ABSTRACT

THE USE OF SPATIAL, TEMPORAL, AND METAPHORICAL TERMS BY CHILDREN WITH AUTISM SPECTRUM DISORDER

by Colleen Gail Scheible

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder impacting social communication. In people with ASD, social uses of language, including non-literal uses are often universally impaired. Prepositions are used in concrete ways as spatial concepts (e.g., *in* the house) and in abstract ways as temporal concepts (e.g., *in* the morning) or metaphorical concepts (e.g., *in* love). This study examined the production of prepositions by children with ASD. We predicted participants with ASD would exhibit difficulties with abstract uses of prepositions. Narratives of participants with ASD (N=19) and typical development (TD) (N=20), matched for language, age, and intelligence, were analyzed for the production of prepositions. We found TD participants produced significantly more prepositions and spatial prepositions than participants with ASD. However, contrary to our hypothesis, children with ASD did not produce fewer abstract terms than TD children. Number of prepositions was significantly related to the age of participants; older participants produced more prepositions than younger participants, suggesting a developmental trajectory. Severity of ASD symptoms was negatively related to the number of prepositions produced, although both ASD and TD participants used prepositions flexibly. These findings suggest prepositions may be an area of weakness for fluent children with ASD.

# THE USE OF SPATIAL, TEMPORAL, AND METAPHORICAL TERMS BY CHILDREN WITH AUTISM SPECTRUM DISORDER

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# Dedication

I'd like to dedicate this work to my loving and supportive family. Dad, your work ethic is admirable and I would not be the professional I am today without you as my role model. Mom, I am thankful for your encouragement, positivity and love during this process. Claire and Cole, you bring so much joy to my life and you are both truly my best friends. Thank you all for your unconditional love.

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# The Use of Spatial, Temporal, and Metaphorical Terms by Children with Autism Spectrum Disorder

## Language and Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by variable difficulties with social communication and interactions, along with restricted and repetitive behaviors (APA, 2013). Individuals with ASD demonstrate a range of language abilities from fluent language to minimally-verbal (Tager-Flusberg & Kasari, 2013). Despite the range of language abilities, difficulties in the pragmatic (social) uses of language are universal (Loukusa & Moilanen, 2009). Due to pragmatic difficulties, individuals with ASD experience difficulties in understanding figurative, non-literal uses of language and tend to make literal interpretations of figurative phrases (Adachi, Koeda, Hirabayashi, Maeoka, Shiota, Wright et al., 2004; Happé, 1993; Kerbel & Grunwell, 1998; Mashal & Kasirer, 2011; Rapin & Dunn, 2003; Rundblad & Annaz, 2010; Vogindroukas & Zikopoulou, 2011). Therefore, individuals with ASD often struggle to understand metaphors (Dennis, Lazenby, & Lockyer, 2001), idioms (Attwood, 2007), and sarcasm (Attwood, 2007). For example, the phrase, "*Who let the cat out of the bag*" could be confusing for someone with ASD because the literal meaning of the phrase (releasing a feline from a sack) does not provide clues for interpretation of the intended, metaphorical meaning (revealing a secret).

Spatial words (e.g., *in*) can be used to represent concrete ideas (e.g. *in the room*) and abstract concepts, like time (e.g. *in the morning*). Although many studies have explored how individuals with ASD interpret and use metaphors, idioms, and sarcasm, few studies have specifically explored the metaphorical and abstract uses of spatial language.

In this thesis, I will explore the uses of spatial, temporal, and metaphorical terms by children with ASD in order to understand if their usage is impaired or delayed compared to children with typical development (TD). Before we explore the possible differences in the use of spatial and temporal terms by children with ASD, we must first understand how spatial and temporal terms are expressed in English, and how children with typical development acquire them.

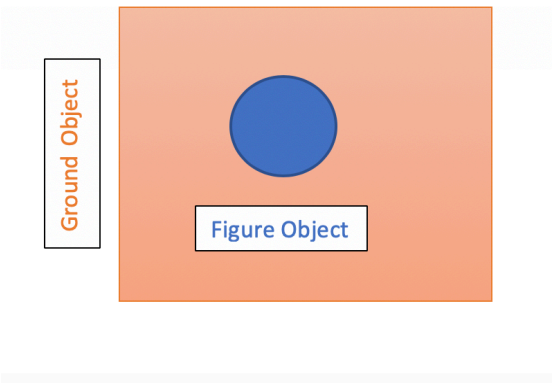
## Space in English

In English, spatial language refers to phrases that describe configurations between objects and movement of objects through space. Individuals use spatial language every day in order to

describe their location and to refer to the location of entities. Spatial language configurations often include a preposition. Prepositions are words that join or separate the relationship between two concepts (Johannes, Wilson, & Landau, 2016). Prepositions can be grammatical markers, such as *of*; can be used to describe spatial relationships such as *up* and *down*, *front* and *back*; or can describe movement of objects such as *into* and *out of*. In English, we use prepositions (e.g., *indoors*, *outdoors*) to help us understand directions more precisely, ask detailed questions about the locations of entities, and express ideas about physical movement in space.

In prepositional phrases, the preposition typically assists the listener to orient two objects being described to one another. These objects are described as the ground object and the figure object. The ground object is used as a reference point around which the figure object's position is described. The preposition's role is to describe the spatial configuration of the figure object in relation to the ground (Talmy, 1972). For example, in the phrase, '*the blue circle is in the orange box*' (Figure 1) the figure object would be the *circle* and the ground object would be the box. The preposition *in* is being used to reference the *circle* in relation to the *box*.

*Figure 1: Example Figure- Ground Relationship "The blue circle is in the orange box"*




Each preposition can be used to represent many different spatial relationships and can be quite different from one another. For example, the spatial referencing between *dog* and *porch* in the phrase *the dog is on the porch* is very different from the configuration between *button* and *pants* in the phrase *the button is on the pants*. To explain this, some scholars have proposed that prepositions have a core meaning and a peripheral meaning (Lakoff & Johnson, 1980). The core sense of a preposition is its primary meaning, while peripheral senses are extensions from that

core meaning. For example, consider the prepositions *in* and *on*. The core meaning of *in* refers to containment (e.g., *the ball is in the box)* and the core meaning of *on* refers to support (e.g., *the cup is on the table*). Additionally, both words *in* and *on* can be used to describe extensions from those more basic containment or support references. For example, in the sentence, *The bird is in the sky*, 'the sky' acts as a container for the bird, in that the bird is surrounded by the sky. However, unlike the previous example (*the ball is in the box*), the relationship between 'the bird' and 'the sky' is not a clear example of containment. This is because the ground object, 'the sky' does not have clear boundaries and is not typically considered an object whose function is containment like a box. Similarly, for *on*, in the sentence *The fan is on the ceiling, on* indicates a support relationship between 'the ceiling' and 'the fan', although 'the fan' is technically hanging from (under) the ceiling, rather than on top of it. When phrases like '*the bird is in the sky'* and '*the fan is on the ceiling'* are used, the containment reference of *in* and support reference of *on* are extended to relationships between objects that are not as clear examples of containment or support.

**Time in English**

Spatial uses of prepositions that were described above can be considered concrete, because the objects being referenced are visible in material or physical form and can be experienced directly. In addition to these concrete uses, prepositions are also used to describe abstract concepts such as time (Kemmerer, 2004; Boroditsky, 2000; Clark, 1973; Traugott, 1978). Although we are able to experience time by directly observing change, such as changes in sunlight that correspond to phases of the day (e.g., *night* or *morning*), such temporal concepts are not tangible. One cannot touch or hold *night* or *morning*. The distinction between *morning* and *afternoon* may be subtly observable, but ultimately time is a human abstraction. There are other temporal expressions that are even more abstract such as a *week*. In this case, there is not a directly observable start or end point to *week*, aside from the observable changes on a calendar.

We also use spatial prepositions to assist in communicating other temporal ideas (Levinson, 2003). For example, sentences such as *The party is on Wednesday* and *We are leaving in the morning,* use the prepositions *in* and *on* to describe the relationship between events and temporal concepts, rather than the spatial concepts of containment and support. But why are spatial terms, like prepositions, used to describe time? There is evidence that as English evolved through history, words that originally held only spatial meaning were gradually extended to

represent temporal concepts (Kemmerer, 2004). For example, the words *before* and *after* were historically used to describe spatial locations. The archaic sentence, *I am standing before the doo*r is synonymous to the contemporary sentence, *I am standing in front of the door*. Over time, both *before* and *after* were used to describe temporal concepts and eventually lost their spatial sense altogether.

Following Clark (1973), Lakoff and Johnson (1980) explained that humans use concrete language to talk about abstract concepts in order to understand them. In this way, spatial language aids humans' understanding and communication of abstract concepts (Levinson, 2003). Using spatial terminology to organize abstract ideas may not only be a feature of language. Some have argued that it is a cognitive process that shows conceptualization and application of concrete knowledge onto abstract ideas (Gentner & Boroditsky, 2001; Gentner, Imai, & Boroditsky, 2002).

The use of concrete, spatial terms to describe abstract concepts, like time, may be metaphorical. In fact, Lakoff and Johnson list hundreds of metaphorical concepts such as *time is a stationary object* to explain thousands of English expressions (e.g., *as we go through the years*) (Lakoff & Johnson., 1980, pp. 42-43).

If we are indeed metaphorically applying spatial concepts onto time in order to talk about time, it would follow that communicating about time requires an understanding of spatial concepts and terms (Boroditsky, 2000). Given this close relationship, we would expect children to acquire spatial terms before they can extend the use of those terms to temporal (and other abstract) uses of the same terms.

**How do typical children acquire spatial terms?**

The acquisition of spatial language in children is influenced by the complexity of the concepts being learned (Johnston & Slobin, 1979; Johnston, 1988*)*. The concepts expressed by terms such as *in*, *on, into* and *out of* (i.e., containment, support, entering, and exiting, respectively) are typically acquired relatively early. In contrast, concepts such as *across, over, through,* and *between*, are acquired later. The acquisition patterns of prepositions seem to reflect the core uses of prepositions. For example, prepositions *in* and *on* tend to appear early in children's vocabulary, but their uses tend to be examples of more straightforward containment and support relations. Children start to use and understand phrases such as *apple in the bowl* and

*cup on the table* as early as two years of age (Johannes et al., 2016; Meints, Plunkett, Harris, & Dimmock, 2002; Johnston et al., 1979).

In Brown's Table of Morphemes, Roger Brown (1973) provides ages at which early grammatical morphemes are typically mastered. Mastery is defined as the age when words are correctly used 90% of the time. According to Brown (1973), the word *in* is typically mastered between 27-30 months, while the word *on* is typically mastered between 27-33 months of age. Longitudinal data showed that though comprehension of prepositions comes before production, children as young as 19 months were producing the preposition "*on*" (Friedman & Seely, 1976)

As children get older, their use and understanding of prepositions broadens beyond the core sense and it can take many years for them to master all of the spatial senses of prepositions. For instance, Johannes et al. (2016) completed a study that explored how 4 and 6-year-olds use basic spatial expressions (*is in*, *is on*) across subtypes of containment and support compared to adults. They found that a child's ability to use phrases such as *is in* and *is on* in different ways continues to develop beyond the age of 6 (Johannes, et al, 2016).

Similarly, Durkin (1978) studied the use of *above* and *below* that found children ages 3-7 years continue to make errors in the use of these prepositions. The types of errors varied according to context but provided evidence that children are continuing to develop the terms *above* and *below* through 7 years of age (Durkin, 1978). These findings suggest that the acquisition of spatial language develops over quite a long period of time. In general, the relationship between children's use of spatial prepositions increases with age; as a child gets older they tend to use a wider range of spatial prepositions in their language (Grant 1915, Young 1941).

**How do typical children acquire temporal terms?**

Children's development and use of prepositions to describe spatial concepts typically appears before they begin to use the same prepositions to talk about time (Boroditsky, 2000; Richards, 1979). As explained above, this suggests that children must understand spatial concepts before they can use spatial terminology to discuss and refer to temporal or metaphorical concepts.

Studies have demonstrated that children demonstrate difficulty with not only the use of temporal language but also its comprehension (Busby & Suddendorf, 2005; Suddendorf, 2010). Children typically begin to acquire terms for temporal concepts between the ages of 18 months

to 2 years. They tend to use deictic words such as *yesterday* and *tomorrow* as early as 2-3 years of age, although they make general statements with many errors when using these early words due to the ambiguous nature of these words (Ames, 1946; Busby Grant, & Suddendorf, 2011). Children struggle to use and understand these deictic words not only because their abstract nature, but also because they are unfixed and changeable. For example, the meaning of deictic words are always changing; Monday's *tomorrow* is different from Thursday's *tomorrow*. The acquisition of these words poses great challenges to English-learning children as research shows the gap between the first uses of deictic time words around 3 years of age and eventual mastery of these words in elementary school (Ames, 1946; Busby et al., 2011; Harner, 1975; Harner, 1981). Additionally, early references of time refer to events (Christmas, birthdays), actions (going to school, playing sports) familiar to the child and their experiences (Ames, 1946; Antinucci & Miller, 1976; Eisenberg, 1985; Sachs, 1983; Veneziano & Sinclair, 1995). The developmental difficulties children demonstrate with acquiring temporal language are due to the underlying abstract quality of time as a concept.

Although children initially differ from adults in the way they use temporal terms, they tend to use words systematically when referencing time (Tillman et al., 2017). Until the development of temporal language is complete, children rely on concrete examples revolving around daily activities and interests to assist in comprehension of time. Children often link temporal expressions to activities such as school time or bedtime as the comprehension of conventional time gradually develops (Weist, 2002). Furthermore, Rice (1999) identified additional factors influencing the onset of temporal phrases including the frequency of input from communication partners and the use of favorite expressions or fixed phrases, revolving around daily routines of eating, bathing, napping, toileting, or shopping. In short, it is essential for children to first understand and use concrete concepts (such as space) to understand and talk about time, similar to adults.

**Acquisition and use of spatial and temporal terms in ASD**

There is contradictory evidence and mixed results about possible impairments in spatial working memory (Wang et al., 2017), visual perspective taking (Pearson, Ropar, & de C. Hamilton, 2013), and spatial navigation (Smith, 2015) for individuals with high functioning autism. An early study by Ohta (1987) found that individuals with HFA performed lower on spatial comprehension tasks than their TD peers. There is limited data on this topic, suggesting a

wide range of abilities but also supporting the hypothesis that children with ASD may struggle to extend the same prepositions to multiple situation due to impaired or disordered spatial cognition.

Despite a general lack of research into how children with ASD acquire and use spatial and temporal terms, early research completed by Churchill (1972) reported that children with ASD have difficulty in the acquisition of prepositional phrases expressing spatial relationships. Other early work examined the spontaneous speech of 20 children with ASD and found that over half of the children showed varying language difficulties with prepositions including omitting them in phrases and using prepositions such as *up* and *down*, *front* and *back,* and *left* and *right* to describe spatial relationships incorrectly (Wing, 1969). Following that study, Ricks and Wing (1975) later concluded that children with ASD have an overall impairment in the comprehension and production of complex symbolic functions of language for communication.

Later, Menyuk and Quill (1985) described some concepts that were frequently difficult for children with ASD. They argued that children tend to have difficulty using words with multiple related meanings and will instead assign one meaning to a word. As described above, prepositions are just this kind of word. They have a core sense and a related, but different, extended sense. As a result, a child with ASD may understand the phrase, "*the cup on the table*" and relate the word "on" to meaning support, but struggle to understand why "on" is used in the phrase, "*fan on the ceiling*". Consequently, children with ASD may really struggle when "on" is used to describe abstract, temporal (metaphorical) relationships, such as in the phrase "*school is on Monday*".

More recently, a group of scholars has begun investigating more subtle uses of spatial language in children with ASD and have concluded that there is evidence that children with ASD struggle with spatial uses of prepositions. Bochynska, Coventry, Vulchanov, & Vulchanova (submitted) examined the spatial language abilities in 25 individuals with high-functioning autism and 25 TD individuals, matched for age and cognitive abilities. The study concluded that individuals with high functioning ASD demonstrated difficulties with the production of spatial terms. Although they were unable to determine the variable influencing the differences, they were able to conclude that verbal abilities did not explain the differences in spatial language between the two groups. Furthermore, these researchers also found that individuals with ASD demonstrated difficulties with proximal terms such as *far* and *near*, projective prepositions such

as *left* and *right* and directional terms such *into* and *out of* (Bochynska, Vulchanova, Vulchanov, & Landau, unpublished manuscript).

Additionally, there is an argument that children with ASD specifically struggle with prepositions that have multiple meanings. More specifically, children with ASD are able to use and understand the core meaning of prepositions but struggle to use and understand extensions of these same prepositions. Bochynska, Vulchanov, & Vulchanova, (submitted) investigated the differences in core uses of *in* as a container and *on* as support compared to extended use of *in* and *on* by children with high functioning ASD. They tested 23 children with high functioning ASD and 23 TD children matched on age and cognitive abilities. They found that individuals with high functioning ASD overall scored lower on peripheral tasks compared to the TD groups. The study also found that different factors predicted the mastery of *in* and *on* in the testing groups; age was the best predictor for the TD participants, while language abilities was the best predictor of performance for individuals with high functioning ASD.

Therefore, if children struggle in particular with extensions of prepositions, and if temporal uses of prepositions are metaphorical extensions from the core, spatial sense, then it can be predicted that children with ASD may struggle particularly with temporal uses of prepositions. To our knowledge, there has been no research to-date on the use of temporal terms by children with ASD. However, given the difficulties that children with ASD have with non-literal uses of language, we hypothesize that children with ASD and intact language abilities could demonstrate difficulties with metaphorical uses of spatial and temporal language. The purpose of this thesis is to explore the question, do children with ASD, intact language and average intelligence will struggle with abstract uses of prepositions, such as temporal terms and metaphorical terms.

## Method

### Participants

Participants for the study were children with and without ASD between the ages of 10 and 18 years. The participants were divided into two groups: typically developing participants (n=20) and participants with ASD (n=19). The Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) was used to confirm the diagnosis of ASD of participants within the ASD participant group (Lord, Rutter, et al., 2012). Individuals who scored autism or autism spectrum disorder on the ADOS-2 received a score at or above the threshold for autism (7 for ADOS-2

Module 3 and Module 4). The mean ADOS-2 score was 11.5, with scores ranging from 7-20, and a standard deviation of 3.22. The Social Communication Questionnaire (SCQ) was used to confirm that the children in the TD group were not at risk for ASD (Rutter, Bailey, & Lord, 2003). A score of 14 or below indicate children are not at risk for the diagnosis of ASD. The mean SCQ score for the TD group was 2.3, with a range from 0-5 and a standard deviation of 1.34.

The two groups were matched for chronological age, language as indicated by standardized language test scores, and nonverbal intelligence. The Clinical Evaluation of Language Fundamentals-5 (CELF-5) was used to determine the language abilities of the participants and the Kaufman Brief Intelligence Test (KBIT) was used to determine nonverbal intelligence scores of the participants. T-tests revealed there was not a significant difference between the groups for chronological age ($t(37)=.16$, $p=.87$), language ($t(37)=.11$, $p=.92$), or nonverbal intelligence ($t(37)=-.33$, $p=.74$). Average chronological age, CELF-5 scores and KBIT scores are listed (see Table 1). There was no relationship between autism severity score and age ($r(37)= -.06$, $p= .73$), language ($r(37)= -,15$, $p=.36$) and nonverbal intelligence score ($r(37)=-.08$, $p=.65$).

Table 1

*Mean Demographics of Participants*

| Participants (n=39) | Mean Age in Years | Mean CELF-5 | Mean KBIT |
|---|---|---|---|
| TD Participants (n=20) | 13.8 (2.34) | 109 (10.67) | 110.0 (11.92) |
| Participants with ASD (n=19) | 13.7 (2.21) | 106 (19.99) | 109.95 (20.84) |

**Procedure**

Participants were given a narrative task using the Trier Social Stress Test, a procedure used to induce a high- stress environment and measure physiological effects. (Birkett, 2011; Kirschbaum, Pirke, & Hellhammer, 1993). The data were recorded at Emerson College by researchers who were interested in comparing physiological reactions to socially stressful situations between typically developing children and children with ASD. The main objective of the study completed at Emerson was to analyze and compare physiological reactions to stress between the TD participants and participants with ASD. Although the study did not involve

analyzing language skills in these children, the study did yield spontaneous language samples from both participant groups during with consistent and controlled conditions. Fortunately, since all participants were subjected to the same procedure, we can assume similar levels of stress between groups, and we can compare language behaviors between groups. All participants were given the same prompt. They were given an opening to a story and were told they would need to come up with the rest of the story. They were instructed that they would have five minutes to prepare this story, and that they would then perform their full story in front of a panel of judges. Participants were told they could create notes during their five-minute preparation time, but they would not be able to use those notes during their performance.

**Story Prompt**: *Yesterday, my best friend Robert and I went home from school. Suddenly, we had the idea to visit Mr. Greg who lived in the big old house located in the dark forest near our town. Mr. Greg was a crazy old man and our parents didn't like the idea that we sometimes went to visit him. There was a rumor in town that there was a mystery about the old house. When we arrived at the house we were surprised that the door was open. Suddenly, we heard a strange noise and cautiously, we entered the dark hall...*

After five minutes, participants were brought into a room, where they saw three judges on a computer screen. They were told that these judges were live on Skype, but participants were actually shown a pre-recorded video of three people, that was edited to look like a live Skype call (see Figure 2).

*Figure 2. Screenshot of fake Skype call presents to participants*

To make the video resemble a live call, the video contained moments when the research assistant appeared to "interact" with the judges. The research assistant would turn to the computer screen at predetermined moments and ask the judge a question. The judge would then "answer" this question as though they had heard the research assistant. The children were not actually being evaluated during the Skype call, but the experiment successfully created an illusion of live judgement. Even though this paradigm was designed to induce stress, the effect of this stress is not of interest for this project's research question and analysis. Participants were instructed to stand in front of the judges for three minutes and tell their stories. If a participant's story ended before three minutes were up, the research assistant would ask them to try to add more to their story. This allowed for each sample to be of consistent duration for each child. During the three minutes, the participants' stories were audio- and video-recorded.

**Coding**

These three-minute audio recordings were transcribed by undergraduates at Miami University using *ELAN* transcription software (Wittenburg, Brugman, Russel, Klassmann, Sloetjes, 2006). The transcriptions were refined by two transcribers for consistency using the following procedure. Each transcription was transcribed once by an undergraduate student and was then re-transcribed blindly by a second undergraduate student. Coding guidelines were designed and were compiled into a single reference document. Coders relied on that document to determine coding criteria for each sample. Whenever a coder encountered a word or phrase in the sample for which coding wasn't straightforward, the coder would bring that word/phrase to a coding team meeting, and a group decision was made. Once transcriptions and prepositional codes were deemed to be accurate, the transcribed stories were exported into Microsoft Excel files for additional identification of spatial and temporal terms. The first step was to identify all the prepositional phrases used. Then, we determined whether the phrase would be included for further analysis. Most prepositional phrases were included, but some prepositions were excluded altogether because they are never used spatially or temporally (e.g., *of* or *for*). Other prepositions were included only when they were actually acting as prepositions (e.g., heading a noun phrase). Uses were excluded when the preposition was used as a particle in a phrasal verb (e.g., *he threw the trash out*) or when *to* was used to mark an infinitive (e.g., *I want to talk to him*). Table 2 presents prepositions included in and excluded from coding, along with uses that were excluded.

Prepositions that were not used in a spatial or temporal way were eliminated from coding to allow to specific analysis of only spatial and temporal prepositions (see Table 2).

Table 2

*Prepositions Included and Excluded from Coding*

| | |
|---|---|
| Spatial Prepositions Included | |
| Spatial prepositions | Above, across, against, along, alongside, amidst, amongst, around, at, atop, behind, below, beneath, beside, between, betwixt, beyond, by, down, from, in, inside, into, near, nearby, off, on, onto, opposite, out, outside, over, past, through, throughout, to, toward, under, underneath, up, upon, via, with, within, without |
| Spatial compound prepositions | Far from, in back of, in between, in front of, in line with, on top of, to the left of, to the right of, to the side of |
| Intransitive prepositions | afterwards, apart, away, back, backward, downstairs, east, forward, here, inward, left, north, outward, right, sideways, south, there, together, upstairs, upward, west |
| Temporal Prepositions Included | |
| Always temporal prepositions | Ago, after, before, during, since, until |
| Prepositions Excluded | |
| Prepositions | As, because of, despite, like, of |
| Uses of Prepositional Forms Excluded | |
| Verbs using "to" to mark an infinitive form | Phrases such as "I wanted to walk" … "listening to music" |
| Prepositions used as particles, as part of a phrasal verb | "Parents were mad at us"<br>"Popped up"<br>"Clicked it on"<br>"Write them down" |

Prepositional phrases were identified and classified into two categories: concrete or abstract, and spatial, temporal or metaphorical. The second step was to identify each

prepositional phrase as either concrete or abstract. Concrete prepositions were always coded as spatial uses, but abstract prepositions were coded as either temporal or metaphorical uses. Therefore, the next stop was identifying whether abstract uses were temporal (e.g., *I'll be there in a minute*) or some other kind of metaphorical, abstract use (e.g., *I am in love*). We labeled these latter phrases "metaphorical". The last step was identifying times when the child used the preposition in an unconventional way, so that we could compare atypical uses of prepositions between participant groups. The phrases in Table 3 are examples of how phrases were coded as concrete or abstract and how they were coded as spatial, temporal, or metaphorical (see Table 3).

Table 3

*Examples of Completed Coding*

| Phrase | Concrete or Abstract | Spatial, Temporal, or Metaphorical | Unconventional Uses |
|---|---|---|---|
| ***From the ceiling, inside the house, up to your room*** | Concrete | Spatial | No |
| ***The floor was cracking underneathing*** | Concrete | Spatial | Yes |
| ***In the past, in a few, after this*** | Abstract | Temporal | No |
| ***I seen he went through the gunshots*** | Abstract | Metaphorical | Yes |
| ***In despite, from our lives, in trouble*** | Abstract | Metaphorical | No |

**Reliability**

A second coder was recruited to blindly code half of the total number of speech samples for inter-rater reliability. A coding guide was created and included instructions on how to code the prepositional phrases according to the parameters outlined in the methods. The student was instructed to follow the coding guide and identify the prepositional phrases within the stories and label then as being either a) concrete or abstract, b) spatial, temporal, or metaphorical, and c) identify any unconventional uses or errors. In the first round of recoding half of the language samples, discrepancies between the two coders were identified and were used to modify and

improve the coding scheme. Then, the second coder recoded the other half of the samples (n=20). The second coder then categorize the prepositional phrases as explained above (concrete or abstract, spatial, temporal, or metaphorical, and identify unconventional or errors) for the second half of the samples. The second round of coding completed by myself was then cross-examined with the coding completed by our second coder. Errors were identified and 421 out of 435 preposition categorizations agreed, for an inter-rater agreement of 96%.

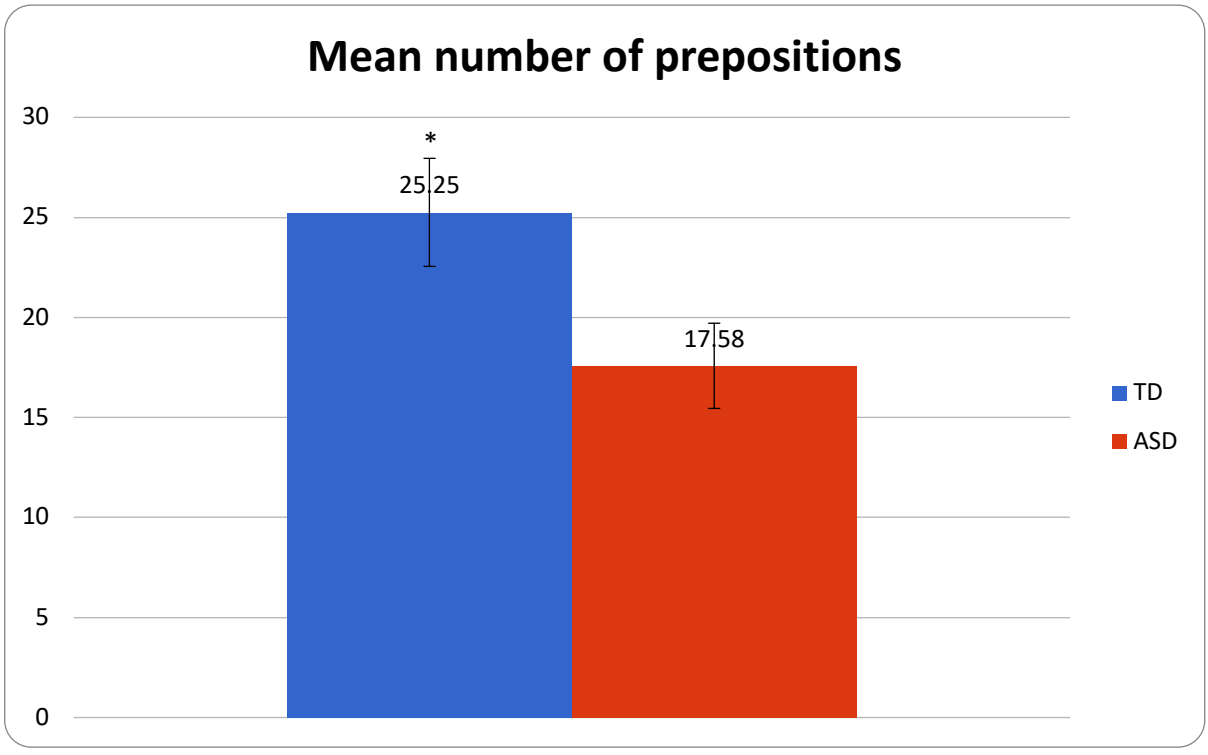
## Results

The purpose of this study was to examine the production of spatial, temporal, and metaphorical prepositions in children with ASD with average intellectual and linguistic abilities. Length of narratives did not differ between groups (TD: M=411.75, SD=100.77, range 193-567; ASD: M=342.67, SD=141.45, range 83-571; (t(37)=1.78, p=. 08), showing that children with ASD and TD produced similar length narratives with the alluded time.

### Comparison of Total Prepositions

Overall, TD children produced significantly more prepositions (M=25.25, SD=12, range 3-51) than children with ASD (M=17.58, SD= 9, range 1-36; *t*(37)=2.27, *p*=.03), see Figure 3.

*Figure 3. Mean number of total prepositions produced*

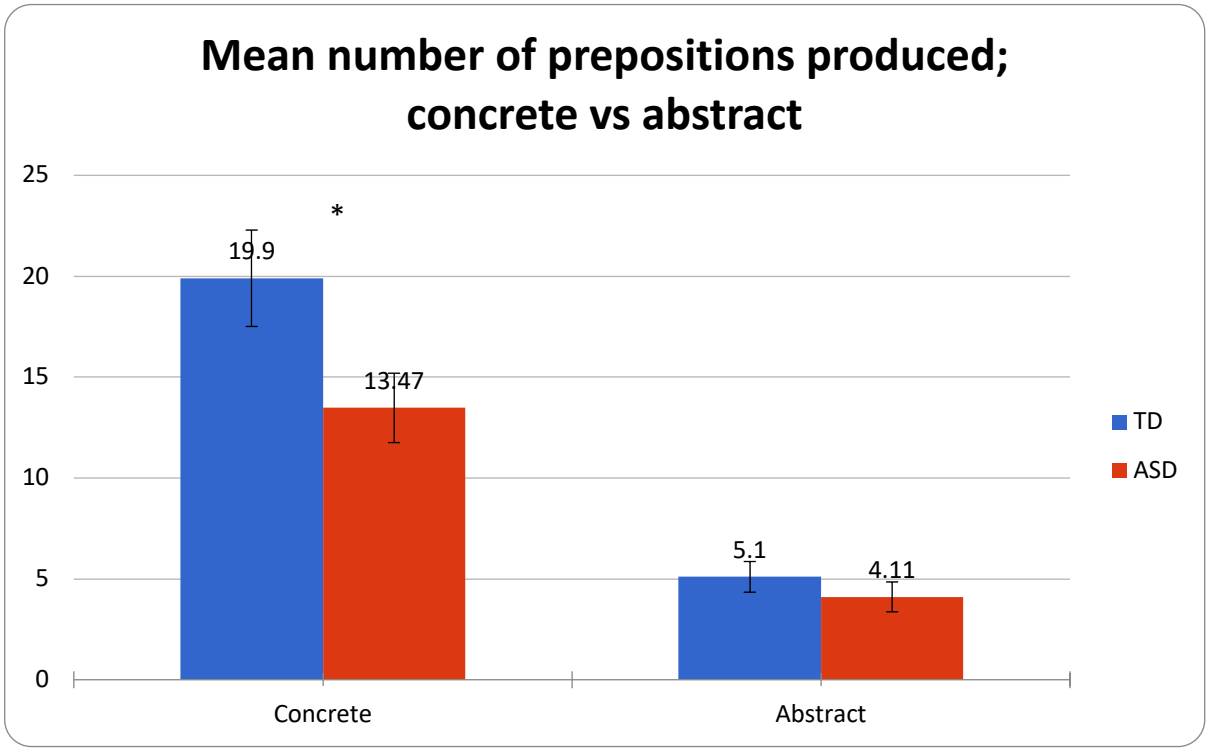


Additionally, the number of different prepositions produced by each participant was calculated. TD children (M=12.2, SD= 4.29, range 3-19) produced more unique prepositions in their narratives compared to children with ASD (M= 8.68, SD= 4.12, range 1-18; $t(37)=2.61$, $p= .01$).

**Comparison of Concrete and Abstract Terms**

To further analyze this result, prepositions were divided into concrete and abstract terms. TD children produced significantly more **concrete** terms (M=19.95, SD= 10.67, range 2-44) than children with ASD (M=13.47, SD= 7.5, range 1-30; $t(37)=2.20$, $p=.04$). However, there was no significant difference in the total number of abstract terms produced between the TD (M=5.25, SD=3.4, range 0-13) and ASD (M=4.11, SD= 3.21, range 0-14) groups ($t(37)=1.07$, $p=.36$), see Figure 4.

*Figure 4. Mean number of prepositions produced; concrete vs abstract*

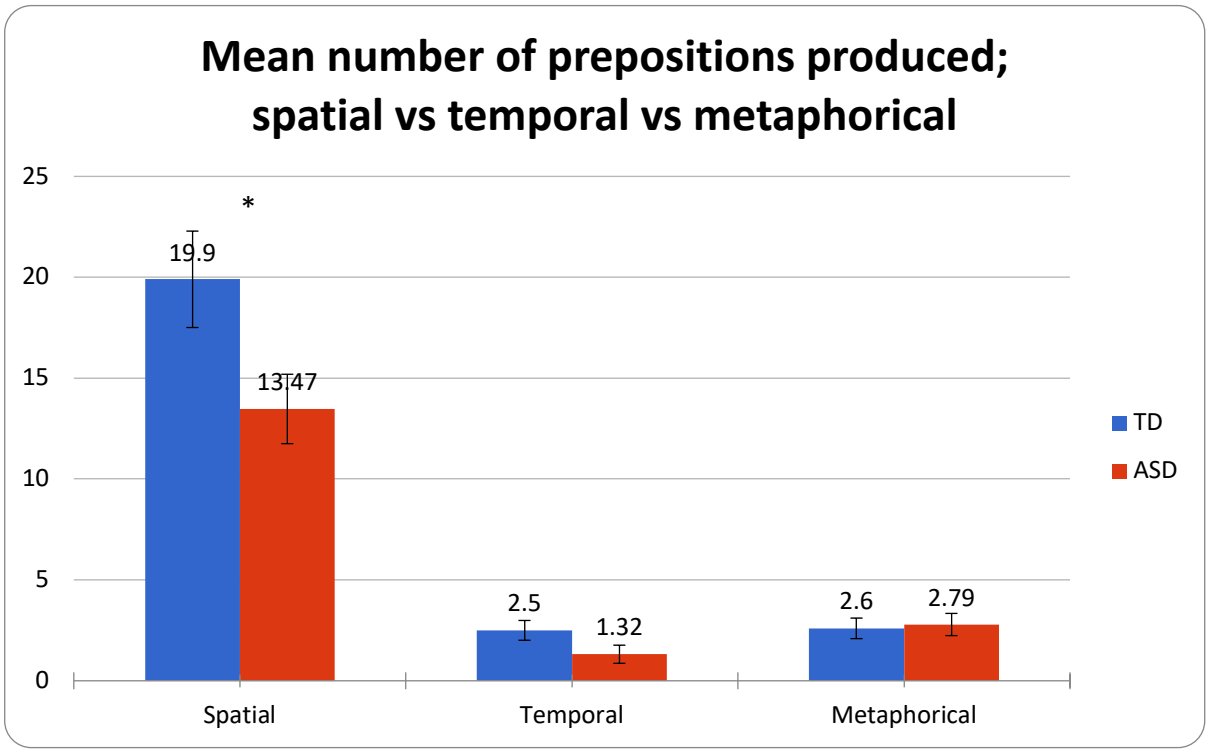



**Comparison of Spatial, Temporal, and Metaphorical Terms**

The total prepositions were separated into spatial, temporal, and metaphorical uses. There was a significant difference in the use of **spatial** terms between TD and ASD participants (F (1,37) =4.76, $p=.04$). There were no significant differences in the use of temporal (F (1,37)

=1.39, *p*=.25), or metaphorical (F (1,37) =.23, *p*=.63) terms between TD and ASD participants (see Figure 5).

*Figure 5. Mean number of prepositions produced; spatial vs temporal vs metaphorical*




**Individual Prepositions Produced**

In order to determine if there were any differences in specific word production between groups, we completed a one-way analysis of variance (ANOVA) to identify significant differences between the means of individual prepositions produced by subject. Out of all the prepositions produced, the only word that was significantly different between the TD and ASD group was *into* (F (1,37) = 5.97, *p* = .02). The word *to* approached significance (F (1,37) = 3.83, *p* = .06). The words *by, under, across,* and *ago* were only produced once within the sample so an ANOVA analysis could not be completed (see Table 4).

Table 4

*Analysis of Individual Preposition Production*

| | TD | ASD | F | *p* |
|---|---|---|---|---|
| *In* | 4.37 (2.89) | 4.25 (2.21) | F(1,37) = .02 | .89 |
| ***Into*** | **2.71 (1.32)** | **1.43 (.54)** | **F(1,37) = 5.97** | **.02** |
| ***To*** | **3.16 (2.01)** | **1.91 (.83)** | **F(1,37) = 3.83** | **.06** |
| *On* | 1.69 (.94) | 2.67 (1.87) | F(1,37) = 2.61 | .12 |
| *Through* | 1.82 (.98) | 2.00 (1.29) | F(1,37) = .12 | .74 |
| *Inside* | 2.83 (2.14) | 1.83 (1.17) | F(1,37) = 1.01 | .34 |
| *Down* | 1.63 (1.06) | 1.25 (.50) | F(1,37) = .44 | .53 |
| *From* | 1.40 (.70) | 2.17 (1.27) | F(1,37) = 2.91 | .10 |
| *Up* | 2.14 (1.07) | 1.00 (0) | F(1,37) = 3.20 | .11 |
| *Upstairs* | 1.25 (.46) | 1.00 (0) | F(1,37) = .26 | .63 |
| *Behind* | 1.17 (.41) | 1.67 (.58) | F(1,37) = 2.33 | .17 |
| *Outside* | 1.75 (.96) | 1.00 (0) | F(1,37) = 1.75 | .24 |
| *Out* | 1.42 (.67) | 1.75 (.89) | F(1,37) = .92 | .35 |
| *Over* | 1.40 (.55) | 1.00 (0) | F(1,37) = 1.50 | .27 |
| *Back* | 2.50 (2.12) | 1.50 (.58) | F(1,37) = .97 | .38 |
| *Around* | 1.80 (1.32) | 1.88 (1.13) | F(1,37) = .02 | .90 |
| *Forward* | 1.50 (.71) | 2.50 (2.12) | F(1,37) = .40 | .59 |
| *After* | 1.63 (.74) | 2.17 (1.60) | F(1,37) = .72 | .41 |
| *Toward* | 1.00 (0) | 1.50 (.58) | F(1,37) = .60 | .50 |
| *With* | 1.40 (.55) | 3.00 (2.12) | F(1,37) = 2.67 | .14 |
| *For* | 2.00 (2.00) | 1.20 (.45) | F(1,37) = .75 | .41 |
| *There* | 2.43 (1.34) | 2.78 (2.11) | F(1,37) = .24 | .63 |
| *Here* | 1.25 (.50) | 1.67 (1.16) | F(1,37) = .44 | .54 |
| *At* | 2.00 (1.16) | 1.40 (.70) | F(1,37) = 2.18 | .15 |
| *About* | 2.00 (1.50) | 2.00 (1.41) | F(1,37) = .00 | 1.00 |
| *Since* | 2.00 (1.42) | 1.00 (0) | F(1,37) = .33 | .67 |

**Correlations between Prepositions and Demographic Characteristics**

In addition to testing the differences between the number and types of prepositions produced by the two groups, we were curious about the influence that age, intelligence, language, and autism severity may have on the quantity of prepositions produced. We calculated Pearson product-moment correlation coefficients to compare the relationship between the number of prepositions produced and age, intelligence, language and autism severity scores. There was a strong correlation between number of prepositions produced and age ($r(37)=0.39$, $p=0.014$), indicating that older participants, both TD and ASD, produced more prepositions than younger children.

Once prepositions were separated into spatial, temporal, and metaphorical terms, age was significantly related with spatial ($r(37)=.34$, $p=.03$) and temporal ($r(37)=.32$, $p=<.05$) production but not metaphorical ($r(37)=.20$, $p=.23$), indicating older children produce more spatial terms as well as temporal terms.

There was a negative correlation between SCQ scores and number of prepositions produced $r(37)=-.38$, $p=.01$), indicating that the more severe the autism symptoms (higher SCQ score), the fewer prepositions were produced. CELF-5 scores, indicating overall language abilities, and KBIT scores, indicating overall nonverbal intelligence were not significantly correlated with the number of prepositions produced (CELF-5: $r(37)=-0.06$, $p=.67$; KBIT: $r(37)=-0.03$, $p=.86$).

To investigate the possible explanations for differences in preposition production, all subjects were divided into two groups; high preposition producers and low prepositions producers. To do so, the mean number of prepositions of all subjects was calculated (M=21.51, SD=11.35, range 1-51). The groups were then divided into those who produced 4 or fewer than the mean (<17) or more than 4 above the mean (>25). This eliminated the middle area of participants who were close to the average in order to better compare high-and-low preposition producing participants. We ran an ANOVA analysis to determine if high producers and low producers differed in terms of age, CELF-5 scores and intelligence scores. The high producers were significantly older than low producers. The two groups did not differ in terms of language and intelligence (see Table 5).

Table 5

*Descriptive Characteristics: High vs Low Preposition Producing Participants*

| | Mean number of prepositions | Mean Age | Mean CELF-5 | Mean KBIT |
|---|---|---|---|---|
| High- producers (n=16) | 33.13 (6.6) | 15.21 (1.95) | 107 (11.85) | 108.13 (13.61) |
| Low-producers (n=16) | 11 (4.2) | 12.98 (1.88) | 109.63 (16.69) | 111.38 (20.01) |
| F | 128.01 | 10.84 | .26 | .29 |
| *p* | .000 | .003 | .62 | .60 |

**Flexible Use of Prepositions**

We counted the number of children who used at least one preposition in more than one way, demonstrating the ability to use prepositions flexibly (i.e., the same word was used both spatially, temporally, or metaphorically). Out of each group, 12 TD children and 13 children with ASD used at least one preposition flexibly. There was no difference between the two groups ($X^2$(1, N=39) = 0.30, $p$=.58), indicating that both children with ASD and TD were able to be flexible with their prepositions.

**Unconventional Uses**

Out of all of the samples (n=39), 10 (TD=4, ASD=6) of the participants produced a preposition or prepositional phrase in an odd or unconventional way. There was no difference between the two groups ($X^2$ (1, N=39) =1.36, $p$=.24). There were four patterns observed. The first pattern was the invention of new words, or more specifically, using prepositions as verbs. For example, a TD participant used the word "*underneathing*" in the phrase, "*the floor was cracking* ***underneathing***" as a way to describe the location of an object. The second pattern was participants doubling prepositions to convey an idea. For example, a participant with ASD used "*inside into*" in the phrase, "*we were trapped* ***inside into*** *the darkness*". The third and most common unconventional pattern, which was only produced by children with ASD, was the creative and idiosyncratic use of prepositions. For example, the following phrases were produced by a participant with ASD:

1. "***Within*** *his body, I see- I seen he went* ***through*** *the gunshots, the violence/* ***at*** *all with its terror of my mistakes, I feel comformity with myself, we've all been* ***through*** *terrors, getting shot down by a sniper* ***in*** *the day of normady"*

2. *"my master has passed away but transferred his soul **into** me/ she put her soul **into** me"*
3. *"quite an amazing GPS it's **in** a task that costs several hundred dollars"*
4. *"**In** the darkness I'd go **forward**, and then I had turned **around**, He's protecting it **from** the fear monsters, Suddenly, the floor blenea- **beneath** me dropped"*

Lastly, both participants with ASD and TD used prepositions in an ungrammatical way, causing the phrase to sound odd and unconventional. Examples of these are, "*in* despite"- TD, "*parents come **in** day*"- ASD, and "***to** where the old man was*"- TD.

## Discussion

Contrary to our hypothesis (i.e., that children with ASD may struggle with temporal and metaphorical uses of prepositions), we found that children with ASD did not differ from TD children in their production of temporal or metaphorical terms but did produce fewer prepositions overall. When prepositions were divided into categories, TD participants produced more concrete/spatial terms than children with ASD. This finding correlates with previous research by Churchill (1972) reporting that children with ASD have difficulty in the acquisition of prepositional phrases expressing spatial relationships. In addition to producing significantly more spatial prepositions, TD participants also produced a greater number of different prepositions within their narratives.

One theory that might support this finding is individuals with high functioning autism (HFA) may have impairments with spatial cognition, particularly in spatial working memory (Lai et al., 2017; Wang et al., 2017) and spatial navigation (Lind, Bowler, & Rober, 2014; Lind, Williams, Raber, Peel, & Bowler, 2013), which underlie spatial language. One explanation for fewer spatial prepositions in the ASD group is that children with ASD may have difficulty in conceptualizing and producing spatial terms.

A second theory that could explain these differences in preposition production is the idea that TD children may have more sophisticated narrative abilities. Prepositions help tell a story; they set the scene of a story by highlighting time, place or direction, and they help the listener conceptualize and link events within a story. Spatial prepositions help to paint a picture of the story in the listener's mind. Studies have described that children with ASD have difficulties producing narratives, particularly with qualitative aspects of storytelling (i.e., narrative structure and complexity) (Loveland et al., 1990; Norbury and Bishop, 2003; Diehl et al., 2006). One

study analyzed specific narrative skills of individuals with high functioning autism (HFA) and found that children with ASD produced fewer coherent narratives when compared to their TD peers (Ferretti et al., 2018). Additionally, there is evidence that individuals with ASD may be less likely to use expressions that add substantial detail to stories, including setting the scene, sequencing events, providing conflict and resolution, and provided a cohesive ending (Colle et al. study).

There was a negative relationship between SCQ scores and preposition production, indicating that the children with more severe autism symptoms produced fewer prepositions. Although the two groups were matched for intelligence and language, it is possible that prepositions are an area of weakness and are difficult for children with ASD to conceptualize and master. It is possible that this negative relationship is again related to narrative skills of children with ASD. There was no statistical difference between length of narratives, however, children with ASD produced on average 343 words, while TD participants produced 412 words. Children with ASD may have been speaking more slowly than their TD peers, and as a result, produced fewer words and prepositions.

An analysis of the relationship between age, intelligence, and language scores revealed that age was the only contributing factor that influenced the number and types of prepositions produced. The younger participants in the study produced significantly fewer overall prepositions regardless of diagnostic identification. The younger participants also produced fewer spatial and temporal prepositions, but not metaphorical prepositions within their narratives than the older participants. This finding is supported by the developmental trajectory outlined in the introduction. It takes neurotypical children quite a long time to acquire and master the use of prepositions, and temporal uses tend to come after spatial prepositions (Boroditsky, 2000; Richards, 1979). As a result, preposition production increases with age as children acquire and learn how to properly use prepositions within their language. This aligns with our finding that the older children did, in fact, use more spatial and temporal prepositions in their narratives. There were no differences in metaphorical preposition production between older and younger participants, possibly because there were too few instances within the narratives to show a significant difference.

Standardized language and intelligence scores were not related to the amount or types of prepositions produced. It is possible that the CELF-5 scores did not capture the differences in

prepositions shown in our study. We used four subtests from the CELF-5 to calculate a Core Language Score, which includes the following subtests: **Word Classes** evaluates the child's ability to understand relationships between words. This subtest does not contain any prepositions or prepositional phrases. **Formulated Sentences** evaluates the child's ability to formulate complete, and grammatically correct sentences, using given words (e.g., car, if, because) and contextual constraints imposed by illustrations. This subtest does give the examinee four prepositions as the word for their sentence: *in*, *before*, *until*, and *after*. **Recalling Sentences** evaluates the child's ability to listen to spoken sentences and repeat the sentences without changing words or sentence structure. This subtest does not allow the examinee to use or demonstrate their understanding of specific prepositions. Finally, **Semantic Relationships** evaluates the child's ability to interpret sentences that (a) make comparisons, (b) identify location or direction, (c) specify time relationships, (d) include serial order, or (e) are expressed in passive voice. This subtest does use specific prepositions but being a receptive listening task, did not provide an opportunity for examinees to produce prepositions (CELF-5; Wiig, Semel, & Secord, 2013). These subtests offer little, to no examination of preposition use or comprehension. Therefore, it is possible that participants may have scored within the average range for language and still have difficulties with prepositions. As described within each subtest, the information gained from the CELF-5 Core Language Score does not allow for much interpretation of preposition use and understanding and it's possible the language score did not capture preposition weaknesses.

When examining the different production of individual words, *into* and to a lesser extent, *to*, were the only two words that TD participants produced more often than participants with ASD. Both *into* and *to* are directional terms, meaning they indicate some type of motion or movement. These are different than words like *in* and *on* because they are not static and indicate change. Again, this difference may be due to narrative skills in that TD children are able to use words to indicate change of scenery or location within their story.

We hypothesized that participants with ASD would demonstrate decreased flexibility in their ability to use a given preposition in more than one way. However, TD participants and participants with ASD did not differ in flexibility with the use of prepositions in narratives. This is surprising, because individuals with ASD tend to have more rigid and stereotyped language. This suggests that our participants with ASD may be too high functioning or too fluent to show

any differences. Finally, it is interesting that in our sample, both TD and ASD participants demonstrated unconventional uses of prepositions within their narratives. The narratives produced by both groups were creative, unique, and ungrammatical at times, displaying a range of abilities within diagnostics groups.

**Limitations**

We strove to examine the production of spatial, temporal, and metaphorical prepositions by children with ASD with average to above average language and intelligence. Still, one limitation to the study is we did not test for narrative skills prior to the study, which may have had an impact on the production of prepositions, since they aid in narrative production. Therefore, we have no way of determining whether narrative skills of either group impacted the number of prepositions produced. Although the CELF-5 was used to determine language abilities, the CELF-5 assessment itself does not test narrative abilities to a reasonable extent. Similarly, we did not test participants for spatial abilities and are unable to determine whether the deficits found within our study are due to underlying spatial deficits or due to the diagnostic identification of participants (TD or ASD). Therefore, it is possible that the TD participants produced more prepositions as a result of better narrative skills.

Additionally, a limitation to our study was our lack of control with the high-stress condition for this particular research question. These narratives were elicited for a different purpose, where researchers were curious about biological and physiological reactions to stress. Although we were not interested in this particular variable of the original study, we have no reason to believe that stress would impact only the production of prepositions.

Finally, the prompt we used did not have a temporal aspect and focused on using spatial language. The prompt was not designed well for a temporal study and therefore it is possible the participants produced too few temporal prepositions to detect differences between groups.

**Future Directions**

Future studies should test younger participants with lower language skills. This would eliminate the possibility of our participants being too advanced or fluent in our sample to show any differences. further analysis of participants with ASD and their production of prepositions should be completed and possibly investigate their use of prepositions in more naturalistic environments or in conversational speech.

One key finding was that the participants with ASD were not less flexible with the prepositions they did use, which might seem to contradict this expectation. However, we did not explore to see whether the participants with ASD were less flexible in their spatial use of a preposition, particularly in their ability to use both core and peripheral extensions of prepositions. Future studies should investigate whether our ASD participants differ in their ability to use core meanings of prepositions as well as use peripheral extensions of these.

Finally, future studies should use a prompt that has both a spatial and temporal aspect. The limited number of abstract terms produced by both groups may be due to the spatial descriptors of the story prompt. The current study was not originally designed to probe for preposition use. So, future studies could aim to encourage participants to use spatial and temporal prepositional phrases.

**Conclusion**

Children with ASD produced fewer prepositions on a narrative task compared to their TD peers, despite being well matched for age, language skills and nonverbal intelligence. Children with ASD also produced fewer concrete/spatial prepositions, however, no differences were found in the production of temporal or metaphorical terms. The age of participants was associated with the overall number of prepositions produced, supporting the acquisition literature stating that as children get older, they produce more prepositions. These findings have clinical implications for Speech Language Pathologists working with individuals with ASD. Prepositions may be an area of weakness for children with high functioning autism and intact language and intelligence. Difficulties with prepositions may lead to difficulties with communication, describing events, and linking relationships between entities. Therefore, this may be an area of weakness clinicians should identify that standardized tests may not capture.

## References


Adachi, T., Koeda, T., Hirabayashi, S., Maeoka, Y., Shiota, M., Wright, E., et al. (2004). The metaphor and sarcasm scenario test: A new instrument to help differentiate high functioning pervasive developmental disorder from attention deficit/hyperactivity disorder. *Brain and Development, 26,* 301–306.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed). Washington, DC: American Psychiatric Association.

Ames, L. B. (1946). The development of the sense of time in the young child. *Journal of Genetic Psychology, 68*, 97–125.

Antinucci, F., & Miller, R. (1976). How children talk about what happened. *Journal of Child Language*, *3,* 167–189.

Attwood, T. (2007). Language. In: Attwood, T (ed). *The complete guide to Asperger Syndrome.* London: Jessica Kingsley Press; (pp. 202-227).

Birkett M. A. (2011). The Trier Social Stress Test protocol for inducing psychological stress. *Journal of visualized experiments: JoVE*, (56), 3238.

Bochynska, A., Coventry, K., Vulchanov, V., Vulchanova, M. (submitted). Tell me where it is: Selective difficulties in spatial language in high-functioning individuals with autism.

Bochynska, A., Vulchanova, M., Vulchanov, V. (2018). Spatial language abilities in high functioning individuals with autism. *International Society for Autism Research*.

Bochynska, A., Vulchanov, V., Vulchanova, M. (submitted). When geometry is ambiguous: the use of prepositions *in* and *on* in high-functioning autism.

Boroditsky, L. (2000). Metaphoric Structuring: Understanding Time through Spatial Metaphors. *Cognition, 75*, 1-28.

Brown, R. W. (1973). *A first language; the early stages*. Cambridge, Mass., Harvard University Press.

Busby, J., & Suddendorf, T. (2005). Recalling yesterday and predicting tomorrow. *Cognitive Development, 20*, 362–372.

Busby Grant, J., & Suddendorf, T. (2011). Production of temporal terms by 3-, 4-, and 5-year-old children. *Early Childhood Research Quarterly*, *26*(1), 87–95.

Churchill, D. W. (1972). The relation of infantile autism and early childhood schizophrenia to developmental language disorders of childhood. *Journal of Autism and Childhood Schizophrenia*, *2*(2), 182–197.

Clark, E. (1973). Non-linguistic strategies and the acquisition of word meanings. *Cognition*, *2,* 161–182.

Colle, L., Baron-Cohen, S., Wheelwright, S., & Van Der Lely, H. (2008). Narrative discourse in adults with high-functioning autism or Asperger syndrome. *Journal of Autism and Developmental Disorders*. *38*(1), 28–40.

Dennis, M, Lazenby, A.L., & Lockyer, L. (2001). Inferential language in high-function children with autism. *Journal of Autism Developmental Disorders. 31*(1), 47-54.

Durkin, K. (1978). Young children's success on a picture identification task of *with* and its antonyms. *Papers in Linguistics, 11,* 355-371.

Eisenberg, A. R. (1985). Learning to describe past experiences in conversation. *Discourse Processes, 8*(2), 177-204.

Ferretti, F., Adornetti, I., Chiera, A., Nicchiarelli, S., Valeri, G., Magni, R., Vicari, S. and Marini, A. (2018). Time and narrative: an investigation of storytelling abilities in children with Autism Spectrum Disorder. *Frontiers in Psychology, 9,* 944.

Friedman, W., & Seely, P. (1976). The Child's Acquisition of Spatial and Temporal Word Meanings. *Child Development, 47*(4), 1103-1108.

Gentner, D., & Boroditsky, L. (2001). Individuation, relativity and early word learning. In M. Bowerman & S. Levinson (Eds.), *Language acquisition and conceptual development* (pp. 215-256). Cambridge, UK: Cambridge University Press.

Gentner, D., Imai, M., Boroditsky, L. (2002). As time goes by: Evidence for two systems in processing space and time metaphors. *Language and Cognitive Processes, 17*(5), 537-565.

Grant, J. R. (1915). A child's vocabulary and its growth. *Pedagogical Seminary 22*, 183-203.

Happé F. G. E. (1993). Communicative competence and theory of mind in autism: a test of relevance theory. *Cognition, 48*, 101–119.

Harner, L. (1975). Yesterday and tomorrow: Development of early understanding of the terms. *Developmental Psychology,11*(6), 864–865.

Harner, L. (1981). Children's understanding of time. *Topics in Language Disorders, 2*(1), 51–66.

Johannes, K., Wilson, C., & Landau, B. (2016). The importance of lexical verbs in the acquisition of spatial prepositions: The case of in and on. *Cognition, 157,* 174-189.

Johnston, J. R. (1988). Children's verbal representation of spatial location. In J. Stiles-Davis, M. Kritchevsky, & U. Bellugi (Eds.), *Spatial cognition: Brain bases and development* (pp. 195-205). Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Johnston, J. R., & Slobin, D. I. (1979). The development of locative expressions in English, Italian, Serbo-Croation, and Turkish. *Child Language, 6*(3), 529–545.

Kerbel, D., & Grunwell, P. (1998). A study of idiom comprehension in children with semantic-pragmatic difficulties. Part I: Task effects on the assessment of idiom comprehension in children. *International Journal of Language and Communication Disorders, 33*(1), 1–22.

Kemmerer, D. (2004). The spatial and temporal meanings of English prepositions can be independently impaired. *Neuropsychologia, 43*(5), 797-806.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993) The 'Trier Social Stress Test'—a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*, 76-81.

Lai, C. L. E., Lau, Z., Lui, S. S. Y., Lok, E., Tam, V., Chan, Q., … Cheung, E. F. C. (2017). Meta-analysis of neuropsychological measures of executive functioning in children and adolescents with high-functioning autism spectrum disorder. *Autism Research, 10*(5), 911–939.

Lakoff, G., & Johnson, M. (1980). Metaphors we live by, Chicago, IL: University of Chicago Press.

Levinson, S.C. (2003). *Space in Language and Cognition*. Cambridge: Cambridge University Press.

Lind, S. E., Bowler, D. M., & Raber, J. (2014). Spatial navigation, episodic memory, episodic future thinking, and theory of mind in children with autism spectrum disorder: evidence for impairments in mental simulation? *Frontiers in Psychology, 5*, 1–20.

Lind, S. E., Williams, D. M., Raber, J., Peel, A., & Bowler, D. M. (2013). Spatial navigation impairments among intellectually high-functioning adults with autism spectrum disorder: Exploring relations with theory of mind, episodic memory, and episodic future thinking. *Journal of Abnormal Psychology, 122*(4), 1189–1199.

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2)*. Torrance: Western Psychological Services.

Loukusa, S., & Moilanen, I. (2009). Pragmatic inference abilities in individuals with Asperger syndrome or high-functioning autism. A review. *Research in Autism Spectrum Disorders*, *3*(4), 890-904.

Mashal, N., & Kasirer, A. (2011). Thinking maps enhance metaphoric competence in children with autism and learning disabilities. *Research in Developmental Disabilities, 32*(6), 2045-2054.

Meints, K., Plunkett, K., Harris, P. L., & Dimmock, D. (2002). What is 'on' and 'under' for 15-, 18- and 24-month-olds? Typicality effects in early comprehension of spatial prepositions. *British Journal of Developmental Psychology, 20*(1), 113-130.

Menyuk, P. (1978). The language of autistic children: What's wrong and why. In M. Rutter and E. Schopler (Eds.), *Autism: A reappraisal of concepts and treatment* (pp. 105–116). New York: Plenum Press.

Ohta, M. (1987). Cognitive disorders of infantile autism: A study employing the WISC, spatial relationship conceptualization, and gesture imitations. *Journal of Autism and Developmental Disorders, 17*(1), 45-62.

Pearson, A., Ropar, D., & Hamilton, A. F. d. C. (2013). A review of visual perspective taking in autism spectrum disorder. *Frontiers in Human Neuroscience, 7,* Article ID 652.

Rapin, I., & Dunn, M. (2003). Review article: Update on the language disorders of individuals on the autistic spectrum. *Brain & Development, 25,* 166-172.

Rice, S. (1999). Patterns of acquisition in the emerging mental lexicon: The case of *to* and *for* in English. *Brain and Language. 68*, 268-276.

Richards, M. (1979). Sorting out what's in a word from what's not: Evaluating Clark's semantic Prior, M. R. (1984). Developing concepts of childhood autism: The influence of experimental cognitive research. *Journal of Consulting and Clinical Psychology, 52*(1), 4-16.

Ricks, D. M., & Wing, L. (1975). Language, communication and the use of symbols.*Journal of Autism and Childhood Schizophrenmia, 5*, 191–221.

Rundblad, G., & Annaz, D. (2010). The atypical development of metaphor and metonymy comprehension in children with autism. *Autism*, *14*(1), 29–46.

Rutter, M., Bailey, A., & Lord, C. (2003). The Social Communication Questionnaire. Los Angeles: Western Psychological Services.

Sachs, J. (1983). Talking about there and then: The emergence of displaced reference in parent-child discourse. In K. E. Nelson (Ed.), *Children's language* (pp. 1–28). Hillsdale, NJ: Erlbaum.

Smith, A. D. (2015). Spatial navigation in autism spectrum disorders: A critical review. *Frontiers in Psychology, 6,* 1-8.

Suddendorf, T. (2010). Linking yesterday and tomorrow: Preschooler's ability to report temporally displaced events. *British Journal of Developmental Psychology, 28,* 491–498.

Tager-Flusberg, H., & Kasari, C. (2013). Minimally verbal school-aged children with autism spectrum disorder: the neglected end of the spectrum. *Autism Research: Official Journal of the International Society for Autism Research*, *6*(6), 468–478.

Talmy, L. (1972). *Semantic Structures in English and Atsugewi*. Berkeley: University of California Ph.D. dissertation.

Tillman, K. A., Marghetis, T, Barner, D., & Srinivasan, M. (2017). Today is tomorrow's yesterday: Children's acquisition of deictic time words. *Cognitive Psychology,* 92, 87-100.

Traugott, E. C. (1978). On the expression of spatiotemporal relations in language. In J. H. Greenberg (Ed.). *Universals of human language: Vol. 3*. *Word structure* (pp. 369–400). Stanford, CA: Stanford University Press.

Veneziano, E., & Sinclair, H. (1995). Functional changes in early child language: The appearance of references to the past and of explanations. *Journal of Child Language*, *22*(3), 557–581.

Vogindroukas, I., & Zikopoulou, O. (2011). Idiom understanding in people with Asperger syndrome/high functioning autism. *Revista da Sociedade Brasileira de Fonoaudiologia. 16*, 390-395.

Vulchanova, M., Talcott, J.B., Vulchanov, V., Stankova, M., & Eshuis, H. (2013): Morphology in autism spectrum disorders: Local processing bias and language, *Cognitive Neuropsychology*, *29*(7-8), 584-600.

Wang, Y., Zhang, Y., Liu, L., Cui, J., Wang, J., Shum, D. H. K., ... Chan, R. C. K. (2017). A meta-analysis of working memory impairments in autism spectrum disorders. *Neuropsychology Review*, *27*(1), 46-61.

Weist, R. M. (2002). Temporal and spatial concepts in child language: Conventional and configurational. *Journal of Psycholinguistic Research, 31*(3), 195–210.

Wiig, E.H., Semel, E., & Secord, W.A. (2013). *Clinical Evaluation of Language Fundamentals-Fifth Edition (CELF-5)*. Bloomington, MN: NCS Pearson.

Wing, L. (1969). The handicaps of autistic children--a comparative study. *Journal of Child Psychology and Psychiatry, 10,* 1-40.

Wittenburg, P., Brugman, H., Russel, A., Klassmann, A., & Sloetjes, H. (2006). ELAN: a Professional Framework for Multimodality Research. In: Proceedings of LREC 2006, Fifth International Conference on Language Resources and Evaluation.

Young, F. M. (1941). An analysis of certain variables in a developmental study of language. *Genetic Psychology Monographs, 23,* 3-141.