5-14-2022

Dynamic measures of referential communication reveal hidden pragmatic strengths for adolescents with autism spectrum disorder

Mariana Schreuders
James Madison University

Dynamic Measures of Referential Communication Reveal Hidden Pragmatic Strengths for Adolescents with Autism Spectrum Disorder

---

An Honors College Project Presented to

the Faculty of the Undergraduate

College of Health and Behavioral Studies

James Madison University

---

by Mariana Schreuders

April 2022

Accepted by the faculty of the Department of Communication Sciences and Disorders, James Madison University, in partial fulfillment of the requirements for the Honors College.

FACULTY COMMITTEE:

____
Project Advisor: Emily Zane, Ph.D.
Assistant Professor, Department of
Communication Sciences and Disorders

____
Reader: Geralyn Timler, Ph.D., CCC-SLP
Professor, Department of Communication
Sciences and Disorders

____
Reader: Jamie Lee, Ph.D., CCC-SLP
Assistant Professor, Department of
Communication Sciences and Disorders

HONORS COLLEGE APPROVAL:

____
Bradley R. Newcomer, Ph.D.,
Dean, Honors College

PUBLIC PRESENTATION

This work is accepted for presentation, in part or in full, at the Honors Symposium on April 22, 2022.

Dedication Page

To my parents, my sister Alida, and my fiancé Skyler, these past two years would not have been possible without all your steadfast love, encouragement, and support. I am extremely grateful for all that you have done for me, and I would not be where I am today without you.

To my housemates and best friends, thank you for believing in me and pushing me to my fullest potential. You all played such a huge role in the completion of this journey, and I am grateful for each of you.

To Olivia, my fellow thesis pioneer, I could not have gotten to where I am without you! From our long hours of library thesis sessions, to keeping me accountable throughout deadlines, I am very grateful for the friendship that has emerged from this process!

Table of Contents

List of Tables

List of Figures

Acknowledgments

My sincerest gratitude goes to my thesis advisor, Dr. Emily Zane, for guiding me through this process. Her expertise is meritorious, and her passion for research is contagious. I am extremely grateful for the time and energy she has put in throughout this process in helping me complete this project. Her support and dedication were truly instrumental throughout. Dr. Zane, thank you for seeing potential in me before I saw it in myself. Learning from you continues to be an incredible honor. I would also like to thank my readers, Dr. Geralyn Timler and Dr. Jamie Lee, for the time and attention to detail that you invested into this project.

Abstract

The ability to communicate effectively and efficiently while maintaining mutual understanding is a fundamental aspect of human-to-human interaction. Studies have shown that individuals with autism spectrum disorder (ASD) face challenges in areas of social communication skills, such as aspects of referential communication; or the ability to refer to things in such a way that a listener will know what the speaker is describing. The current study used data from a preexisting Barrier study to compare the referential communication abilities of school-aged children with ASD to those of neurotypical children (NT). Referential communication was observed during a barrier task, where participants sat across an opaque barrier from a communication partner and used language to refer to objects the partner could not see. Effectiveness and efficiency were coded and characterized quantitatively in the results and qualitatively in the discussion. Effectiveness was observed through the participants' use of strategy-switching, and by the use of uninformative utterances. Measures of efficiency included a subset of strategy switching timing data, as well as the production of redundancies. Results demonstrated that groups did not significantly differ in measures of strategy switching or timing; however, group differences did occur in the use of uninformative and redundant language. By using broad measures that capture communication quality across the entire task, the current honors capstone project builds upon previous research by accounting for the dynamic nature of human-to-human interaction, which relies not only on the behaviors of the speaker but on their interlocutor, and how those behaviors evolve across the interaction.

Introduction

In conversation, it is necessary to establish mutual understanding between speaker and listener at the very beginning of the exchange, and then to sustain that understanding throughout the duration of the discourse. While both the speaker and listener work together to ensure conversational success, a large portion of the responsibility falls on the speaker. To ensure understanding, a speaker must recognize what is known and unknown to the listener, and then refer to this knowledge to produce an effective and efficient message. Referential communication involves a speaker referencing information, ideas, objects, people, etc., and a listener recognizing what the speaker is referring to (Volden, Mulcahy & Holdgrafer, 1997).

Successful referential communication can be described in terms of its effectiveness and its efficiency. *Effectiveness* is the primary metric of success. Effective referential communication entails that the speaker has conveyed reference in a clear, unambiguous way, so that the listener can successfully identify the reference targeted by the speaker. *Efficiency* is a secondary way of describing successful referential communication, as it entails the speaker conveying reference as quickly as possible, including only the relevant information. Thus, a speaker's primary objective is to be effective. For example, imagine you want to offer your friend a book to borrow. You tell your friend, "The book is on the desk in my office." When she walks into your office, there is only one book on the desk. In this case, your communication signal (e.g., "the book on my desk") is both effective and efficient. If you had added adjectives (e.g., "the big, green, paperback book on my desk"), this message would have also been effective but inefficient. If you had left out the information about the desk (e.g., "the book is in my office"), your message would likely be less effective (your friend would have to look around your office to find the book), even though the signal itself was more efficient (shorter). From this example, it is clear that effectiveness and efficiency depend on communication context. For instance, if there were many books on your desk, saying “it’s on the desk in my office” is no longer effective, and adding adjectives (e.g., “green”, “paper-back”) is not only efficient but necessary.

In fact, speakers are usually very good at creating an initial communication signal that is both effective and efficient (and, thereby, meeting their listener’s needs), and there are various theories to explain how they do this. Arguably, the most well-known of these is Grice’s theory of communication (Grice, H.P., 1989). Grice describes four maxims (quantity, quality, relation, and manner) of conversation that speaker’s follow, which allow them to effectively and efficiently communicate reference to their listener. Importantly, Grice’s maxims account for the role of communicative context, including the roles and background knowledge of the speaker and listener. For example, the most *relevant* (meeting the maxim of relation) information depends on who is speaking and who is listening and what background knowledge is understood to be shared between them.

A key aspect of referential communication is that it is *dynamic*: Communication signals evolve across discourse, based on the success or failure of previous reference. When reference is initially successful (i.e., effective), speakers can adapt their subsequent messages to be more efficient. For example, imagine two friends taking a lunch break during a day of shopping. One friend says to the other, “I tried on *a green shirt at the Gap* and now I wish I had gotten it.” Now that she has established reference, the speaker can subsequently refer to it by using shorter expressions (“the green shirt” or “that shirt”), rather than repeating “the green shirt from the Gap” each time. This is called “referential shortening:” Referential expressions get shorter once reference is established (Holler & Wilkin, 2009; Horton & Keysar, 1996; Krauss & Weinheimer, 1966; Rossnagel, 2000).

There are other accounts of referring expressions, which similarly describe how success in previous referencing can allow for the use of shorter or "lighter" referential terms in subsequent speech. Referential phrases that refer to something mentioned earlier in the discourse ('anaphors') can be described as "light" or "heavy," depending on how much semantic weight they carry. On the light end are pronouns (e.g., "he, she, it"), which do not carry much semantic information. On the heavy end are full noun phrases. These noun phrases can be made even heavier by being weighted with modifiers (e.g., adjectives, adverbs, dependent clauses). Models of anaphora hierarchy – based on Grice's rules of conversation – suggest that the weight of anaphora has an inverse relationship with the saliency of reference (Givon, 1983; Ariel, 1990; Gundel, Hedberg & Zacharski, 1993). When a referent is salient and easily accessible, a lighter anaphor is possible; when the referent is completely unknown or harder to access, a heavier anaphor is needed. For example, if I want to tell my listener a story about my friend, Sarah, and I know I've never talked to that listener about her before, I will initially need to introduce the listener to Sarah (e.g., "I have a good friend from high school, named Sarah"). After successfully establishing reference, I can use lighter (more efficient) anaphora (e.g., "Sarah" or "she"). Both referential shortening effects and anaphor hierarchy models show how subsequent referential strategies are altered to be more efficient (shortened/lightened) based on the effectiveness of previous reference.

Speakers also adjust subsequent referential strategies when a previous attempt has *failed*, (i.e., in situations where the speaker has attempted to refer but the listener is unable to identify the targeted reference). For example, in the case where I want to tell a listener about my friend Sarah, I may assume, incorrectly, that the listener is already aware of this friend (and about her plans to study abroad). In this case, I might initially refer to her by name and use a light expression to refer to the study-abroad trip (e.g., "*Sarah* had to reschedule *her trip* to next summer"). The listener may then signal to me that she is not familiar with Sarah, perhaps by looking confused or directly asking who Sarah is[1]. In this case – assuming I am attending to my listener's signals conveying confusion – I will need to change or amend my previous strategy to repair the misunderstanding (e.g., "Oh, sorry. I thought you knew Sarah. She's my friend from high school, and she's planning to study abroad in Spain"). Thus, successful referential communication is not static. It not only depends on establishing clear reference in the first place, but also requires that the speaker remains vigilant to the efficacy of their own efforts of communication and efficiently adapts to their listeners' feedback. Successful previous referencing yields subsequent referential expressions that are shorter/lighter, failed previous referencing demands that subsequent turns include corrections and new referential strategies, altogether.

Referential communication in ASD

A large body of work has explored the way that individuals with autism spectrum disorder (ASD) convey reference. ASD is diagnosed based on characteristics observed in two categories: difficulties in social communication, and restricted, repetitive behaviors or interests (Hodges, Fealko & Soares, 2020; American Psychiatric Association, 2013). Although the autism spectrum is vast and encompasses individuals with a wide range of cognitive and language abilities, some challenges are believed to be universal across the spectrum. These challenges

[1] Such cases can also lead to a complete "communication breakdown," where there is a consequential mismatch between the speaker's intentions and the listener's representation. For example, the listener may misassociate the story's events with some other person named Sarah (someone the speaker had not meant to refer to) and assume that that person had to reschedule some trip. In this case, it may not be until the end of the conversation (or never!) that the speaker recognizes there has been a breakdown.

include the contextualization and pragmatic, or socially appropriate, use of language (Baron-Cohen, 2000; Dahlgren & Sandberg, 2008; de Marchena & Eigsti, 2016; Nadig, Vivanti & Ozonoff, 2009; Tager-Flusberg, 1999). Some children with a diagnosis of ASD, and who succeed in academically mainstream classrooms, have a normal or higher-than-normal intelligence quotient (IQ), and have normal or higher-than-normal language ability. Despite the capacity for these individuals to score within normal ranges, and to pass as neurotypical in terms of their structural language abilities (e.g., language sounds, word structure, sentence structure) (Loucas et al., 2008), research finds that differences in social language skills can lead to challenges with fundamental aspects of communication, such as maintaining reciprocity and engaging in the effective and efficient exchange of relevant information (Tager-Flusberg, Paul, & Lord, 2005; Dahlgren & Sandberg, 2008; Olivar-Parra, Forns & Iglesia-Gutierrez, 201l; Volden et al., 1997).

With regards to referential communication skills, specifically, studies find that older children and even adults diagnosed with autism spectrum disorder show differences in their ability to communicate reference, and especially the ability to adjust messages to meet listener needs (Malkin, L., Abbot-Smith, K., & Williams, D., 2018; Ostashchenko, et al., 2019). This lies in stark contrast to neurotypical children, who demonstrate mastery of verbal referencing – including adapting communication signals to meet their listener's needs – before the age of 2 (Luchkina & Waxman, 2021). In fact, some authors have even argued that challenges with verbal referencing in ASD can have negative downstream effects on social integration and acceptance with neurotypical peers: the idea is that referential breakdowns disrupt conversational flow and success, which then causes others to be less interested in conversing with this population in the first place (Murphy et al., 2014).

Research on referential communication in ASD has examined both the *effectiveness* and the *efficiency* of their communication signals. Research on effectiveness has mostly focused on ambiguity. For example, Fukumura (2016) and Nadig et al. (2009) both used the frequency of ambiguous referential terms during a barrier task as a proxy for measuring referential effectiveness; both studies report more frequent ambiguity produced by children with ASD (as compared to NT peers) – specifically that children with ASD do not include necessary adjectives (e.g., "big" or "small") when more than one noun of the same type is visible to their partner (e.g., a big apple and a small apple). A substantial body of work has explored how individuals with ASD use referring expressions in narrative contexts. Similar to Fukumura's (2016) work, a significant proportion of this literature reports the relatively frequent use of ambiguous referential expressions (specifically, ambiguous pronouns) in narratives told by adults (Colle et al. 2008) and by children with ASD (Novogrodsky 2013; Suh et al. 2014; Banney, Harper-Hill & Arnott 2015; Novogrodsky & Edelson 2016). Thus, referential effectiveness suffers, because the listener is unable to determine to whom the speaker means to reference. Most of this work explains referential ambiguity (and therefore ineffectiveness) as evidencing struggle with taking the listener's needs into account; that is, they are less effective because they do not provide enough information to meet the listener's needs in a given context.

On the other hand, some of the work on narrative referencing in ASD seems to show the opposite effect. Rather than participants with ASD being under-informative (and therefore ambiguous), participants with ASD *over* inform. For example, Arnold et al. (2009) finds that children with ASD use full noun phrases when pronouns would be appropriate (i.e., reference is already established, so a lighter anaphor is possible). In this case, reference is *effective*, but it is *inefficient*. Other work has confirmed a tendency for autistic speakers to be effective but inefficient referencers. For example, de Marchena and Eigsti (2016) compared the number of words used in narratives told in two conditions: one where the speaker and listener shared background knowledge and another when they did not. They predicted NT storytellers would show referential shortening effects in the shared condition (i.e., they could shorten their story because background knowledge was shared). Findings showed that individuals with ASD produced long narratives, overall, and their narratives were equivalent in length across the two conditions. The authors conclude that they provided *too much* referential information to the listener who shared background knowledge with them, and did not, therefore, show referential shortening. Similarly, Volden, et al., (1997) and Dahlgren and Sandberg (2008) find that individuals with ASD produced significantly more redundant descriptors when referring to pictures (e.g., saying "it's *square shaped* and has *four corners*") than NT participants. Nadig et al. (2009) found that participants with ASD were just generally less efficient at conveying reference in a barrier task (i.e., they produced longer clues, took longer to establish successful reference, etc.).

Addressing a gap in the research: dynamic measures of efficacy and efficiency

While all the research described in the previous section paints a picture where individuals with ASD are less adept at conveying reference than neurotypical peers, they focus only on the *speaker's* behaviors, without describing *listener* behaviors. This means they cannot capture how the speaker adapts subsequent referential strategies based on the success or failure of previous trials. By only examining single frequency metrics (e.g., the number of redundant descriptors), discourse is treated as static, rather than capturing the dynamic, evolving nature of interpersonal communication.

In fact, some of these researchers have noted this very problem as a limitation in their own work (e.g., de Marchena & Eigsti, 2016). Therefore, a gap in research lies in capturing verbal reference abilities in ASD through a lens of identifying the informational needs of the listener.

There is limited evidence that such examinations may reveal referential strengths in ASD that have otherwise gone unnoticed. Nadig et al. (2015) explored how adults with ASD adapted to listener needs and found that they showed similar rates of referential shortening across time, as compared to NT participants. Thus, it is possible that research focusing only on overall measures (or measures comparing conditions, e.g., de Marchena & Eigsti, 2016) has missed out on the way that speakers with ASD adapt to their listener in real time.

This honors project provides a quantitative analysis of how verbal referencing evolved across time, as older children with and without ASD attempt to communicate information to a listener during a barrier task. In the discussion, we provide qualitative descriptions of these changes.

Specifically, this project aimed to answer the following research questions, which measured both the efficiency and effectiveness of referential communication:

1. Will participants in the ASD group be less likely to change their communication strategy based on the failure of previous trials?
2. When a communication breakdown occurs (a previous turn was unsuccessful), will participants in the ASD group be slower to adjust their referential strategy to repair reference?

3. Will participants with ASD show more uses of redundant and/or uninformative descriptors, and will they do so throughout the task or only when initially establishing reference?

Based on work suggesting that individuals with ASD are less sensitive to their listener's needs, we hypothesize that they should be less adept at adapting subsequent turns based on the failure of previous ones. Specifically, we predict they will continue to use a strategy even when it has previously been ineffective, and, accordingly, they will be slower to establish mutual reference after a breakdown has occurred. Additionally, based on previous work, we predict that participants with ASD will also produce more redundant (but not irrelevant) and uninformative utterances than the NT group. By describing the nature of the entire interaction within this study, and by characterizing how it evolves across time, we hope to capture a more holistic picture of the way older children with ASD communicate during a task that is designed to be challenging for them.

Design and Methods

The data presented in this honor's capstone project was originally collected by Dr. Emily Zane at Emerson College. The study was IRB approved at Emerson. The original study was designed to look at the perspective-taking abilities in NT individuals and individuals with ASD. This honors capstone project focused on conducting observational analyses using this data.

Participants

Participants included in the current analysis are 34 adolescents between the ages 10-17. There were 16 participants in the neurotypical group (4 female, 12 male), and 18 participants in the autism group (5 female, 13 male). Participants were recruited through Facebook, parenting group blogs, and Craigslist. Prior to coming into the lab, researchers used a telephone screening to ensure that NT participants did not have a comorbid diagnosis. Neurotypical individuals had never been previously diagnosed with neurological conditions, language impairment, cognitive impairment, attention deficit hyperactivity disorder (ADHD), or ASD, nor did these individuals have siblings with ASD. The diagnostic screening for the ASD group was confirmed via the Autism Diagnostic Observation Schedule (ADOS-2) by administrators in the lab who achieved research reliability with a certified trainer. In the lab, participants completed the Core Language Subtests of the Clinical Evaluation of Language Fundamentals, 5th Edition (CELF-5) to assess basic language ability and the Kaufman Brief Intelligence Test, 2nd Edition (K-BIT-2) to assess cognitive ability. All of the participants were succeeding academically in mainstream classrooms and tested as having language and IQ scores that fell within or above typical ranges (as measured by the CELF-5 and KBIT-2, respectively). The two groups did not differ significantly in age, IQ, language ability, or gender (Table I).

Table 1. Demographics

	Neurotypical (n = 16) Mean [range]	Autism (n = 18) Mean [range]	Statistical Comparisons
Age	168.28 [130-214]	166.22 [121-229]	P = .87
Sex	4 female, 12 male	5 female, 13 male	P = .88
IQ (K-BIT-2)	113.38 [86-147]	109.83 [80-129]	P = .56
Language (CELF-5)	111.94 [94-143]	105.44 [83-133]	P = .26

Materials

Experimental stimuli for this task included four shapes that were designed in PowerPoint. Each shape was black, had seven or eight straight sides, and had an orange dot to signify which side was its "top." Eight printouts of these shapes were used for the experiment itself. Four of them were affixed to a cardboard reference board, and the other four were laminated and were used by a researcher to indicate which shape she believed the participant was describing (see Procedures). A toy chair was affixed, with Velcro, to the center of the reference board (amidst the four shapes) and a doll was placed in this chair.

Experimental Setup

The participant was seated on one side of a room divider, "the barrier," with a researcher (RA1) on the other side (See *Figure 1*). The barrier was completely opaque so that neither RA1 nor the participant was able to see each other. In front of the participant was the reference board. Another researcher, RA2, sat next to the participant. The role of this researcher was to provide instructions and feedback and to facilitate the experiment. RA2 presented the PowerPoint slides to the participant and moved the reference board and doll to their positions for each set. On the ground in front of the participant and RA2 was the laptop containing the PowerPoint. RA2 moved the chair in the center of the board so that it was facing the appropriate direction for the first set and then placed the doll in the chair. On the other side of the barrier, RA1 was sat in the same position as the doll, within the same configuration of the four black shapes. Therefore, the doll was intended to be a symbol of RA1 behind the barrier.

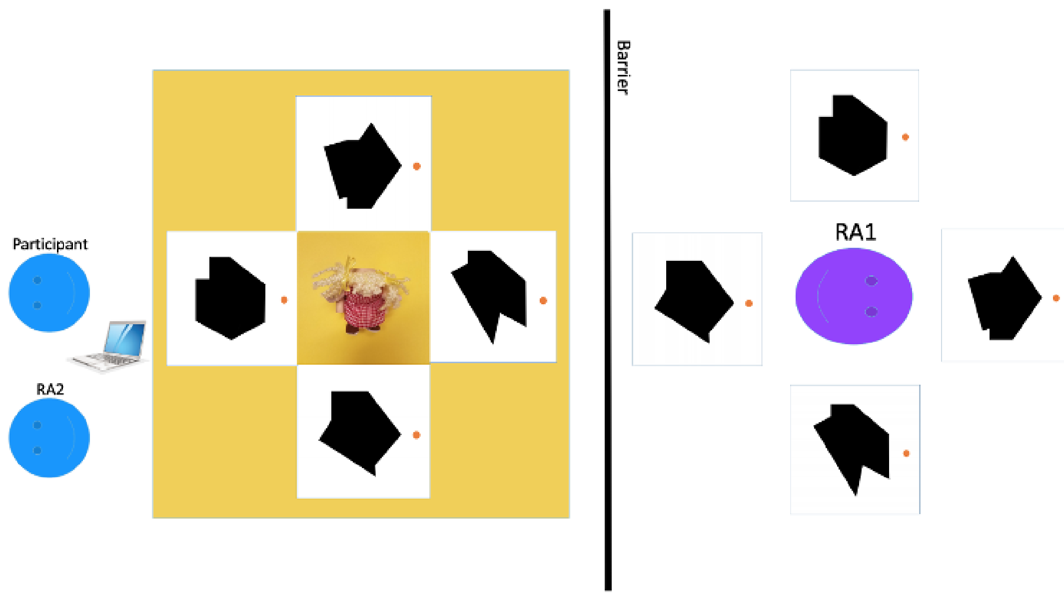

Figure 1. Experimental setup

Procedure

At the start of the task, RA2 told the participant that s/he would be playing a game with RA1. RA2 explained that RA1 was behind the barrier and was positioned in the same way as the doll on the board, with the same shapes surrounding her in the same way. RA2 then explained to the participant that their job was to get RA1 to pick the shape that was displayed on the computer screen. The participant was told to use whatever language s/he thought was efficient and effective to get RA1 to pick the correct shape. The task began with the two practice trials (Appendix A).

During the practice trials, the participant would use language to encourage RA1's selection of the appropriate shape. RA1 would then select whichever shape she believed the participant was referencing and would then pick up the shape and hold it out so that it was visible from the side of the barrier, and therefore visible to the participant and RA2. If RA1 picked the correct shape (the shape displayed on the laptop), RA2 would say "correct." If not, RA2 would say "incorrect." After providing feedback, RA2 would proceed to the next slide. Thus, participants were not afforded a second attempt at the same trial. If participants seemed confused, RA2 would remind the participant of study instructions, e.g., "Remember, RA1 is facing the shapes the same way the doll is. See if you can get her to pick this [pointing to the computer screen] shape."

After the practice trials, RA2 replaced the practice board with the experimental reference board (Appendix A), and the experiment continued. The same procedures for practice items were repeated for experimental items, including RA2 providing verbal feedback and a reminder of study directions whenever participants were confused. After each set, RA2 would move the doll to a new position and RA1 would stand up and move so that her position matched that of the dolls.

Experimental items were organized into a list of 68 trials: four practice trials, and eight sets of eight trials. Each trial involved a single shape being presented to the participant via PowerPoint, and each set corresponding to a different doll position (e.g., Set 1 corresponded to the doll facing toward the participant). In each set, each shape was presented twice. The order of each shape within a set was repeated so that if Shape 1 was presented first, it was then presented fifth. The order of shapes set-to-set was alternated so that Shape 1 would begin Set 1, and Shape 2 would begin Set 2.

There were two blocks within the experiment. In Block A, the reference board was either on the ground ("horizontal") or on the chair ("vertical"), and in Block B, the reference board was on the chair or ground, respectively (See *Figure 2*). Whether participants saw the board on the chair or floor first was alternated child to child. At the beginning of each block, two practice trials were presented via a practice reference board (see Appendix B). The following outlines this sequencing for a child who saw the reference board on the ground first ("horizontal").

A. ***Horizontal***

- ***a. Two practice trials with board on ground***
- ***b. 32 experimental trials with board on ground***
    1. ***Block A, Set 1 (8 trials):*** *DOLL'S FRONT FACES CHILD*
    2. ***Block A, Set 2 (8 trials):*** *DOLL'S FRONT FACES AWAY FROM CHILD*
    3. ***Block A, Set 3 (8 trials):*** *DOLL'S FRONT FACES TO THE RIGHT OF CHILD*
    4. ***Block A, Set 4 (8 trials):*** *DOLL'S FRONT FACES LEFT OF CHILD*

B. ***Vertical***

- **a.** ***Two practice trials with board on chair***
- **b.** ***32 experimental trials with board on chair***
    1. ***Block B, Set 1 (8 trials):*** *DOLL'S FRONT FACES CHILD*
    2. ***Block B, Set 2 (8 trials):*** *DOLL'S FRONT FACES AWAY FROM CHILD*
    3. ***Block B, Set 3 (8 trials):*** *DOLL'S FRONT FACES TO THE RIGHT OF CHILD*
    4. ***Block B, Set 4 (8 trials):*** *DOLL'S FRONT FACES LEFT OF CHILD*

I. Horizontal reference board position (A)

II. Vertical reference board position (B)

Figure 2. Horizontal vs vertical trials

The task was video and audio recorded using a standing microphone and a video camera. Both of which were positioned on tripods directly behind the participant.

Data Analysis

Transcription

For analysis and coding, each file was orthographically transcribed in ELAN (ELAN, 2020). Each utterance was transcribed in a "participant speech" tier in ELAN. A team of research assistants (RAs) did this transcription in several stages. First, each participant's video/audio file was transcribed as a first pass, meaning that one RA would transcribe the language throughout the file. Then, each file underwent a second and the third pass by two separate transcribers, to ensure participant speech was captured accurately. In addition to a verbatim transcription of participant utterances in the "participant speech" tier, transcribers also noted in a tier whether the shape shown by RA1 was correct or incorrect.

Coding

A detailed coding scheme was established that allowed for both quantitative analysis (in the results section) and qualitative description in the discussion. Data generated included numbers representing instances of specific actions or behaviors, as well as narratives of what was observed within the realm of the research question. Each participant's video and transcription was reviewed and coded based on observations associated with specific categories.

For the current project, coding was completed by the first author. Coding categories included *strategy-switching, uninformative language,* and *redundant language.* Observations were recorded in an organized Google Sheet.

Coding for Strategy-switching. When referring to the shapes, all participants used at least one of three major strategies. See *Table 2*.

Table 2. Shape-referring strategies

STRATEGY	DEFINITION	EXAMPLE
Spatial Configuration	Participant uses spatial language to describe where the shape is in relation to the researcher's (or doll's) position.	"It's the shape to your left"
Shape Description	Participant describes certain aspects, or pieces, of the shape. Participants frequently described geometric angles, lines, or points.	"There's a line going across the top and diagonally inwards and out, sort of like a 'Z' shape"
Object Resemblance	Participant describes the shape as resembling a real-world object.	"The object that looks like a mouth"

The most common strategy, and the one the study was designed to yield, was spatial configuration, where participants described the position of the object in relation to the position of RA1 or in relation to the position of the doll. The second major strategy, shape description, was to describe geometric features of the shapes. The final major strategy, object resemblance, was to describe how the shape resembled a real-world object.

We coded all participants' trials as one of these three strategies, and we additionally coded each trial as successful or unsuccessful. A successful trial was one where RA1 correctly identified the shape the participant was targeting. An unsuccessful trial was one where RA1 identified a different shape. We could then use those two codes (strategy type and success) to determine how participants changed their communication strategies depending on the success/failure of the previous trial.

Figure 3 presents a schematic of how participants fell into different strategy-switching categories.

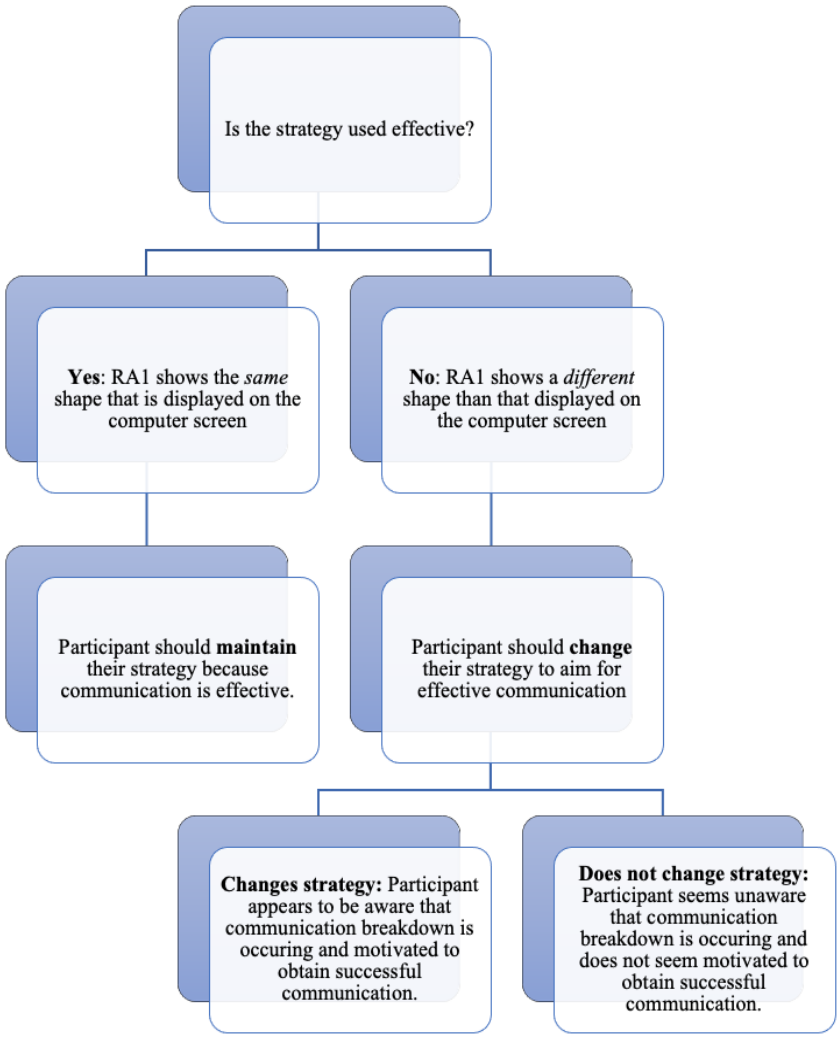

Figure 3. Coding for strategy-switching

This resulted in participants falling into four main categories, based on their strategy switching behavior from the first trial on. See *Table 3*.

Table 3. Subcategories of strategy-switching

Successful at start	**Unsuccessful at start**		
	Switched to successful	**Switched to unsuccessful**	**Never switched**
ASD n	ASD n	ASD n	ASD n
NT n	NT n	NT n	NT n

Participants did not need to switch strategies when they employed an effective strategy from the start. Participants needed to switch strategies when they began the task with an ineffective strategy. Participants' strategy sequence in this latter category were then coded based on if they 1) started with an unsuccessful strategy and then replaced that strategy with a successful one, 2) started with an unsuccessful strategy and then replaced with another unsuccessful strategy, and 3) started with an unsuccessful strategy and never replaced it with another strategy. As we were interested in comparing participants' ability to adjust their ineffective strategy to accommodate the dynamics of the interaction, we narrowed in on the latter groups of which were, by definition, displaying ineffective communication.

Redundant and Uninformative language. There were two qualities of language -- redundant language and uninformative language-- that we coded for, as they represented descriptions that were not optimally efficient nor effective. An utterance was coded as being inefficient when it included redundant language, further, when the participant combined more than one description of a shape or its position (e.g., 'It's to the left of you and it looks like an arrow'). An utterance was coded as ineffective when participants used uninformative language. This measure captures descriptors that do not actually distinguish one shape from another (e.g., 'It is a black shape,' when all shapes in the task were black). While uses of both redundant and uninformative language are similar in that they do not optimally convey the speaker's message, they are in fact quite different from one another. While redundant language is overly informative, since the speaker is providing too many distinguishing characteristics and thus impacts the *efficiency* of communication, uninformative language -- as its name suggests -- involves descriptors that are not distinguishing at all and therefore decrease the *efficacy* of the referential attempt.

Analysis

Strategy-switching

We used a Fisher's exact test to compare the proportion of participants who fell into each of these subgroups (the shaded cells in *Table 3*) between groups.

Strategy-switching timing

As a secondary analysis of strategy switching, we calculated and compared the efficiency of participants' strategy switching. To do this, for participants who did switch their strategy from unsuccessful to one that was successful (participants who fell into subgroup 2 in the list presented in the previous section), we identified the trial number when the switch occurred.

Then, we used a two-tailed Mann-Whitney U test to compare the timing (i.e., trial number) of successful strategy switching between groups.

Redundant/uninformative language

We used a two-tailed Fisher's tests to compare the frequency proportion of participants who used redundant and uninformative language between groups.

Results

Strategy-switching

There were 7 children in each group who employed an effective strategy from the start. There were 10 NT participants and 11 ASD participants who were not effective and who, therefore, should have switched their strategy in order to achieve successful reference. These participants were then divided into three subgroups:

1. Participants who started the task with an unsuccessful strategy but replaced that strategy with a successful one (8 NT; 8 ASD).
2. Participants who started the task with an unsuccessful strategy and then replaced that strategy with another unsuccessful strategy (1 NT; 1 ASD).
3. Participants who started the task with an unsuccessful strategy and never replaced it with another strategy (0 NT; 2 ASD).

Table 4. Strategy-switching data

Initial strategy	**Successful**	**Unsuccessful**		
Switching of subsequent strategies	**n/a**	**Switched to successful strategy**	**Switched to unsuccessful strategy**	**Never switched**
ASD (18)	7 (38%)	8 (50%; 73%)	0 (0%; 0%)	3 (100%; 27%)
NT (16)	7 (41%)	8 (50%; 80%)	1 (100%; 11%)	0 (0%; 0%)

Table 4 demonstrates the number of children in each group who switched/did not switch strategies. Numbers in parentheses present percentages of children in each group. When more

than one percent is provided, the first represents the percentage of children within a group (e.g., ASD) and the second represents the proportion of children in that group who needed to change their strategy. Grayed cells represent those that were compared in the Fisher Exact Test.

Fisher Exact Test results revealed that the proportions of participants in each group who did or did not switch to a successful strategy were not significantly different between groups (p = 0.218).

Timing

As shown in *Table 4*, there were eight individuals from each group (ASD and NT) who were unsuccessful at the start of the task but who changed their strategy to a successful one. *Table 5* demonstrates averages and standard deviations as measures of efficiency for participants in each group.

Table 5. Timing data

	n	Median trial number [Range]	Standard Deviation
ASD	8	6.5 [3-43]	13
NT	8	28.5 [9-60]	21

A two-tailed, Mann-Whitney test was used to compare groups, and the results show a marginally significant difference between groups (Mann-Whitney U = -2.26, p = 0.024), reflecting quicker strategy switching, on average, in the ASD group.

Uninformative and Redundant language

Table 6. Uninformative language data

Group	n	Uninformative language	No uninformative language
ASD	18	6	12
NT	16	1	15

A Fisher's Exact test revealed that groups did not differ in proportions of participants who use uninformative language, although results approached significance (p = 0.09).

Table 7. Redundant language data

Group	n	Redundant language	No redundant language
ASD	18	7	11
NT	16	2	14

A Fisher's Exact test found that groups did not differ in proportions of participants who use redundant language (p = 0.13).

Discussion

The results of this study do not accord with our hypotheses. Both groups were similar in success from the start of the task (seven participants were initially successful) and the same number of participants in each group switched to a successful strategy when their initial strategy was unsuccessful. Results further demonstrate the ASD group outperforming the NT group in terms of how quickly they were able to adjust their communication strategy from something unsuccessful to a successful one. Participants in the ASD group switched to a successful strategy significantly more quickly (after fewer trials) than NT participants did. Finally, although more participants in the ASD group showed uses of redundant and uninformative language, there were no significant differences between groups.

In the discussion that follows, we will provide qualitative descriptions of some of these findings, to help provide some nuance that is lost when we merely compare numbers. In this section, we will refer directly to specific participants. Appendix A provides demographic information about the participants who are referenced in this section.

Efficacy

Strategy-switching

Our hypothesis regarding *efficacy* was that participants with ASD would be less effective at achieving successful reference, specifically, they will continue to use a strategy even when it is ineffective. The first half of this hypothesis was not supported due to the ASD group, in general, being just as effective at creating successful references. Further, the ASD and NT groups did not differ on quantitative measures of strategy switching; however, the second portion of the hypothesis was somewhat supported. Findings demonstrated that two participants used a strategy despite its ineffectiveness (a behavior that only occurred in the ASD group), thus aligning with the original hypothesis, strategy switching data demonstrated no significant group differences, suggesting that both groups were similarly able to adjust their communication strategies to meet their listener's needs. This contradicts previous literature that suggests individuals with ASD should struggle with communicating effective reference to meet listener needs (Malkin, L., Abbot-Smith, K., & Williams, D., 2018; Ostashchenko, et al., 2019). However, our findings match previous research conducted by Volden et al. (1997) which discovered no differences between groups in their primary measure of perspective-taking abilities. Because perspective-taking ability is directly correlated with successful reference in this barrier task, our findings support this previous research. Our findings also match results in Nadig et al. (2015) which found that the ASD and NT groups were similarly effective at communicating reference.

One suggestion for why our research aligns with the two previous studies and does not align with a large portion of previous literature, is that we examined language dynamically. When viewing the interaction in a dynamic manner, our measures became nuanced in that they did not solely focus on the behaviors of the participant. Our measures of strategy switching effectiveness were measures of dynamic communication because strategy switching within the task was dependent on how the interlocutor understood, and responded to, what was said by the participant. These measures of effectiveness were viewed from a lens of how well reference was working, from the perspectives of the sender and receiver, across the interaction, which may have attributed to all participants performing in a similar manner. Therefore, we can infer that dynamic analysis of verbal reference tasks may highlight pragmatic strengths in ASD that have gone otherwise uncaptured. In fact, there is a little support for this explanation from one previous study. Nadig et al. (2015) explores referential communication skills dynamically – examining both the effectiveness and the efficiency (to be discussed later) – of speakers with and without ASD in communicating reference to a partner. They find, when looking across trials, that participants with ASD were able to adapt a communication strategy that met the needs of their partner. Interestingly, this work also shows that participants with ASD struggled to adapt to a *new* partner when their original partner was replaced with someone else. Since our participants only had to match their referential strategies to a single person, our findings accord with those of Nadig et al. (2015) where participant groups were able to maintain or switch strategies to effectively communicate reference to their listener.

Although, again, there were no significant differences between proportions of children in each group who fell into these categories of strategy-switching behavior, the other two categories did yield different numbers of participants between groups. First, there was only one participant who switched their strategy due to an unsuccessful initial strategy, but who never landed on one that worked. Surprisingly, this participant (P9) was from our NT group. P9 begins the task by using the shape description strategy (unsuccessfully) and then proceeds to adding small forms of spatial configuration language to the descriptions (e.g., "... in front of you there's like a peak"). Unfortunately, these spatial descriptions were inaccurate, as they did not actually describe the shapes from the doll/RA's perspective (i.e., there was a peak at the top of the shape from the participant's perspective, but that part of the shape was not "the top" from the doll/RA's point of view). It was evident that P9 was struggling to accurately take the perspective of RA1, and after receiving an incorrect response from RA1, P9 reverted to solely describing the object.

There were only three participants who did not switch from their initial strategy, despite referential failure, and all three of these participants were from the ASD group (P5, P6, and P8). We begin by discussing P5. P5 began the task by using shape description, describing small geometric features of each shape (e.g., it has a diagonal line, part of it is L-shaped, etc), rather than describing the entire shape. P5 persisted with shape description throughout the entirety of the task, even in the presence of negative feedback. In fact, the RAs were so surprised by his inability to shift his strategy to perspective-taking spatial descriptions (e.g., “it’s the shape in front of you”) that they even lifted the barrier to reveal RA1’s position (to help the participant recognize that describing the spatial configuration of the shapes would be a more effective strategy). He was the only participant for whom the RAs did this.

However, this glimpse “behind the scenes” did not alter his strategy, except for one trial when he attempted spatial configuration to describe the spatial position (“that… facing that \ facing that”) while pointing to the shape he was targeting. When RA1 did not hold out a shape (as she did not recognize he was finished with his turn), he returned to shape description.

We suspect that this participant knew that spatial information would have been helpful for completing the task, but he seemed unable to formulate language that could convey this without incorporating gestures (e.g., pointing). Since these gestures were clearly unhelpful, as his partner couldn’t see them, he committed to using shape descriptions, despite his lack of success.

It is worth noting that P5 repeatedly asked the researchers how much more of the game he had left, and he frequently elicited other verbalizations (e.g., sighs and groans) that insinuated he wanted the game to be over. This is important for two reasons: On one hand, it suggests that he wasn’t particularly motivated to participate, which may have negatively affected his ability to settle on an effective strategy. On the other hand, his eagerness to finish the task as quickly as possible should have motivated him to identify a strategy that would convey reference quickly (in order to end the task sooner). As it was, his ineffective strategy made the task much longer than average (29 minutes), and in this way, it is clear how ineffectiveness can also yield inefficiency.

P6 used spatial language from the beginning. However, he did not adjust spatial language as the position of the doll changed, especially confusing right and left references, even when the doll was facing the same direction as him. Importantly, P6 was aware that communication breakdowns were occurring, and he frequently elicited utterances of frustration due to those breakdowns, e.g., "Ugh! I'm saying to your right and then you're going to the left ... right is *this* way (while pointing in the indicated direction)." In such examples, he implicitly expressed those misunderstandings were consequences of his partner's confusion, which supported the lack of amendment on his part. Our suspicion is that this participant – who was one of the youngest participants in our experiment – struggled to discriminate "left" from "right," and was unable to adjust his communication to be more effective. Thus, even though he recognized that spatial configuration was the most efficient/effective method for conveying reference, he was unable to do so accurately. Further, even though he was ineffective at amending reference himself, he recognized there were breakdowns, and he communicated this to his partner. We highlight all of this as representing communication/pragmatic strengths. If he were in a typical interaction, where his partner could see him (and vice versa), his corrections (e.g., "right is *this* way!") would be effective at clarifying reference with that partner.

P8 was the third (and final) participant who did not adjust her strategy despite initial failure. She utilized a unique strategy in that she utilized cardinal directions (e.g., "face north," "face east"). Although Participant 8 used the same strategy for the whole task, and was inconsistently effective, she switched the way in which she used the cardinal directions as the task went on. For instance, at the beginning of the task, "north" referred to the shape furthest from her, at the top of the reference board. In subsequent trials, as the reference board was turned to different angles, she still referred to that same shape as “north,” suggesting that she had given that shape the name “north” based on its position in the first set. When RA1 still was not guessing the correct shape, she began referring to other shapes as “north,” thus suggesting that she recognized her strategy wasn’t working. We are unable to determine how she identified shapes as “north”/“south”/“east”/“west” for the remainder of the experiment (after she stopped using the directions as labels), but she did make adjustments, so that “north” sometimes referred to the shape furthest from her (at the “top”) of the board, and sometimes it did not. This demonstrated to researchers that P8 was motivated to amend her communication strategies to achieve effective reference despite never arriving there it. From this example, it is clear that the coding procedures of this project (where each trial was coded as one of three major categories) do not provide the nuance needed to reflect a participant’s motivation to meet their listener’s needs and their subsequent actions to do so. Although P8 did not achieve referential effectiveness, she did work for it. We discuss this in more detail in the limitations section

Uninformative Language

When participants used descriptors that overlapped across more than two shapes (e.g., mentioning that the shape is black or has pointy edges), we described such descriptors as uninformative. Because RA1 could never determine the targeted shape from such overlapping features, we include uninformative language under the larger umbrella of ineffective referencing. In relation to efficacy, we hypothesized that participants with ASD would produce more uninformative, or ambiguous, reference labels. This hypothesis was accepted in terms of the qualitative measure of uninformative language, further, we found that the ASD group produced more uninformative reference than the NT group, although not statistically significant. The examples below demonstrate examples of this language. The underlined text was coded as uninformative.

Uninformative Example	Participant	Utterance
1	**P3**	"This one is another black shape. It almost looks like a hexagon, but it has a little rectangle of white down at the bottom and is sort of lop-sided with an orangish dot above it."
2	**P4**	"The one you are looking for, it has an orange dot at the top and there is a line going across the top and diagonally inward sort of like a z-shape and it is shaped sort of like the cockpit of a plane and the bottom is flat with a right angle."
3	**P5**	" I see an orange dot and a triangle shape at the back."
4	**P6**	"The object is right behind you. It's black and it has a little orange dot right above it."
5	**P7**	"This one has a horizontal line where the orange dot is and opposite the orange dot is a diagonal line and near the orange dot is an indent that is large and far away from the orange dot is a tilted ninety-degree angle."

Results found that more participants with ASD used uninformative language than NT peers (ASD n = 6; NT n =1), and this difference approached significance. This finding aligns with previous research. A large body of research on narrative production in ASD has found that participants with ASD produce ambiguous referencing in narratives (Colle et al., 2007;

Novogrodsky, 2012; Novogrodsky & Edelson, 2016; Suh et al., 2014; Norbury & Bishop, 2003; Norbury, Gemmell, & Paul, 2014). Further, in referential communication tasks similar to ours, literature finds more ambiguous referencing in ASD. Specifically, participants in these studies do not use discriminating adjectives to help their partner determine which of two objects (e.g., a big vs. small apple) to pick (Fukumura, 2016; Nadig et al., 2009).

A difference in how our findings compare to previous literature lies in experimental setup. Most previous studies typically only had two shapes that shared characteristics rather than all *four* shapes sharing characteristics. Our intention in providing four similar shapes was to motivate participants to use spatial language. However, in doing so, we may have unintentionally "trapped" participants into being uninformative because all our shapes were strikingly similar.

Because utilizing descriptors that are shared across more than one shape is ineffective, it frequently led to communication breakdowns. One possible explanation for more frequent use of uninformative language by participants with ASD comes from Horton & Keysar (1996). These authors propose the "monitoring and adjustment account," which suggests that initial language production processes are egocentric, and perspective-taking comes into play during late production processes. Fukumura, 2016 has taken this account further and suggested that there are two stages in development of reference, thus proposing that participants with ASD are more uninformative because they have not gotten to that stage of development.

It is important to note that there is wide variation in the frequency of uninformative language for these participants. For instance, P4 mentioned the orange dot once and this was his only example of uninformative language, while P5 referenced the orange dot on several trials. It is also important to point out the variation in the amount to which each participant relied on uninformative features in a single description. For instance, compare P3's example utterance in the previous table to P5's. P3 included some uninformative characteristics (e.g., mentioning that the shape is black), but she interweaved such features with informative ones (e.g., saying that it looks like a hexagon that's a little lop-sided). In contrast, P5 relied strictly on uninformative descriptors. An orange dot is visible for all four shapes, and three of four of them can be described as having a "triangle at the back." P6's description was unique in that it contained both uninformative features (the shape's color and the mention of the orange dot) with *redundant* features (mentioning that the shape was behind RA1 before going on to describe it). This is interesting because P6 uses spatial language in isolation frequently and it is successful, but every now and then P6 combines those successful descriptions with "the orange dot" or that the "shape is black" and suddenly the description becomes less effective (and less efficient), requiring the listener to sift through the received information and select which piece of the description to act upon.

An additional participant, P7, was also recorded as including non-distinguishing features (specifically, references to the orange dot) in her descriptions. P7 used these types of descriptions 20 times throughout the experiment. Although these types of utterances are arguably *not* uninformative, since non-distinguishing features are used as a part of a distinguishing characteristic (e.g., there is a diagonal line *opposite* from the orange dot), rather than used on their own, we still include this participant's descriptions in the uninformative section for two reasons. First, these utterances do technically include non-distinguishing features, which was our criteria for uninformative language. Second, while these descriptions are not straightforwardly uninformative, they are certainly not *optimally* communicative, as such detailed descriptions were both ineffective and inefficient at signaling which shape was being described. P7's experiment session lasted a relatively long time, and her descriptions were often not successful in that RA1 was often not able to select the shape that P7 intended to reference.

Efficiency

Timing

Our hypothesis regarding establishing *efficient* reference was that the ASD group would be slower than the NT group in establishing mutual reference after a breakdown occurred. This hypothesis was rejected due to results demonstrating that the ASD group proved to be faster based on trial number of successful switch. The data displayed in Table 4 demonstrates that of participants who were unsuccessful at the start of the task but changed their strategy to one that was successful. The ASD group determined a successful strategy earlier in the task than participants in the NT group did (ASD: m =Trial 11; NT: m = Trial 30). Although this difference was only marginally significant, we suggest that it does represent a group difference worth discussing.

Because previous research has not looked specifically at this measure, our findings that the ASD group was faster in adjustment than the NT group are unique. In previous studies looking at referential shortening, researchers used the number of words per trial as an efficiency metric. For example, de Marchena & Eigsti (2015) found that NT participants produced shorter narrations when they shared knowledge with their listener, and ASD participants did not. The authors interpret this as suggesting that the ASD participants were not as successful at amending their communication to their listener’s needs/background knowledge. In contrast to the findings from De Marchena & Eigsti (2015), Nadig et al., (2015) finds the ASD group showing similar rates of referential shortening *across time*, as compared to NT participants. These findings suggest that looking at measures dynamically captures strengths in ASD that may not be seen in measures that solely focus on the speaker. Thus, as previously stated, it is possible that research focusing only on overall measures (or measures comparing conditions) may not capture the same strengths.

Because the current study enabled RA1 to contribute communicatively/ strategically to speaker success by showing the correct or incorrect shape, the speaker was able to adjust as the task went on. Further, both parties were able to adjust their responses based on the success of failure of previous trials, aiding in overall success within the interaction. By analyzing timing, a better sense of the quality of the interaction is gained. From the surface, quantitatively, it appears as though the ASD and NT groups are equal in participants who were unsuccessful at the start of the task but changed to successful over time; however, when a more narrowed approach at the data was examined, it appeared as though the ASD group was better, in terms of efficiency, at amending their strategy to achieve successful communication. Therefore, our findings show that participants with ASD become successful *earlier* than the NT group, which suggests that there is value in looking at referential communication tasks from a dynamic lens. This conclusion suggests a strength within the individuals with ASD in this task and not only in terms of recognizing when they should change their strategy, but also doing so more quickly.

Redundant Language

Utterances that contained multiple descriptors of which could have been sufficient on their own were coded as redundant. We include redundant language under the larger category of efficiency, as the data showed that nine participants used redundant language (7 ASD and 2 NT). We hypothesized that the ASD group would produce more redundant utterances than the NT group, and this hypothesis was supported. Although this difference did not reach significance, the fact that there were more participants with ASD who used redundant language accords with previous literature (Volden et al., 1997; Dahlgren and Sandberg, 2008; Colle et al., 2007; Nadig et al., 2009; Fukumra, 2016).

The examples below demonstrate examples of two participants producing redundant language. The underlined text was coded as redundant.

Redundant 1

1	**P1**	Behind you is …
2	**RA1**	((Hesitantly shows shape)) Should I just pick it? Or no? You're still going?
3	**P1**	<u>Behind you</u> is … I guess you could say ... <u>the bottom kind of looks like a version of the trapezoid</u> um well the part facing away from the orange dot
4	**RA1**	Okay can I just show you the one behind me or do you want to keep describing?
5	**P1**	I'm going to keep describing um and then on top it looks kind of like a parallelogram that isn't quite parallel and then those two are shoved together and they added a square in the corner
6	**RA1**	Okay this one? ((shows shape))
7	**RA2**	((nods head)) Okay next one ((Hits arrow on computer for next shape)) So all you have to do is get her to pick which object
8	**P1**	A <u>hexagon with something weird in the lower-left corner</u> … and that is <u>to your right</u>

In utterances 3, 5, and 8, P1 (ASD) uses multiple distinct strategies to refer to the shape. All underlined portions of these utterances would have been sufficient on their own. For example, the underlined portion in 8 is redundant because there is only one shape that resembles a hexagon, and there is only one shape to the right of the interlocutor. Therefore, using either one of these underlined portions would have been sufficient as a stand-alone description. In the following exchange, a "moment of epiphany" occurs sometime between line 9 and line 16, after P1 recognizes that RA1 holds the shape out *immediately* after P1 provides a spatial word. Although his next turn is also redundant ("hexagon" and "to your right"), he follows that with only a spatial description, and continues to use those for the remainder of the experiment.

9	**P1**	In front of you is…
10	**RA1**	((Abruptly shows shape))
11	**P1**	Okay you already guessed
12	**RA2**	((Next shape))
13	**P1**	The same hexagon with the weird thing on it, and it's to your right
14	**RA1**	((Shows shape))
15	**RA2**	((Next shape))
→16	**P1**	Behind you

The RA seems to have timed their showing of the shape deliberately, so as to implicitly communicate to the participant that the spatial descriptions are optimally communicative. This highlighted the way in which P1's reference adapted to RA1's behavior. We interpret this sequence of behaviors as suggesting that the participants' original redundancies reflected motivation to be communicative but also insecurity as to what strategy would be most communicative. P1 navigated this by utilizing multiple strategies until he was sure which strategies were working. RA1 contributed to this epiphany that spatial language was sufficient by showing the correct shape immediately after sufficient language was elicited, thus dynamically contributing to the efficiency of the interaction.

P2 (ASD) also used redundant language (see table below). The motivation behind P2's behavior is not totally clear, but it is worth pointing out that P2 was unique in that he interpreted the experiment as a game, where he and RA2 were playing against each other, on competing teams. In fact, at the beginning of the task, when determining which strategy he should use to communicate the correct shape to RA1, P2 verbalized his intention to make the game more difficult for RA2. Thus, unlike P1, who likely used redundancies due to a lack of awareness and/or confidence in what communicative strategy was most effective, P2 seemed to opt for redundant descriptions intentionally, perhaps to be less communicative (i.e., to make the game more challenging) and/or to be less *efficiently* communicative (i.e., to make the game last longer). After multiple trials of unsuccess, P2 attempted to find a strategy that was successful by voicing his confusion to RA2, who explained that RA1 was facing everything in the same way as the doll.

Redundant II

1	**P2**	Okay this object, for me, it's <u>behind the doll sitting in the chair</u>… it's one of the two that have <u>a dot over a flat side like for me to the left there's a ramp and it goes down and to the right there is a ramp that goes inward and it's jagged sort of like a mouth</u>… <u>it's kind of looks like a loaf of bread</u>
2	**RA1**	((laughs)) Okay this one? ((shows shape))
4	**RA2**	No ((Next shape))

5	**P2**	Uh I have a question… I am going to whisper it in your ear because I think it is part of the game ((whispers question to RA2))
6	**RA2**	You can say whatever you want
7	**P2**	((laughs)) Okay I'm not going to do that because I think it's going to be too obvious ((P persists with extensive shape description))

Similar to P1, a "moment of epiphany" occurred after P2 recognized that RA1 held the shape out *immediately* after P2 provided enough information for reference to be effective (line 12, below).

8	**P2**	Okay so this one is like facing the doll's right hand it's got a dot facing a flat edge it's that one I said before that was like a cut-out hexagon
9	**RA1**	((shows shape))
10	**P2 and RA2**	((With enthusiasm)) Yeah!
11	**RA2**	((Next shape))
12	**P2**	Okay this one is that first one I said that was behind the doll and it's the one facing the flat edge and it looks like a weirdly--
13	**RA1**	((shows shape))
14	**P2 and RA2**	((with enthusiasm)) Yes!
15	**RA2**	((Next shape))
16	**P2**	I should have described the doll in the first place!

P2's use of redundant language was interesting in that it seemed to stem from a very different underlying motive in comparison to P1. While P1 used redundant language at the beginning of the task *until* he had an epiphanic moment, P2 produced this redundancy even *after* he had already established a successful strategy. At the start of the task, P2 used shape descriptions and object resemblance to refer. Eventually, P2 had the epiphany that spatial language was sufficient and proceeded to *supplement* their shared labels ("cut-out hexagon") with spatial descriptions ("to the left of the doll") and continued to use multiple strategies in each turn for the remainder of the task. Thus, P2 began the task by being more efficiently communicative than he ended it, as he initially avoided redundancies and then later was consistently redundant.

Limitations

One of the major limitations of our findings is that we decided to do a separate analysis of this data in a way that the study was not designed to do. Participants dealt with the task in such different ways which made it difficult to characterize. Additionally, the RA's behaviors across tasks varied. The RA's prerogative in the task was to get the participants to switch to spatial language because that is what the study was designed to observe. Therefore, the RAs at times were purposefully uncooperative in order to guide participants to change their strategy, thus sometimes interfering with the success of the interaction. Another limitation occurred in our chosen measures for the current study. It is probable that the measures we came up with were not sufficient in categorizing all the behavior (e.g., discussion of P8 in *strategy switching*). In this way, it is clear that the coding procedures of this project (where each trial was coded as one of three major categories) did not provide the nuance needed to reflect a participant's motivation to meet their listener's needs and their subsequent actions to do so. Therefore, not all participants were optimally categorized.

Conclusions

Overall, our findings suggest that adolescents with ASD can be successful referential communicators. We suggest that these findings reflect the value of looking at communication dynamically – how it changes across an interaction and how both interlocutors adapt to one another. Such measures paint a full picture of the behaviors of both the speaker and the interlocutor, thus capturing skills that more closely mirror those needed in real-life conversation. By using such measures to study communication abilities in autism, we have identified pragmatic strengths which have previously gone unnoticed, and we encourage future research to build upon our work.

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Ariel, M. (2014). Accessing noun-phrase antecedents (Rle linguistics b: Grammar) (0 ed.). Routledge. https://doi.org/10.4324/9781315857473

Baron-Cohen, S. (2000). Theory of mind and autism: A review. In International Review of Research in Mental Retardation (Vol. 23, pp. 169–184). Elsevier. https://doi.org/10.1016/S0074-7750(00)80010-5

CDC. (2020, September 25). Data and statistics on autism spectrum disorder | CDC. Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/autisam/data.html

Colle, L., Baron-Cohen, S., Wheelwright, S., & van der Lely, H. K. J. (2008). Narrative discourse in adults with high-functioning autism or Asperger syndrome. Journal of Autism and Developmental Disorders, 38(1), 28–40. https://doi.org/10.1007/s10803-007-0357-5

Dahlgren, S., & Sandberg, A. D. (2008). Referential communication in children with autism spectrum disorder. Autism, 12(4), 335–348. https://doi.org/10.1177/1362361308091648

De Marchena, A., & Eigsti, I.-M. (2016). The art of common ground: Emergence of a complex pragmatic language skill in adolescents with autism spectrum disorders. Journal of Child Language, 43(1), 43–80. https://doi.org/10.1017/S0305000915000070

ELAN (Version 6.0) [Computer software]. (2020).

Fukumura, K. (2016). Development of audience design in children with and without ASD. Developmental Psychology, 52(1), 71–87. https://doi.org/10.1037/dev0000064

Grice, H. P. (1989). Studies in the way of words. Harvard University Press.

Givón, T. (1983). Topic continuity in discourse: The functional domain of switch-reference. In J. Haiman & P. Munro (Eds.), Typological Studies in Language (Vol. 2, p. 51). John Benjamins Publishing Company. https://doi.org/10.1075/tsl.2.06giv

Gundel, J. K., Hedberg, N., & Zacharski, R. (1993). Cognitive status and the form of referring expressions in discourse. Language, 69(2), 274. https://doi.org/10.2307/416535

Hodges, H., Fealko, C., & Soares, N. (2020). Autism spectrum disorder: Definition, epidemiology, causes, and clinical evaluation. Translational Pediatrics, 9(S1), S55–S65. https://doi.org/10.21037/tp.2019.09.09

Holler, J., & Wilkin, K. (2009). Communicating common ground: How mutually shared knowledge influences speech and gesture in a narrative task. Language and Cognitive Processes, 24(2), 267–289. https://doi.org/10.1080/01690960802095545

Horton, W. S., & Keysar, B. (1996). When do speakers take into account common ground? Cognition, 59(1), 91–117. https://doi.org/10.1016/0010-0277(96)81418-1

Krauss, R. M., & Weinheimer, S. (1966). Concurrent feedback, confirmation, and the encoding of referents in verbal communication. Journal of Personality and Social Psychology, 4(3), 343–346. https://doi.org/10.1037/h0023705

Loucas, T., Charman, T., Pickles, A., Simonoff, E., Chandler, S., Meldrum, D., & Baird, G. (2008). Autistic symptomatology and language ability in autism spectrum disorder and specific language impairment: Autistic symptomatology and language ability. Journal of Child Psychology and Psychiatry, 49(11), 1184–1192. https://doi.org/10.1111/j.1469-7610.2008.01951.x

Luchkina, E., & Waxman, S. (2021). Acquiring verbal reference: The interplay of cognitive, linguistic, and general learning capacities. Infant Behavior and Development, 65, 101624. https://doi.org/10.1016/j.infbeh.2021.101624

Malkin, L., Abbot-Smith, K., & Williams, D. (2018a). Is verbal reference impaired in autism spectrum disorder? A systematic review. Autism & Developmental Language Impairments, 3, 239694151876316. https://doi.org/10.1177/2396941518763166

Nadig, A., Vivanti, G., & Ozonoff, S. (2009). Adaptation of object descriptions to a partner under increasing communicative demands: A comparison of children with and without autism. Autism Research, n/a-n/a. https://doi.org/10.1002/aur.102

Nadig, A., Seth, S., & Sasson, M. (2015). Global similarities and multifaceted differences in the production of partner-specific referential pacts by adults with autism spectrum disorders. Frontiers in Psychology, 6. https://doi.org/10.3389/fpsyg.2015.01888

Norbury, C. F., & Bishop, D. V. M. (2003). Narrative skills of children with communication impairments. International Journal of Language & Communication Disorders, 38(3), 287–313. https://doi.org/10.1080/136820310000108133

Norbury, C. F., Gemmell, T., & Paul, R. (2014). Pragmatics abilities in narrative production: A cross-disorder comparison. Journal of Child Language, 41(3), 485–510. https://doi.org/10.1017/S030500091300007X

Novogrodsky, R. (2013). Subject pronoun use by children with autism spectrum disorders (Asd). Clinical Linguistics & Phonetics, 27(2), 85–93. https://doi.org/10.3109/02699206.2012.742567

Novogrodsky, R., & Edelson, L. R. (2016). Ambiguous pronoun use in narratives of children with Autism Spectrum Disorders. Child Language Teaching and Therapy, 32(2), 241–252. https://doi.org/10.1177/0265659015602935

Ohtake, Y., Wehmeyer, M. L., Nakaya, A., Takahashi, S., & Yanagihara, M. (2011). Repair strategies used by verbal students with autism during free play. Focus on Autism and Other Developmental Disabilities, 26(1), 3–14. https://doi.org/10.1177/1088357610396079

Olivar-Parra, J.-S., De-La-Iglesia-Gutiérrez, M., & Forns, M. (2011). Training referential communicative skills to individuals with autism spectrum disorder: A pilot study. Psychological Reports, 109(3), 921–939. https://doi.org/10.2466/10.11.15.28.PR0.109.6.921-939

Ostashchenko, E., Geelhand, P., Deliens, G., & Kissine, M. (2019b). Struggling with alternative descriptions: Impaired referential processing in children with Autism Spectrum Disorder. Research in Autism Spectrum Disorders, 66, 101414. https://doi.org/10.1016/j.rasd.2019.101414

Rossnagel, C. (2000). Cognitive load and perspective-taking: Applying the automatic-controlled distinction to verbal communication. European Journal of Social Psychology, 30(3), 429–445. https://doi.org/10.1002/(SICI)1099-0992(200005/06)30:3<429::AID-EJSP3>3.0.CO;2-V

Suh, J., Eigsti, I.-M., Naigles, L., Barton, M., Kelley, E., & Fein, D. (2014). Narrative performance of optimal outcome children and adolescents with a history of an Autism Spectrum Disorder (Asd). Journal of Autism and Developmental Disorders, 44(7), 1681–1694. https://doi.org/10.1007/s10803-014-2042-9

Tager-Flusberg, H. (1999). A psychological approach to understanding the social and language impairments in autism. International Review of Psychiatry, 11(4), 325–334. https://doi.org/10.1080/09540269974203

Tager-Flusberg, H., Paul, R., & Lord, C. (2005). Language and Communication in Autism. In F. R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), Handbook of autism and pervasive developmental disorders: Diagnosis, development, neurobiology, and behavior (pp. 335–364). John Wiley & Sons Inc.

Volden, J., Mulcahy, R. F., & Holdgrafer, G. (1997). Pragmatic language disorder and perspective taking in autistic speakers. Applied Psycholinguistics, 18(2), 181–198. https://doi.org/10.1017/S0142716400009966

Appendix A

Table 8 demonstrates a participant table in which all participants mentioned in the discussion are listed along with group (ASD or NT), age, and sex.

Table 8. Participant table

Participant	Group	Age (Years; Months)	Sex
1	ASD	12; 6	M
2	ASD	14; 3	M
3	ASD	12; 8	F
4	ASD	12;11	M
5	ASD	17; 2	M
6	ASD	10; 9	M
7	NT	12; 8	F
8	ASD	13; 9	F
9	NT	11; 6	M

Appendix B

Reference boards

The practice reference board differed in appearance from the experimental practice board. Practice items for this task included two green shapes that were also designed in PowerPoint. These two shapes each had 20 sides with a black triangle in its center, again, to point "up." A practice reference board was also created, with printouts of these shapes affixed to it, along with Velcro, so that the chair used in experimental trials could be affixed to this board for practice trials. Two more printouts of the practice shapes were used by the researcher during practice trials. Following the practice trials, RA2 replaced the practice reference board with the experimental reference board, and the same procedure continued.

Figure 4. Practice reference board vs experimental reference board