 'speech act' theory, intends to lend key insights into whether, for MV individuals with ASD, pragmatic functions are preserved in the context of reduced speech output or whether they present with a distinct pragmatic speech profile.

Pragmatic Impairments in ASD

Pragmatic language refers to a broad array of social-linguistic skills encompassing social and communicative aspects of conversational interaction, communicative intentions, nonverbal communication (e.g., gestures, body language, facial expressions), presupposition (recognizing the needs of the conversational partner), social discourse, and narrative skills (Lord and Paul 1997; Young et al. 2005). One primary context to investigate pragmatic speech is during conversational discourse. Engagement in conversational discourse requires the ability to monitor and adjust to the behaviors of the conversational partner, entailing moment-to-moment integration of contextual, emotional, and social cues, while implementing the rules of a socially contextualized language

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(Adams et al. 2002; Quill 2002). Such conversational interactions may include turn-taking, topic initiation, maintaining a topic, and elaborating upon a topic, requiring a range of discourse functions (Ninio and Snow 1996; Wetherby 2006).

Impairments in pragmatic speech are a distinctive linguistic feature of ASD regardless of language level or age (Baird and Norbury 2016; Lam and Yeung 2012; Kim et al. 2014; Wilkinson 1998; Young et al. 2005; Volden et al. 2009). Individuals with ASD range from those with no spoken language to those who score above average on standardized assessments of receptive and expressive language abilities (Tager-Flusberg 2004; Young et al. 2005), highlighting the importance of including the full autism spectrum in pragmatic speech research (Tager-Flusberg and Joseph 2003).

Inclusion of Minimally Verbal (MV) Individuals with ASD

Although more recent research has begun investigating receptive and word learning abilities in MV individuals with ASD (e.g., Plesa-Skwerer et al. 2016; Joseph et al. 2019), this heterogeneous subgroup remains under-researched in understanding and characterizing the communicative aspects of their spoken language despite the fact that approximately 30% of children with ASD remain MV into adulthood (Anderson et al. 2007; Howlin et al. 2014; DiStefano et al. 2016; Pickles et al. 2014; Tager-Flusberg and Kasari 2013). One primary challenge is defining what it means to be 'MV' (Tager-Flusberg and Kasari 2013; Bal et al. 2016). Based on comparing a variety of approaches, Bal et al. (2016) concluded that in general, assignment of individuals to Module 1 of the Autism Diagnostic Observation Schedule (ADOS) provides a valid and reliable approach to defining this group for most research purposes. The criteria for assigning Module 1 of the ADOS includes speech abilities ranging from no speech to simple phrases with phrase speech used inconsistently (Lord et al. 2012). Another challenge is conducting valid assessments of this subgroup given the variability in their behavioral difficulties and language deficits (Kasari et al. 2013). However, inclusion of this subgroup in pragmatic speech research is warranted, as difficulties in pragmatic speech can influence communication competency and social interactions, impacting peer relationships, social relatedness, friendships, and learning (Joseph et al. 2019; Philofsky et al. 2007; Tomasello 2001).

Evaluating Pragmatic Speech Abilities

Previous research studies have employed a variety of standardized measures and assessment tools to evaluate the pragmatic speech abilities of children (Bishop and Baird 2001; Philofsky et al. 2007; Lam and Yeung 2012) and adolescents with ASD (Koning and Magill-Evans 2001; Paul et al. 2008; Shriberg et al. 2001). Nonetheless, standardized assessments may not capture variation in abilities in individuals with ASD who are MV, who may also have difficulty performing under standardized testing situations. MV children with ASD often showcase floor effects on a variety of standardized assessments; however, they often show evidence of skills in other situations and contexts (Kasari et al. 2013).

Natural Language Sampling

Fewer studies have used semi-structured and naturalistic contexts, while applying natural language sampling (NLS) methodology, or recordings of spontaneous expressive language (Capps et al. 1998; Loveland et al. 1988; Tager-Flusberg and Anderson 1991). Tager-Flusberg and Anderson (1991) used NLS to investigate how children with ASD respond while engaged in a conversational interaction with their mothers during a naturalistic context. As language advanced, typically developing children and a comparison group of children with Down syndrome used more comments and more speech which was contextually and topically relevant as compared to children with ASD. NLS is considered to be a highly valid method in capturing actual conversational interactions and exchanges to assess pragmatic speech skills, which may be difficult to measure using other methods (Tager-Flusberg et al. 2009). Language sampling provides a more comprehensive view of an individual's pragmatic speech abilities and is particularly useful given the heterogeneity that is characteristic of ASD (Barokova and Tager-Flusberg 2018). Thus, when evaluating pragmatic speech abilities in individuals with ASD, the use of natural language sampling can lend key insights into understanding the communicative intent of the speaker.

Role of Context

The type of context may influence pragmatic speech. Kover et al. (2014) varied the conversational partner (parent or examiner) and context (play session or ADOS), and found that the highest frequency of utterances and different words were produced during the parent–child free play, followed by the examiner-child free play, followed by the ADOS. In their study, children with ASD used more requests, comments, and took more conversational turns during free play than during the ADOS. However, for the current study, the ADOS was selected as it was administered across all participants and it provides a useful context in which to collect natural language samples (e.g., Condouris et al. 2003; Tager-Flusberg et al. 2009). The ADOS, which consists of a variety

of open-ended activities (e.g., bubble play activity, birthday party for baby-doll), is designed to elicit social interaction and communication by providing opportunities to generate social initiations and responses allowing for the assessment of social speech in a semi-structured context (Lord et al. 2012).

Pragmatic Speech Profiles

Conversational Turn-Taking and Topic Maintenance

Engagement in reciprocal interactions and sustaining the conversational interaction are areas of pragmatic difficulty for children and adolescents with ASD (Chin and Bernard-Optiz 2000; Jones and Schwartz 2009; Paul et al. 2004; Paul et al. 2009). Research conducted primarily with verbal children with ASD has documented deficits in conversational turn-taking and maintaining an appropriate and relevant topic during a conversational exchange (Landa et al. 1992; Tager-Flusberg and Anderson 1991). When compared to typically developing children or children with other neurodevelopmental disorders, verbal children with ASD expanded less on the conversational topic, were more off-topic, and engaged in less conversational turn-taking (Capps et al. 1998; Lam and Yeung 2012; Losh and Capps 2003; Loveland et al. 1990). Reduced reciprocity may be attributed to difficulties in responsiveness to verbal and nonverbal cues influencing the comprehension of intentions behind those cues (Paul et al. 2009). However, other studies have found differing results. Specifically, out of the total speech utterances, children with ASD did not differ in turn-taking compared to age and language-matched children with Down syndrome, although, as in other studies, they were less likely to expand on topics of conversation (Tager-Flusberg and Anderson 1991). Additional studies have assessed conversational turn-taking and maintaining a conversational topic in VF adolescents with ASD (Koning and Magill-Evans 2001; Paul et al. 2009; Philofsky et al. 2007; Shriberg et al. 2001). When compared to typically developing adolescents, VF adolescents with ASD also engaged in less conversational turn-taking, had difficulty maintaining the conversational topic, and were more off-topic. Researchers propose that difficulties in perspective-taking, circumscribed interests, and presupposition, or the ability to predict what the listener already knows or wishes to know, may contribute to reduced conversational turn-taking and difficulties in topic management (Baron-Cohen 1997; Klin et al. 2007; Tager-Flusberg 1999; Wilson et al. 2004). However, no studies have characterized whether and how MV individuals with ASD participate in turn-taking during communicative exchanges with an interaction partner, or whether they are able to establish topics of communication and engage in topic management during such interactions. In short, it remains to be determined whether the pragmatic speech profiles of MV individuals with ASD are unique from those with more language abilities.

Echolalic vs. Non-echolalic Speech in ASD

One communication characteristic of ASD is echolalic speech (repetitive and stereotyped use of speech; Capps et al. 1998; Volden and Lord 1991). The use of echolalic speech may alter the interactional pattern of communicative exchanges, which are rendered more routinized than typical conversations, resulting in less flexible language and reduced spontaneous sharing of information and social actions in the absence of explicit cues (e.g., Nadig et al. 2010; Quill 2002). However, use of echolalic speech can also serve a variety of interactive purposes and communicative goals (Sterponi and Shankey 2014). Researchers suggest that MV individuals with ASD may use more echolalic speech that includes scripted words and phrases (e.g., "up, up, away") and repetitive speech compared to language delayed, typically developing children, and children with specific language impairment (Kasari et al. 2013; Loveland et al. 1988; van Santen et al. 2013; Volden and Lord 1991). Reduced use of non-echolalic speech in individuals with ASD has been related to various factors including impairments in joint attention and Theory of Mind (ToM; Baron-Cohen 1997; Mundy et al. 1990). However, no studies have systematically examined non-echolalic and echolalic speech (repetitions and scripted recitation) in MV individuals with ASD during a social-interactive context to further characterize their pragmatic speech profiles.

Pragmatic Functions in ASD

One avenue to further explore communicative intent and characterize pragmatic speech profiles is to assess the communicative functions of utterances during the conversational exchange (Kasari et al. 2014; Tager-Flusberg et al. 2009). Non-echolalic utterances directed to the conversational partner may serve the purpose, for example, to ask a question, elaborate on a topic (comment), respond to a question, or agree/disagree with the conversational partner. Overall, when compared to children with developmental delay and typically developing children, VF children with ASD demonstrated difficulties in responding to questions, responded more infrequently to communication bids, and provided fewer new contributions during a semi-structured conversation (Capps et al. 1998; Jones and Schwartz 2009; Marans et al. 2005; Rubin and Lennon 2004). When comparing individuals with ASD who differed in their speech abilities, previous studies found that VF children with ASD were more likely to offer new information and elaborate on

a topic compared to children who had more limited speech abilities (e.g., Stone and Caro-Martinez 1990). However, the specific pragmatic functions used by MV individuals with ASD and importantly, how they are using their spoken language to communicate and connect with others, remains unexplored. From an intervention framework, it is important to investigate which pragmatic functions this heterogeneous subgroup is using during a social interactive context to determine whether specific functions should be targeted to enhance their social development.

Current Study

The primary aim of the current study was to investigate how MV children and adolescents with ASD are using their spoken language as a tool of communication and in what ways this compares to VF individuals with ASD during the ADOS. This study seeks to answer the following question: for MV individuals with ASD, are pragmatic functions preserved in the context of reduced speech output (no absence of multiple pragmatic capacities) or is there a specific and distinct pragmatic profile? In particular are there differences between MV and VF individuals with ASD in their:

1. Speech production, intelligibility, turn-taking, topic maintenance, and non-echolalic speech?
2. The types of pragmatic functions of their non-echolalic speech?

Method

Participants

Participants included 100 individuals with a diagnosis of ASD (mean age = 12.50; range = 6.0–21.6; 22 females), who were previously recruited through schools, clinics, advertisements, autism-related events, and word-of-mouth. Study procedures were approved by the Boston University and Massachusetts Institute of Technology Institutional Review Boards. Participants were included if they had an ASD diagnosis confirmed by meeting Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord et al. 2012) cut-off scores and cut-off scores on the Autism Diagnostic Interview-Revised (ADI-R; Lord et al. 1994) or the Lifetime Form of the Social Communication Questionnaire (Rutter et al. 2003), as administered in prior studies. Participants were excluded if English was not the primary language spoken in the home or if they had a diagnosis of a known genetic disorder.

Participants were categorized into two groups based on their expressive language level. The groups comprised minimally verbal (MV) individuals with ASD and verbally fluent (VF) individuals with ASD, with 50 participants per group. Definitions of MV and VF were linked to modules of the ADOS, in accordance with Bal et al. (2016). MV was defined as speech abilities ranging from no speech to a few simple phrases used inconsistently. Minimally verbal participants younger than 12 years ($n = 17$) were assigned module 1 of the ADOS-2, appropriate for pre-verbal/single words level of communicative ability, whereas MV participants older than 12 years ($n = 33$) received module 1 of the Adapted ADOS. The Adapted ADOS (A-ADOS; Hus et al., 2011) was developed for older individuals who have not acquired fluent speech by school-age and the materials were designed to be developmentally appropriate. Verbally fluent (VF) language status was defined as the ability to produce a range of flexible sentence types and grammatical forms using language to provide information about events out of the immediate context and producing logical connections within a sentence. These participants received either a module 3 ($n = 32$) or a module 4 ($n = 18$; for older VF individuals) of the ADOS-2. Social affect (SA) and restricted and repetitive behavior (RRB; includes linguistic and non-linguistic behavior) algorithm scores and calibrated symptom severity (CSS) scores were calculated. T-tests were conducted to determine whether groups differed in ADOS overall, SA, and RRB CSS scores. Higher scores indicate more severe ASD symptoms.

Non-verbal Cognitive Ability

Since the participants were drawn from three different studies, different IQ measures were administered. VF participants completed either the Kaufman Brief Intelligence Test (n = 23; Kaufman 2004), the Wechsler Abbreviated Scale of Intelligence (n = 17; Wechsler and Hsiao-pin 2011), or the Raven Colored Progressive Matrices (n = 10; Raven et al. 1998). MV participants completed the Leiter International Performance Scale (n = 34; Leiter-3; Roid et al. 2013) or the Raven Coloured Progressive Matrices (n = 15; Raven et al. 1998). One MV participant did not obtain a score on the Leiter-3. Raw scores were converted into standard scores. A t-test was conducted to determine whether groups differed in nonverbal IQ (NVIQ) standard scores.

Receptive Vocabulary Ability

The Peabody Picture Vocabulary Test (PPVT-4; Dunn and Dunn 2007) was administered to assess receptive lexical knowledge. Participants were asked to point to the correct picture labeled by the examiner. Since the participants were drawn from three different studies, a subset of 44 MV and 26 VF participants completed this assessment. Raw scores were converted into standard scores. A t-test was

Table 1 Participant characteristics

Characteristic	MV	VF	*p* value
Chronological age *M*(*SD*)	12.41 (4.15)	12.60 (3.96)	.820[a]
Male [*n* (%)]	38 (76)	40 (80)	.630[b]
Ethnicity			.560[c]
Non-Hispanic [*n* (%)]	43 (91)	45 (92)	
Hispanic	3 (7)	4 (8)	
Prefer not to respond	1 (2)	0 (0)	
Race			.750[d]
Caucasian [*n* (%)]	34 (72)	40 (82)	
African American	1 (2)	1 (2)	
Asian	4 (9)	4 (9)	
Native Hawaiian or Other Pacific Islander	1 (2)	0 (0)	
More than one race	7 (15)	5 (10)	
Nonverbal IQ standard score *M* (*SD*)	62.24 (18.11)	104.66 (20.52)	.0001[e]
PPVT-4 standard score *M* (*SD*)	28.34 (2.50)	99.19 (5.47)	.0001[f]
ADOS Overall CSS *M* (*SD*)	7.48 (1.46)	6.72 (2.34)	.055[g]
ADOS SA CSS	7.14 (1.53)	6.46 (2.43)	.097[h]
ADOS RRB CSS	8.34 (1.53)	7.08 (2.48)	.003[i]

MV minimally verbal, *VF* verbally fluent; $n = 50$ participants per group

[a]$t(98) = .24$; [b]$X^2(1) = .23$; [c]$X^2(2) = 1.147$; [d]$X^2(4) = 1.920$; [e]$t(97) = 10.90$; [f]$t(68) = 13.36$; [g]$t(98) = 1.949$; [h]$t(98) = 1.678$; [i]$t(98) = 3.054$

conducted to determine whether groups differed in PPVT-4 standard scores. See Table 1 for a description of participant characteristics.

Data Collection

Transcription and Coding of Speech Samples

The ADOS sessions were recorded using video and audio equipment. Transcripts were prepared from videos using Systematic Analysis of Language Transcripts (SALT), a software program that standardizes the process for transcribing and analyzing speech samples (Miller and Chapman 1985). SALT automatically computes certain measures and allows for the insertion of codes that are then summed by the program. The first 30 min from the ADOS session were selected and coded for pragmatic speech to provide a consistent unit of duration. The duration of module 1 sometimes did not exceed 30 min in administration. This timeframe was also selected as natural speech samples of 30 min in length provide sufficient time and an opportunity to collect a range of utterances (Tager-Flusberg et al. 2009). In accordance with SALT, an utterance was defined as an independent clause with its modifiers (Miller and Chapman 1985). However, given consideration for the speech profiles of the MV population, an utterance could include any vocalization that is approximated or not approximated in its form (e.g., "more" or "all done now"). One transcriber transcribed the video and a second transcriber reviewed the same file to proof the transcription. If there were discrepancies, the transcribers convened, reviewed the transcription, and reached a consensus in accordance with conventions delineated in SALT.

Speech Coding Scheme

The coding scheme was built on one developed by Tager-Flusberg and Anderson (1991), which adopts a 'speech act theory' approach. This approach assumes the minimal unit of human communication is the performance of particular kinds of acts (e.g., statements, asking questions; Austin 1962; Searle et al. 1980; Tager-Flusberg and Anderson 1991). Consistent with this framework, we focused on the pragmatic functions that *individual utterances* play in the context of the communicative exchange, rather than on the dynamics of the conversational interaction between interlocutors, or the action-trajectories that reflect the interactive patterns of discourse. Our scheme was devised to provide a comprehensive and detailed analysis of the pragmatic speech profiles of MV and VF individuals with ASD by including a range of pragmatic functions to evaluate how they are using their spoken language to communicate, in the context of an interaction with an adult. We expected that the thirty minute natural speech sample from an assessment focused on eliciting social and communicative behaviors would provide a window into the pragmatic speech profiles of the two groups of participants

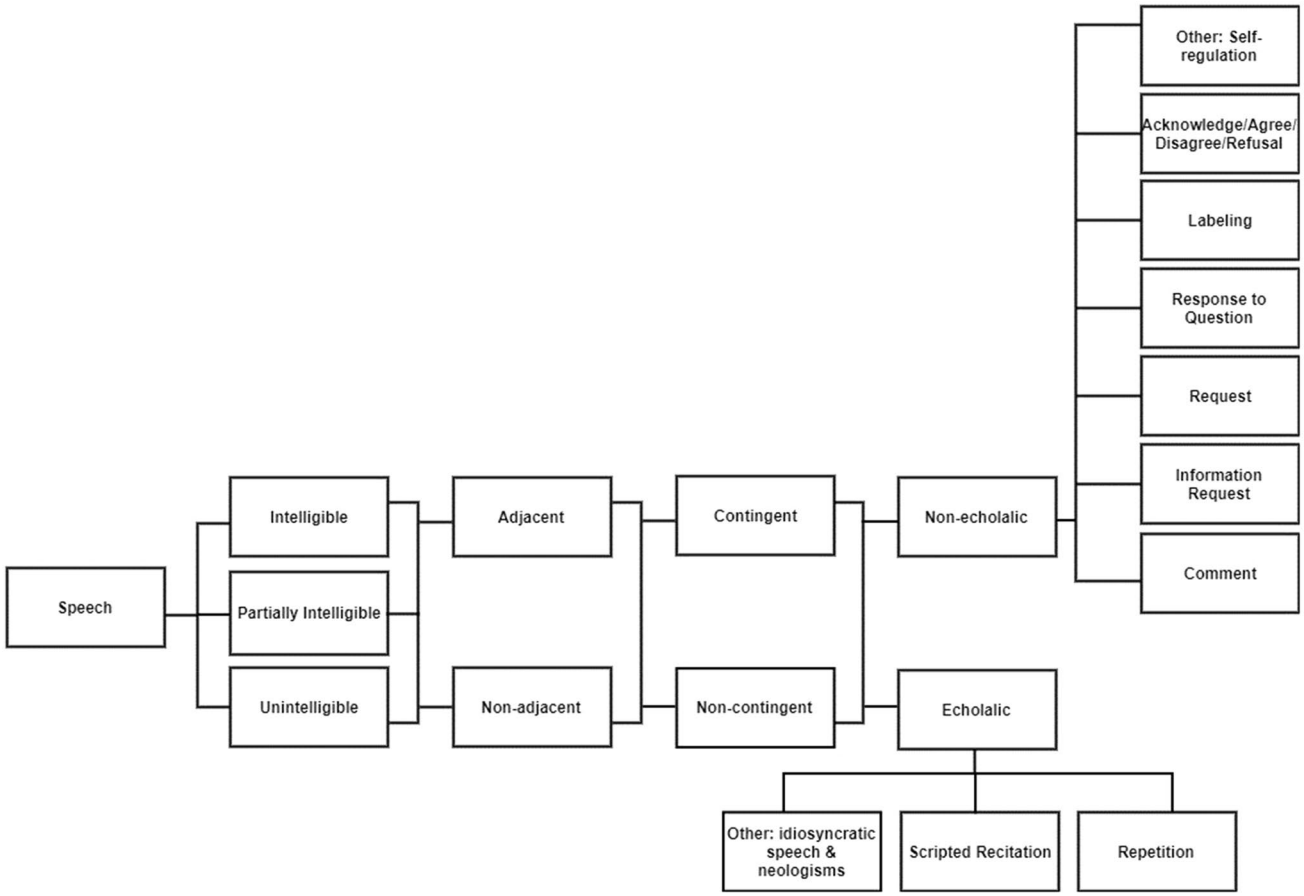

Fig. 1 A depiction of the pragmatic language coding scheme

with ASD. Because we wanted to restrict our analysis only to verbal means of communicating, after identifying which vocalizations constituted speech vs. non-speech, we further characterized speech utterances based on several discourse-related aspects (adjacency, contingency, spontaneity/productivity and pragmatic function) reflected in the levels of the coding scheme. Codes within each level were mutually exclusive (see Fig. 1 for a depiction of the coding scheme).

The first level assessed participants' vocalizations in terms of speech versus non-speech. If a non-speech code was assigned, the remaining levels were discontinued.

1. *Speech*: any verbal, phonemic utterance.
   Non-speech: any vocalization that is a non-phonemic sound (e.g., gasp, cough, moan). Given that we expected MV individuals to display non-speech vocalizations, we sought to capture all attempts at communication in terms of quantity of attempts, but focused on speech vocalization for evaluating qualitative aspects of the communicative attempts.

At the second level, the intelligibility of the utterance was assessed for speech vocalizations only. If an utterance was unintelligible, coding would stop after level three.

2. *Intelligible*: a fully discernable utterance, such that the words were fully understood.
   Partially intelligible: an utterance that was only partially discernable.
   Unintelligible: an utterance that was not understood.

The third level evaluated conversational turn-taking between the participant and examiner by assessing the order of the utterance in context, in accordance with SALT conventions. All speech, including unintelligible speech, was coded here.

3. *Adjacent*: the participant's utterance follows directly after the examiner's utterance.
   Examiner: What do you see?
   Participant: A ship.

Non-adjacent: the participant's utterance does not follow the examiner's utterance, but rather follows the participant's own utterance.

Participant: Want snack.

Participant: More.

The fourth level assessed whether the utterance was topically relevant and contextually appropriate, denoted by the notion of contingency. Only intelligible and partially intelligible speech was coded here.

4. *Contingent*: the participant's utterance is contextually appropriate, such that it is relevant to the topic of the prior utterance.

   Examiner: Ready, set…

   Participant: Go!

   Non-contingent: the participant's utterance is not related to the prior utterance and is not related to part of the play materials or examiner's cues.

   Examiner: Ready, set…

   Participant: Apple.

The fifth level assessed the productive or repetitive/stereotyped quality of speech and different forms of echolalic speech.

5. *Non-echolalic speech*: real-time naturally generated, unprepared speech generated by the participant.

   Echolalic speech: a produced literal repetition of speech heard prior or fragments of scripts from other sources.

   Repetition: a partial or full repetition of the examiner's utterance or repetition of a word(s) or phrase(s) when no longer appropriate. This includes repetition of a prior, non-echolalic participant utterance.

   Examiner: So what's this guy doing?

   Participant: Guy doing.

   Scripted Recitation: repeating fragments from movies, commercials, books, prior routines, or recitation of song lyrics.

   Examiner: Which one do you want?

   Participant: {sings "Clean Up" song}.

   Other: creation of a novel word that is outside spoken language (neologism) or a phrase or utterance that only makes sense to the individual, such that the meaning cannot be determined by the examiner (idiosyncratic speech). Use of these two forms of echolalic speech was very infrequent, resulting in the formation of an "other" category.

At the final level, non-echolalic/productive speech was coded for function.

Pragmatic Functions of Non-echolalic Speech

6. *Acknowledgment, agreement, disagreement, or refusal*:

   Acknowledgment: a word (e.g., oh) that acknowledges the examiner's utterance but does not provide additional detail.

   Agreement: "yes" or "uhuh" (or equivalent) as affirmation of the examiner's utterance.

   *Disagreement***:** "no" (or equivalent) in response to the examiner's suggestion.

   Refusal: a word (e.g., stop) indicating refusal or objection to speech, objects, or actions following the examiner's statement.

Labeling: naming observable objects (e.g., baby) without added detail or elaboration.

Response to a Question: the participant answers a question that is asked by the examiner, but does not provide additional details.

Examiner: How are you doing?

Participant: Good.

Request: the participant communicates a desire or need (request for an object, action, and/or change in environment; e.g., "more snack"). Other statements such as "look here" and "wait" was also coded as requests.

Information Requests: a request for more information from the examiner (e.g., "what's next"?).

Comment: a statement that expands on a label or adds more information to the topic and content of the prior examiner or participant utterance.

Examiner: That is silly.

Participant: It fell on ground.

Other: the participant attempts to self-adjust (e.g., "calm hands") to the demands of his/her surroundings (self-regulation).

Reliability

All transcripts were coded by a primary coder and then a subset of the transcripts ($n = 20$) were coded by another coder to assess reliability. Cohen's kappa was computed to determine inter-rater agreement. Agreement was 100% for the first three levels (speech, intelligibility, and adjacency). There was substantial agreement for contingency, $\kappa = 0.837$ (95% CI, 0.812 to 0.862), $p < 0.0005$, non-echolalic/echolalic speech, $\kappa = 0.816$ (95% CI, 0.789 to 0.843), $p < 0.0005$,

Table 2 Average frequency per 30 min

	MV M (SE)	VF M (SE)	*U*	*p*	*r*
Non-speech	49.52 (5.66)	8.60 (1.42)	248.5*	< .0001	.69
Speech	75.42 (9.17)	269.04 (12.30)	2,429.5*	< .0001	.81
Intelligible	26.14 (6.09)	255.26 (11.85)	2,477.0*	< .0001	.85
Partially intelligible	14.84 (3.53)	10.24 (1.61)	1,365.0	.426	.08
Unintelligible	34.44 (5.30)	3.52 (.65)	428.5*	< .0001	.57
Adjacent	51.64 (5.78)	151.94 (5.92)	2,380.0*	< .0001	.78
Non-adjacent	12.92 (2.68)	107.16 (9.45)	2,439.5*	< .0001	.82
Contingent	25.82 (4.19)	249.42 (11.05)	2,496.0*	< .0001	.86
Non-contingent	14.72 (4.48)	4.84 (1.04)	1,306.0	.694	.04
Non-echolalic	16.80 (2.93)	248.20 (11.10)	2,500.0*	< .0001	.86
Echolalic	24.08 (4.83)	7.90 (1.33)	996.5	.080	.18
Other (self-regulation)	.10 (.08)	0	1,200.0	.155	.14
Acknowledge/agree/disagree/refusal	7.18 (1.88)	32.18 (2.49)	2,291.5*	< .0001	.72
Labeling	1.72 (.41)	8.70 (.96)	2,205.5*	< .0001	.67
Response to question	4.10 (.93)	39.70 (2.61)	2,469.0*	< .0001	.84
Request	2.40 (.51)	5.82 (.94)	1,944.0*	< .0001	.48
Information request	.30 (.12)	13.92 (2.39)	2,356.5*	< .0001	.80
Comment	.84 (.24)	147.54 (9.78)	2,500.0*	< .0001	.88
Other (idiosyncratic speech and neologisms)	.08 (.04)	.50 (.20)	1,435.0*	.040	.21
Scripted recitation	8.66 (2.92)	.84 (.32)	763.5*	< .0001	.37
Repetition	15.44 (4.15)	6.88 (1.17)	1,198.0	.719	.04

MV Minimally verbal, *VF* verbally fluent; 50 participants per group; *M* mean, *SE* standard error

$p < .05$* for a 2-sided Mann–Whitney U test

and for pragmatic functions, $\kappa = 0.812$ (95% CI, 0.796 to 0.828), $p < 0.0005$.

Statistical Methods and Analysis

Analyses were conducted on frequency for the following variables: speech/non-speech, level of intelligibility (intelligible, partially intelligible, unintelligible), adjacency/non-adjacency (turn-taking), contingency/non-contingency (topic relevancy), non-echolalic/echolalic speech (repetitions, scripted recitation, and other), and each pragmatic function (acknowledge/agree/disagree/refusal, labeling, response to question, request, information requests, comments, and other). To compare the profiles of functions used relative to the amount of speech, proportions were calculated by (1) dividing each frequency of intelligible, adjacent, contingent, and non-echolalic utterances by the total frequency of speech utterances, (2) dividing each frequency of scripted recitation and repetition by the total echolalic speech, and (3) dividing the frequency of each pragmatic function used by the total non-echolalic speech. Since all the variables were not normally distributed, the Mann–Whitney U test was conducted to compare the two groups.

Preliminary Spearman's rho correlational analyses were conducted between the relevant pragmatic variables and chronological age, NVIQ, and PPVT-4 standard scores, separately for each language group. The relevant pragmatic speech categories were not associated with NVIQ, receptive vocabulary ability, and chronological age. Thus, analyses were conducted combining all the children and adolescents within each group. For ease of interpretation, Table 2 presents the average rate (frequency per 30 min) by group and the Mann–Whitney U test results for each coding category.[1]

Results

MV individuals with ASD had significantly lower nonverbal IQ scores and receptive vocabulary scores, but did not differ in ADOS social affect calibrated severity scores. No differences were found between groups in ADOS restricted and repetitive behavior calibrated severity scores and overall

[1] All analyses described were also conducted parametrically controlling for age, IQ, receptive vocabulary ability, and similar results were found.

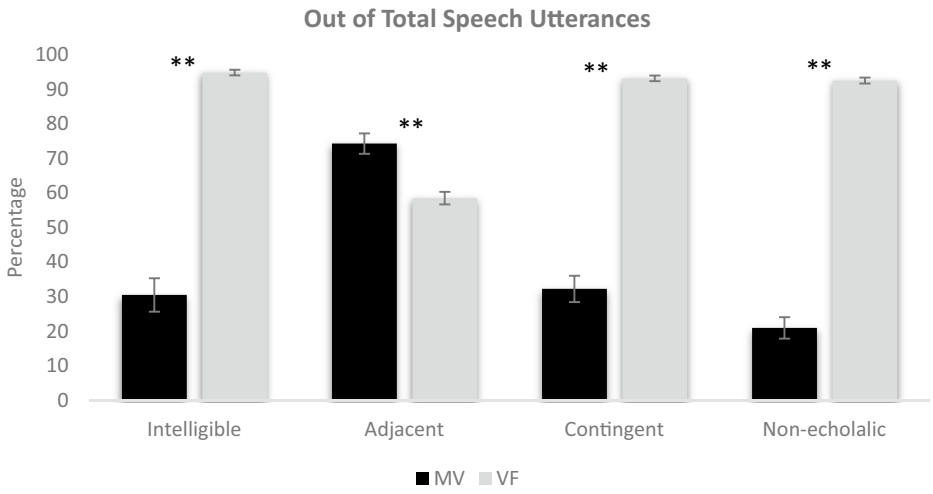

Fig. 2 Percentage of intelligible, adjacent, contingent, and non-echolalic utterances out of the total speech utterances by group. *MV* minimally verbal, *VF* verbally fluent; *$p < .05$, **$p < .01$

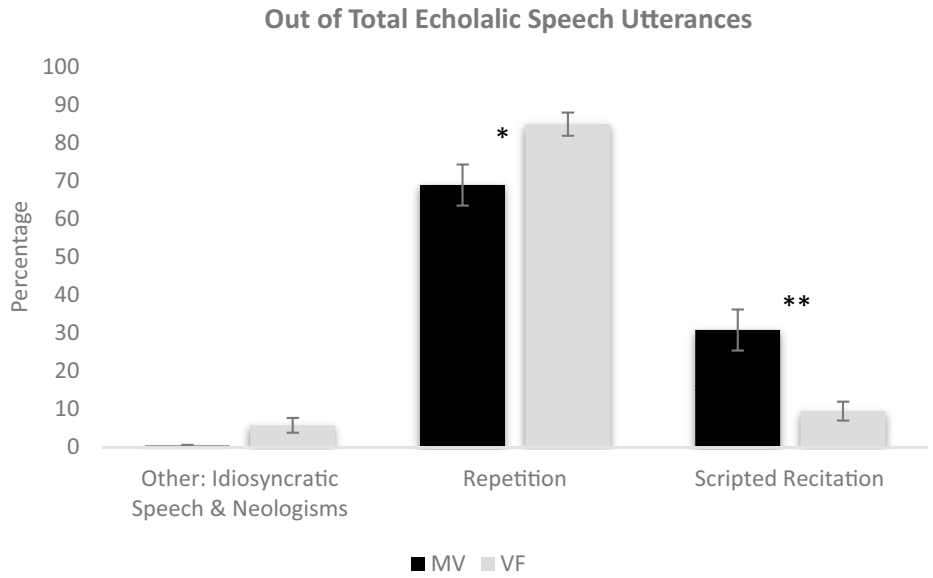

Fig. 3 Percentage of other, repetitions, and scripted recitation out of the total echolalic speech utterances by group. *MV* minimally verbal, *VF* verbally fluent; *$p < .05$, **$p < .01$

calibrated severity scores. Groups were matched on chronological age.

Are there differences in speech production, intelligibility, turn-taking (adjacency), topic relevancy (contingency), and non-echolalic speech?

Out of the 50 MV participants, 3 used no speech utterances. Out of the total speech utterances, the MV group ($n = 47$; Mean ranks = 24.85, 25.02, 24.06, respectively) had proportionally less intelligible ($U = 2310.0$, $p = < 0.0001$, $r = 0.83$), contingent ($U = 2{,}302.0$, $p = < 0.0001$, $r = 0.83$), and non-echolalic utterances ($U = 2347.0$, $p = < 0.0001$, $r = 0.86$) compared to the VF group ($n = 50$; Mean ranks = 71.70, 71.54, 72.44, respectively). Interestingly, the MV group (Mean rank = 63.21) had proportionally more adjacent utterances ($U = 507.0$, $p = < 0.0001$, $r = 0.49$) compared to the VF group (Mean rank = 35.64; see Fig. 2).

Out of 50 MV participants, 38 used echolalic speech. Out of 50 VF participants, 45 used echolalic speech. The MV group (Mean rank = 52.61) had proportionally more scripted recitation compared to the VF group ($U = 452.0$, $p = < 0.0001$, $r = 0.43$; Mean rank = 33.04), while the VF individuals (Mean rank = 47.71) had proportionally more repetitions compared to the MV group ($U = 1{,}112.0$, $p = 0.016$, $r = 0.26$; Mean rank = 35.24). Groups did not differ proportionally in the "other" category (idiosyncratic speech/neologisms; $U = 993.0$, $p = 0.060$, $r = 0.21$; see Fig. 3) which was used very sparsely.

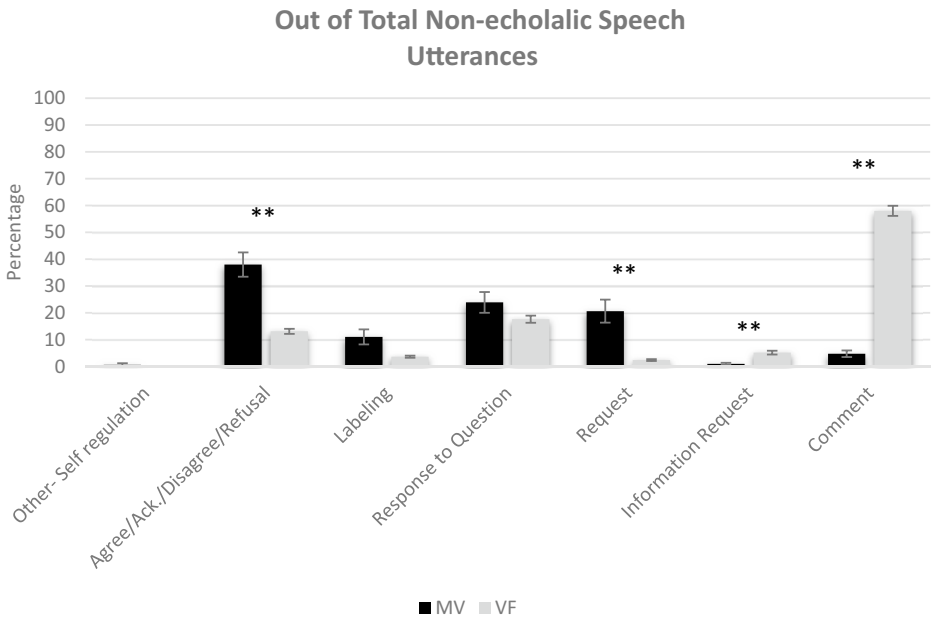

Fig. 4 Percentage of each pragmatic function out of the total non-echolalic speech utterances by group. *MV* minimally verbal and *VF* verbally fluent, *ack.* acknowledgement; *$p < .05$, **$p < .01$

Are there differences in the types of pragmatic functions of their non-echolalic speech?

Out of 7 different non-echolalic pragmatic functions, the MV ($n = 38$ had non-echolalic speech) and VF ($n = 50$) groups differed in the number of different non-echolalic pragmatic functions used ($U = 1695.0$, $p = < 0.0001$, $r = 0.75$), with fewer different (less variety) pragmatic functions found in the MV group ($M = 3.58$; $SE = 0.27$; Mean rank = 24.89) compared to the VF group ($M = 5.90$; $SE = 0.04$; Mean rank = 59.40). The most frequent pragmatic function used in the MV group was agreement/acknowledgement/disagreement/refusal, followed by responding to a question, followed by requests. In contrast, commenting was the most frequent pragmatic function found in the VF group.

Twelve MV participants did not use non-echolalic speech. Out of the total non-echolalic speech, the MV ($n = 38$) and VF ($n = 50$) groups did not differ proportionally in labeling, response to questions, or the "other" category (self-regulatory utterances; p's = 0.735, 0.774, 0.103, respectively). However, MV individuals (Mean ranks = 19.50, 26.45, 61.08, 52.63, respectively) had proportionally fewer comments ($U = 1{,}900.0$, $p = < 0.0001$, $r = 0.86$) and information requests ($U = 1{,}636.0$, $p = < 0.0001$, $r = 0.63$) but proportionally more responses indicating acknowledgement/agreement/disagreement/refusal ($U = 320.0$, $p = < 0.0001$, $r = 0.57$) and requests ($U = 641.0$, $p = 0.009$, $r = 0.28$) compared to VF individuals (Mean ranks = 63.50, 58.22, 31.90, 38.32, respectively; see Fig. 4). Overall, MV individuals with ASD used several different functions, despite reduced speech output. However, given the limited number of utterances overall in the MV group, use of different functions ranged from less to 1 to 7 per 30 minutes during the ADOS. In contrast, for the VF group, different functions used ranged from 5 to 147 (see Table 2).

Discussion

This is the first study to characterize the pragmatic speech profiles of a large sample of MV and VF individuals with ASD using natural language sampling. Use of this methodology allowed us to take a more nuanced approach to assess a *range* of pragmatic functions to provide key insights into how MV individuals with ASD are using their limited speech abilities as a tool of communication during a social-interactive context. Despite differences in the use of pragmatic functions, groups did not differ in ADOS social affect scores, which taps conversational skills, reciprocal social communication, and social overtures. This finding reinforces previous research suggesting that pragmatic communication impairments are a distinguishing linguistic feature of ASD regardless of language level (MV vs VF; Baird and Norbury 2016; Lam and Yeung 2012; Kim et al. 2014; Wilkinson 1998; Young et al. 2005; Volden et al. 2009). Differences in NVIQ and receptive vocabulary scores between groups, suggests that MV individuals with ASD may have difficulty understanding what

is formulated by the conversational partner and in forming concepts, categories, and recognizing patterns. Thus, factors outside of language itself, may contribute in important ways to these group differences.

Importantly, this study sought to answer whether, for MV individuals with ASD, pragmatic functions would be preserved in the context of reduced speech output or whether this subgroup would have a specific and distinct pragmatic profile? Overall, findings revealed a distinct profile when considering turn-taking, topic relevancy, non-echolalic speech, the different forms of echolalic speech, and in particular, the use of comments. For MV individuals with ASD, their linguistic pragmatic phenotype was not marked by a complete absence in the use of different pragmatic functions but only three types of functions (agree/disagree/ack./refusal, response to questions, request) were used on average more than twice per 30 minutes. In contrast, for the VF group, commenting was used more often than other pragmatic functions.

When characterizing the pragmatic speech profiles of MV individuals with ASD, relative to their total speech utterances, only 30% of their speech utterances were intelligible compared to 95% in the VF group. However, counter to previous research, 74% of the speech utterances of MV individuals with ASD were adjacent compared to only 58% in the comparison group. This finding deviates from Tager-Flusberg and Anderson's (1991) study which found no proportional differences in turn-taking when comparing children with ASD to children with Down syndrome. However, in contrast to the current study, Tager-Flusberg and Anderson's (1991) study did not directly compare individuals with ASD who had differing speech abilities and participants were younger in terms of chronological age. Pertaining to the adjacency findings, for the MV group, the examiner may have had more opportunities to pose a question, wait for a response, and then pose another question or provide a comment, etc., resulting in more adjacent utterances. This is especially relevant when considering the types of pragmatic functions MV individuals with ASD used, which often led to a one-word to few words response (e.g., agree/ack./disagree). As such, MV individuals may have been more dependent on examiner talk to produce their own talk, while VF individuals may have been able to initiate talk without examiner scaffolding, and produce turns comprised of more than a single clause. This reinforces the idea that adjacent utterances do not ensure discourse contingency. However, other studies have found reduced conversational turn-taking in VF individuals with ASD, which may, in part, be attributed to the use of overly tangential and detailed speech found in this subgroup (Koning and Magill-Evans 2001; Paul et al. 2008; Philofsky et al. 2007; Shriberg et al. 2001). Further, given that 58% of the total non-echolalic speech of the VF group was comprised of comments (only 5% in the MV group), this particular discourse function may result in more non-adjacent utterances given the breadth of detail supplied by a comment. Per SALT conventions, each communication unit (a clause with its modifiers) is transcribed on its own line. Thus, a speaker who provides an elaboration will likely have multiple communication units following each other, resulting in subsequent non-adjacent utterances.

Only 21% of the total speech utterances of MV individuals with ASD were non-echolalic utterances compared to 92% in the VF group. Given the large amount of echolalic speech produced by the MV group, we analyzed the different forms echolalic speech took to further characterize their pragmatic speech profiles. Out of the total echolalic speech utterances about 31% were scripted recitation in the MV group (only 9% in VF group). Researchers suggest that MV individuals with ASD may use more echolalic speech that includes scripted words and phrases, as a sensory outlet (to calm oneself to cope with overwhelming sensory challenges), as "self-talk", and to serve interactive purposes (Kasari et al. 2013; Sterponi and Shankey 2014; Volden and Lord 1991). However, when considering repetitions, 85% of the total echolalic speech were repetitions for the VF group compared to 31% in the MV group. This form of echolalic speech may be used as a way to communicate ideas when difficulties occur in formulating novel speech patterns. Overall, MV individuals with ASD appear to present with a distinct profile when considering the different types of echolalic speech (use of more scripted recitation).

Are there differences in the types of pragmatic functions of their non-echolalic speech?

Overall, findings revealed that MV individuals with ASD are using *multiple* functions to accomplish communicative goals, although the frequency of these functions relative to their total speech output ranged from less than 1 to 7 per 30 minutes of the ADOS. Their primary pragmatic function used included indicating agreement/acknowledgement/disagreement/refusal (38% out of their total non-echolalic speech utterances), followed by responding to a question (23%), requesting (20%), and labeling or naming an item/thing (11%; VF group: 13%, 18%, 2%, and 4%, respectively). Use of these functions often entailed a one-word to few words response. MV individuals with ASD were not restricted to one communicative function, such as requesting, but rather, found several ways to connect and maintain engagement with the conversational partner. For VF individuals with ASD their primary pragmatic function was commenting, followed by responding to a question, and indicating agreement/acknowledgement/disagreement/refusal. Thus, unsurprisingly, the key function distinguishing these

language groups was in the use of comments, with MV individuals with ASD having a low proportion of comments given their speech production. Out of the total non-echolalic speech, 58% were comments in the VF group compared to only 4% in the MV group. The paucity of commenting in the MV group may be due to impairments in initiating joint attention (Kasari et al. 1990; Mundy and Willoughby 1998), along with differences in language comprehension (McDuffie et al. 2005) and speech production abilities (Sigman et al. 1999). Further, certain activities within modules 3 and 4 of the ADOS may elicit more elaborations (e.g., discussing emotions, friendships) as compared to module 1. Thus, although their rates of pragmatic functions were low overall, MV individuals with ASD appear to be using different types of pragmatic functions to indicate communicative intent during a social-interactive context.

Study Implications

Approximately 30% of children with ASD remain MV into adolescence and beyond (Bal et al. 2016; Tager-Flusberg and Kasari 2013). In spite of deficits in structural speech abilities (e.g., intelligibility), MV children and adolescents are using their speech to communicate with others, thereby showcasing attempts to connect and maintain engagement during a social exchange. Given that pragmatic speech abilities are a critical and essential component of everyday communicative interactions (Young et al. 2005), interventions including MV individuals with ASD should focus on targeting an even broader range of pragmatic functions (e.g., comments) to enhance subsequent speech and social development in this population. Thus, by having an understanding of the ways in which MV individuals with ASD communicate with others (multiple pragmatic capacities), this information can be utilized to enhance current treatments and social/communication-based interventions.

Specialized interventions are beginning to be developed to enhance spontaneous communication in MV children with ASD. For example, Kasari and her colleagues (Kasari et al. 2014) aimed to increase spontaneous utterances in MV children with ASD using two interventions, Joint Attention Symbolic Play Engagement and Regulation (JASPER), which focused on the development of prelinguistic gestures and play skills and Enhanced Milieu Teaching (EMT), which uses responsive interaction and modeling to promote spontaneous speech. Participants who began the intervention with a speech generating device integrated into JASPER + EMT produced significantly more spontaneous communicative utterances, which included commenting, compared to those who began the blended intervention with spoken language only. Overall, these findings suggest that MV children with ASD can make gains in spoken language, thereby expanding their use of discourse functions. These specialized interventions, along with our study findings, emphasize the importance of targeting a range of pragmatic functions, rather than solely focusing on one function such as requesting (Kaiser et al. 2000; Tager-Flusberg et al. 2009).

Limitations

We examined pragmatic speech during one semi-structured assessment (ADOS) with an unfamiliar figure and specifically assessed verbal (e.g., speech) components of pragmatic communication but did not examine nonverbal aspects of pragmatic communication (e.g., use of gestures). Differences between MV and VF groups may be less apparent when modalities other than speech are considered. When considering turn-taking abilities in verbal exchanges, we only assessed adjacency and non-adjacency to the prior utterance. Thus, reciprocity between the examiner and participant may have not been captured, rather this variable may have reflected the order of the utterance. In terms of contingency, determining contextually relevant utterances poses challenges and may not account for the varied ways in which the interactional context is structured, which can differentially influence communicative performance (Sterponi et al. 2015).

The current study used a 'speech act' theoretical approach to conversational interaction in which speech functions are assigned to utterances, which poses a limitation in considering the interactive process between interlocutors. Only participant utterances were included without consideration of the discourse context or characteristics of the examiner's utterances. Participants were also given different NVIQ measures and the functions of echolalic speech were not assessed. Lastly, factors beyond the individual's speech may also contribute in important ways to one's pragmatic communication profile including joint attention, social cognition, receptive language, IQ, social engagement, motivational factors, and participation in previous interventions targeting social and communication skills (Hale and Tager-Flusberg 2005).

Future Directions

Subsequent studies should employ different conversational partners (e.g., familiar and unfamiliar figures), designs and situational contexts (e.g., school, home, clinic) which vary in their structure, especially when considering Kover et al.'s (2014) findings, while examining both verbal and nonverbal aspects of pragmatic communication. Although

the ADOS is designed to be rather open-ended, its format is still structured in nature and therefore, may elicit certain responses. Thus, the use of different contexts to evaluate discourse functions in MV and VF individuals with ASD is warranted and an important direction for future research in this population. The use of different functions of echolalic speech should be explored to provide a more comprehensive understanding of the pragmatic speech profiles of MV individuals with ASD. Importantly, future work should also explore how MV individuals with ASD use other forms of communication (e.g., gesture) to accomplish communicative goals and consider "time" into the assessment of turn-taking rather than solely evaluating the order of the utterance based on communication units. Use of an 'action trajectory' approach, where social actions are mutually produced by conversational partners and implemented over the course of the interaction (Schegloff 2007) should also be explored. Such an approach can lend key insights into the contribution of the interlocutor (specific utterance characteristics) on the communicative performance of this heterogeneous subgroup (Sterponi et al. 2015). Thus, future intervention work should not only consider enhancing children's pragmatic speech capacities, but also their interaction partners'. Additionally, understanding each child's receptive and cognitive abilities can further assist in guiding the content and targets of the intervention (Plesa-Skwerer et al. 2016).

Lastly, efforts should be implemented to include pragmatic speech interventions which target MV adolescents and adults. According to a recent systematic review and meta-analysis assessing pragmatic language interventions for individuals with ASD, of the 21 studies considered, 11 studies included preschool-aged children, 10 studies included primary and elementary school-aged children, but no studies targeted adolescents or adults, highlighting a significant gap in the literature (Parsons et al. 2017). Continuing to investigate developmental differences in the use of pragmatic functions is also warranted to determine how these functions manifest across different ages and life stages. Future studies should also utilize longitudinal designs to assess the developmental trajectory of the pragmatic communication abilities of individuals with ASD (Tager-Flusberg 2004), who vary in their speech abilities across the continuum from MV to VF. This can, in turn, assist in providing a comprehensive understanding of the pragmatic language and communication profiles of individuals with ASD. Let us strive to foster the pragmatic capacities of MV individuals with ASD, to build and expand upon their strengths, and promote the growth of their fullest potential.

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Authors' Contributions CL participated in the study design, coding, statistical analyses, data interpretation, and drafted the manuscript; DPS participated in the study design and coordination, reliability coding, and revised the manuscript critically for important intellectual content; HTF devised the study, participated in its design and interpretation of the data, and revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed involving human participants in this study were in accordance with the ethical standards of the Institutional Research Boards at Boston University and Massachusetts Institute of Technology and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all participants involved in the study.

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