What's That: Whole Object and Taxonomic Constraint in Children with Autism

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Abstract

This paper focuses on determining how children with autism (ASD) approach word learning. Prior research has determined that non-autistic (NA) children exhibit word learning biases to assist with paring down potential or unlikely referent alternatives to effectively learn new word meanings. Some children with autism exhibit some of these word learning biases, but it is unclear if they exhibit two specific biases: the taxonomic and whole object biases. This project aims to investigate if children with ASD exhibit these biases, and if children with ASD perform similarly on the experimental tasks to their NA peers. 22 NA children ages 2-10 years participated in an analysis comparing their performance to that of children in previous studies and 11 ASD-NA pairs were matched for receptive language. Results suggest that children with ASD exhibit a taxonomic bias regardless of a label being presented or not, and that they exhibit a whole object bias. No statistically significant differences between groups arose for the taxonomic or whole object tasks, suggesting that children with ASD perform similarly to their NA peers. We anticipate this research will enhance our knowledge of how children with autism engage in the word learning process.

Introduction

Learning new words is a very complex and prolonged process. Many children utilize strategies to make the word learning process easier. Two strategies that will be discussed in this paper are the taxonomic assumption, in which a child will assume newly learned words extend to an object of the same category, and the whole object assumption, in which children associate a novel label to an object in its entirety. Prior research has suggested that some children with Autism Spectrum Disorder (ASD) utilize other word learning strategies (Abdelaziz et al., 2018; De Marchena et al., 2011), but it is unknown whether they utilize the taxonomic and whole object assumptions. This paper will examine these biases in order to inform educators, parents, and healthcare professionals of the unique cognitive pathways and learning strategies of children with ASD.

Word Learning

Language is one of the most vital tools for human interaction and communication. But, how do children understand the fact that language involves words that represent individual concepts? Or, on a narrower level, how do children understand that a label can be attributed to a particular object?

Word learning is a very slow and gradual process. It takes several years to understand and utilize the complicated structure of language. In fact, throughout the first five years, children are acquiring vocabulary, learning how to increase the complexity of grammatical features, and understanding social aspects of communication (Feldman, 2019). Horst (2017) mentions that slow word learning can actually be an advantage: children will strengthen their understanding of word meanings with reduced risk of learning inaccurate information. For instance, she brings up the example of mismatching *spoon* for *cup* (Horst, 2017). Because cups and spoons often occur in the same situation, a child who is learning words quickly, from only a few exposures, could easily match the word to the incorrect object. Slower, more gradual, word learning is likely to include situations where only one object is in the environment, making the mapping clearer. Children will have more time to decipher which object in their environment the label can be matched to; thus, taking the time to solidify object-label matches will allow for fewer mistakes (Horst, 2017).

Despite this, many children will advance from one word learning milestone to the next very quickly (Horst, 2017). Young infants are rapidly taking in information from the world around them, repeatedly hearing adults point and label *car*, *doggie*, or *milk*—they start to understand not only these word-object connections, but also the larger, fundamental categories of objects (Booth et al., 2005). This early knowledge of object categories can not only aid in facilitating word learning within these categories, but also with making associations between words and their broader concepts (e.g. that *car* is a type of vehicle) (Booth et al., 2005). Once this initial influx of words has been acquired, though, children can start to make inferences about words and their labels in order to assist with the further development of language (Westermann & Mani, 2018). Word learning, as a whole, is a case of induction; induction refers to the need to learn broader principles from individual instances. So, in word learning, one needs to learn not just that this particular object is a *cat*, for example, but that all similar animals are cats as well (Bloom, 2000; Markman & Wachtel, 1988). For instance, Quine (1960) provides the example of a linguist visiting a heretofore unknown tribe—the linguist doesn't know the language that members of the tribe speak. A tribal member points to a rabbit and says, "*Gavagai*!" The linguist cannot 'know' the speaker's intention—did they mean the word to extend to other rabbits, other white things, or something else? There are always multiple interpretations. Despite being in a similar situation, children are able to extend words appropriately most of the time (Bloom, 2000; Markman & Hutchinson, 1984).

But, word learning becomes significantly more complicated when there are several things in one's environment that a label could be referring to. More specifically, upon hearing the label *dog*, how does one know that *dog* refers to dogs and not a specific dog, another four-legged creature, a furry object, or any other characteristic? How does one rule out the possibility of *dog* referring to a toy the dog is playing with or an action the dog is taking (Markman & Hutchinson, 1984)? As one can see, word-object mapping isn't inherently obvious. This word-object mapping difficulty could be even further exacerbated by other factors, including multiple objects being present in an environment that a label could refer to. For instance, Samuelson and McMurray (2016) provide the example of a classroom filled with toys, tables, and other objects. Upon hearing, "Wow, blicket!" how could a child possibly understand what the individual was referring to? How, then, do children ultimately match labels to their referents? This question will be explored throughout this paper.

Word Learning Biases

Due to the influx and variety of the vocabulary children are learning, there is the need for strategies to aid with this complex word learning process. Children often implement word learning strategies to rule out unlikely alternatives for the meaning of words (Markman, 1991). Researchers have identified a number of strategies (also known as biases, assumptions, constraints, or heuristics) that children seem to often use. Two of these biases will be explored more in depth in this paper: the taxonomic and whole object biases.

Taxonomic Bias. One such strategy children utilize to assist with the word learning process is the taxonomic bias. The taxonomic bias states that labels refer to objects of the same category instead of objects that are thematically related (Markman, 1990; Markman & Hutchinson, 1984; Waxman & Gelman, 1986). Markman and Hutchinson (1984) presented a series of tests in which two- to five-year-old children matched a set of comparison stimuli to a 'standard' stimulus, following either a novel label condition or a no-label condition. For instance, a picture of a dog (standard object) was shown to the child while either hearing a novel label ("This is a dax") or no label ("I'm going to show you a new picture"); a taxonomically similar object (another breed of dog) and thematically similar object (dog food) were then presented to the child while asking the child to find either 'another one that is the same as this' (no-label condition) or another dax (label condition). Results demonstrated that children as young as two- and three-years-old utilized the taxonomic constraint when presented with a novel label—without a label, children often select the thematically similar object.

Why might children taxonomically organize language? Markman and Hutchinson (1984) posit that nouns are often taxonomically organized due to the hierarchical organization and relationship of such words. Embedded in taxonomically-related words is a broad category that houses smaller categories—think strawberry being a part of the category fruit, which is a part of the category food. If, then, one is presented with a novel word for an object that is known to be a food, one can make the assumption that the food can be eaten, contains nutrients, and has a certain taste profile. Having the understanding that objects can be part of categories can aid children with attributing an unknown label to an object. Furthermore, if object labels were attributed to objects of the same thematic category, it would get to be confusing and overwhelming (Markman & Hutchinson, 1984). For instance, we would need a single label for dog and dog food, dog and leash, dog and collar, etc. The number of words needed would seemingly become too large for humans to be able to learn. Thus, taxonomically related object labels allow for the paring down of words to their referents based on similar categorical organizations.

Whole Object Bias. Another strategy children utilize to assist with the word learning process is the whole object assumption, where children attribute a label to a whole object rather than its parts, attributes, or actions (Golinkoff et al., 1994; Markman, 1990; Markman & Wachtel, 1988). The MacArthur-Bates Communicative Developmental Inventory displays the first 100 words that the highest proportion of children produce by 30 months. The data illustrates that aside from body parts, which are often explicitly taught, many children 30 months and younger do not utilize many object-part words; instead, they utilize mostly whole words (e.g. *cow* or *firetruck*) (Frank et al., 2016).

Markman and Wachtel (1988) tested preschool-aged children on whether they would select a whole object or part of novel objects upon hearing an unfamiliar label. The researchers specifically chose objects that had separate, highly salient parts. Children selected the novel part only 20% of the time after hearing a label for an unfamiliar part. This result conveys that children are more likely to attribute a novel label to a whole object rather than its part.

The researchers then determined if children would attribute a novel label to a familiar object (Markman & Wachtel, 1988). Children in this condition made more part choices (57%) than whole object selections. As a result, children who hear a novel label in the presence of an object for which a name is already known were less likely to perceive the novel term as referring to the whole object.

Kobayashi (1988) then investigated if acting upon the object would interfere with the children's choices of the whole or part objects. They utilized sets of unfamiliar objects in which two individual parts (e.g. a nut and a u-shaped bolt) were placed together and taken apart while simultaneously given a novel label. The two items were then placed in front of the child and the child was told to find the [novel label]. In an action condition, participants watched the experimenter pull apart and put back together a different set of objects in front of the child (e.g. two identical springs) while simultaneously giving the new objects a novel name. They then acted upon the object: in the case of the springs, the experimenter tugged on the springs a few times. The participants were then told to find the [novel label]. In the no-action condition, the procedure was the same except the object was not acted upon. The researchers found that

24-month-old children were able to learn the label for an unfamiliar object part if an object part was acted upon, but interpreted the label as a referent for the whole object when the part was not acted upon (Kobayashi, 1998).

More recent research conducted by Hollich and colleagues (2007) looked at how children as young as 12 months respond to labels for complex novel objects with particularly salient parts. They compared the performance of 12-month-olds and 19-month-olds to see if there was a tendency to choose the whole over the part as established in previous work. Their study shied away from using object actions to represent salience—as in Kobayashi (1998)—due to actions being short-lived and the fact that wholes may be perceived as more perceptually salient than parts. Thus, they examined the bias by making parts more perceptually salient by adding a patterned design to the part and labeling the object more often when the parts were separated than together (Hollich et al., 2007). For example, one novel object included a ½-inch wood piece that could be separated into two parts; each part was either painted red with blue polka dots or green with yellow stripes to provide extra salience. The experimenters found that a novel label perpetuated the bias towards the whole object over the part for both age groups, despite this added salience to the parts (Hollich et al., 2007).

To summarize, prior work has suggested that a taxonomic bias, or the tendency to generalize labels for objects of the same category, is utilized by children as young as two- or three-years-old (Markman & Hutchinson, 1984). It has been proposed that this bias arises due to the hierarchical nature of words and their broader categories, as well as the necessity to reduce the mental load of paring down words to their referents (Markman & Hutchinson, 1984). Furthermore, the whole object bias states that children will match a label to a whole object instead of its parts, but that the label for parts can be learned through many methods: a training phase where an object part is labeled, adding additional salience to a part, and acting upon and labeling the object part (Hollich et al., 2007; Kobayashi (1988); Markman & Wachtel, 1988). The current study combined methods from these prior works to determine if perceptually salient parts will affect children with ASD and NA children's choice of a whole or part object following a novel label.

Overriding Word Learning Biases

It is crucial to mention that although these word learning strategies help solve the word learning problem, children may not exhibit all the possible biases, and these biases are heavily reliant on culture and linguistic context. For instance, the mutual exclusivity bias suggests that children assume an object only has one label (Markman & Wachtel, 1988). Though, this bias is more frequently present in children who are monolingual (Davidson et al., 1997). Davidson and colleagues (1997) found that some bilingual children tested did exhibit the mutual exclusivity bias, but not as prominently as the monolingual children. This is most likely because multilingual children welcome the possibility of objects having multiple names, whereas monolingualism places a large emphasis on objects only having one name.

These biases are often overridden. One example of this is the use of synonyms in English. Per the mutual exclusivity bias, objects and their meanings can only have one meaning. However, synonyms mean that children are able to learn that two words can have very similar meanings. Overriding the mutual exclusivity bias and learning a second label for an already known object can be more difficult than learning a single label for an object, as conveyed by Liittschwager and Markman (1994) as the ‘synonym effect.’ Liittschwager and Markman (1994) examined whether 16- and 24-month-olds would learn more than one label for an object if the word learning task was simplified. Children were placed into a one-label condition in which they learned a novel label for an unfamiliar object, or a two-label condition where they learned a novel label for a familiar object with an already known label. The researchers hypothesized that learning a new label for an object with a familiar label would be more taxing than learning a label for an unfamiliar object—the unfamiliar label condition is considered “simplifying the word learning process,” as children do not have to go through the mental strain of determining if an object can have a second label if the first label is already known. Liittschwager and Markman (1994) concluded that participants were able to override the mutual exclusivity bias if the demands placed on them were minimal. When the experimenters limited the number of novel labels introduced (only one compared to other studies which had multiple novel labels), children were easily able to learn a second novel label for an object with an already known label. When they increased the demands on the child—increasing the number of novel labels the child is taught—children had a much harder time learning second labels for objects with already known labels (Liittschwager & Markman, 1994). Although children ultimately were able to learn synonyms for words, it appears to be difficult unless the conditions were made less demanding for the child. In summary, while biases such as the mutual exclusivity bias can aid in the word learning process, one is still able to successfully learn new words without their presence if demands placed on the child are alleviated.

Autism Spectrum Disorder and Related Language Development

According to a Center for Disease Control and Prevention (CDC) report, 1 in 31 eight-year-old children were identified with Autism Spectrum Disorder (ASD) in 2022 and ASD is 3.4 times more prevalent in boys than girls (Shaw et al., 2025). ASD is characterized by varying social communication and interaction, sensory differences, and diverse cognitive abilities (Lord et al., 2020). According to the DSM-5, the diagnostic criteria identified for ASD includes persistent social deficits in social interactions, nonverbal communication, developing and maintaining relationships, and restricted and repetitive behaviors (e.g. difficulty with change) (American Psychiatric Association, 2013).

Vocabulary learning in children with ASD varies greatly. Some children with ASD do exhibit strong language abilities. In fact, some children by the preschool and school years are highly fluent, with complex vocabulary and grammar (Thurm et al., 2006). But, some children with ASD have delays in the onset of spoken language. In fact, Norrelgen and colleagues (2014) investigated the proportion of children with ASD who had not yet developed phrase speech—utterances with multiple phrases—during the preschool years. They found that in their sample of 165 children, about 42 children were non-verbal or minimally verbal (Norrelgen et al., 2014). While these results cannot be generalized to the broader population of children with ASD, there is much variability in the verbal communication abilities in children with ASD. Even before this, prelingual communication, such as gestures and joint attention (the ability of two or more individuals to share focus on an object), that provide a foundation for spoken language, may not be as prevalent in some children with ASD (Mitchell et al., 2006). In fact, children between nine and 12 months exhibit fewer pre-verbal and verbal skills than their NA peers, yet many children with ASD did in fact use facial expressions and eye gaze in these early months (Bradshaw et al., 2021). Moreover, scores of receptive language—specifically identification of body parts, people, and objects—were the same across NA and autistic children, conveying that some autistic children have similar receptive language abilities as their NA peers (Bradshaw et al., 2021).

Because some NA children use different strategies and paths to acquire language, it would not be surprising if children with ASD would do the same. For instance, many NA children's early vocabularies consist of a large majority of object names (e.g. nouns) with some verbs, adjectives, and proper names intermixed (Nelson, 1973). Some children, however, have more diverse vocabulary, with more social phrases (e.g. "I want it" or "stop it") and pronouns utilized in conjunction with the nouns, adjectives, and verbs (Nelson, 1973). Nelson (1973) noted that a potential difference could be due to birth order, such that expressive language tended to be more diverse in second born children and in families of a higher socioeconomic status. Thus, different environments may be a contributing factor to varied language development in children. Furthermore, some children utilize different learning styles, such as gestalt language processing, where children learn whole phrases and sentences first instead of single words, whereas other children utilize individual words first and then apply them at the phrase and sentence level (Peters, 1977). Children may utilize these different linguistic styles when presented with different contexts (e.g. using gestalt language in free play but individual words in reading books with a caregiver) (Peters, 1977). Based on the variability in the utilization of parts of speech and linguistic learning styles, it is evident that children may acquire language through different strategies, yet all arrive at the same outcome. Children with ASD may not be exempt from this and will utilize varying strategies to learn language.

In relation to word learning strategies, there are some word learning biases that have been investigated in relation to children with ASD. For instance, the shape bias states that children will attribute a label to an object's shape, rather than its color, material, or other attributes (Landau et al., 1988). The vast majority of non-autistic children exhibit a shape bias, especially for those with larger vocabularies (Abdelaziz et al., 2018). It has been found that toddlers and preschool-aged children with ASD do not typically show a shape bias, though there is much variability and some children with ASD do show this bias (Abdelaziz et al., 2018). The potential to not show the bias may be due to several factors. First, some children with ASD have difficulty focusing on global properties of objects, such as their shape (Abdelaziz et al., 2018). Furthermore, a stronger shape bias is strongly associated with more robust expression and receptive language—children with ASD who are not yet at high expressive and receptive language levels may not exhibit the bias (Abdelaziz et al., 2018). Abdelaziz and colleagues (2018) further explored shape bias in children with ASD by showing that children with ASD with robust expressive language abilities and children who initiated joint attention had higher shape bias performance (Abdelaziz et al., 2018). As one can see, a combination of linguistic output and social pragmatic skills may lead to higher shape bias abilities in some children with ASD, but there is still much diversity in the performance of children on shape bias tasks based on language and social communication abilities.

Another bias that has been explored in children with ASD is mutual exclusivity, or the bias to assume that an object will only have a single label. Some researchers have argued that this bias arises out of pragmatic skills, an area of difference for some children with ASD. According to such theories, the pragmatic account requires children to go beyond a basic process of elimination—does this object have an already known label? If so, then the novel label cannot refer to the object—to go through a reasoning process about the speaker's communicative intentions each time they assign a new label to an object (De Marchena et al., 2011). This ability to rule out unlikely label possibilities requires some semblance of thinking similarly to, 'if dad wanted to refer to the [apple], he would have used the word "apple", but he used the different word "passion fruit", so he must have not been referring to the [apple]. [Passion fruit] seems like the likely choice.' This thought process leads to the conclusion that if an object already has a known label, then the speaker must not be referring to that object. Thus, additional cues about speakers' intent may assist children in matching labels to their referents. With this in mind, De Marchena and colleagues (2011) tested whether children with ASD would exhibit the mutual exclusivity bias. They utilized a standard label condition in which a novel label was attributed to a novel object, and the children had to identify the referent to which the label was attributed (e.g. "Can you give me the *wug*?"). A fact condition was also utilized, where one of the two novel objects was associated with a novel fact (e.g. "My dog likes to play with this") and children were asked to produce the reference of a second novel fact (e.g. "Can you give me the one my sister likes?"). The authors concluded that children with ASD did show the bias for both a word and fact condition (although the bias was stronger in the word condition). They also found that children with more robust language abilities were more likely to exhibit the bias and that mutual exclusivity for the fact condition was closely associated with social-pragmatic abilities (De Marchena et al., 2011).

Because some children with ASD do exhibit shape and mutual exclusivity biases, it remains unclear if they will exhibit other word learning biases as well. It also remains unclear if children with ASD will utilize similar strategies as their NA peers during word learning tasks that have not been researched yet. The current study investigates both.

One behavioral pattern that has been shown with children with ASD is that they tend to direct their attention to salient features of objects to a greater degree than their peers. This has been shown by Johnson and Rakison (2006), who investigated if moving parts of objects affects children with ASD's ability to attribute a label to the individual part of an object that moves or the object as a whole, and its motion trajectory (e.g. bouncing). Each object had a distinct body (e.g. a red oval shape) and parts (e.g. red cylindrical parts that move up and down). The results show that children with ASD around 38 months can attend to the relationship between a moving part of an object and its motion trajectory, but do not associate the label with the whole object in these scenarios. This suggests that children with ASD treat relationships between object parts and their corresponding actions (e.g. legs and walking) as causal, but ignore other crucial properties of the object. This implies that some children with ASD tend to hyperfocus on certain parts of an object, while ignoring other important parts. Given this focus on salience, one might expect that children with ASD would be more likely to consider mapping a new name onto a salient part rather than onto the whole object in our task. If so, they might be less likely to show a whole-object bias than their NA peers when a part is highly salient.

All in all, something that potentially differentiates how well children with ASD perform on tasks involving word learning heuristics could be robust versus reduced language abilities; not every child with ASD exhibits language difficulties, so some children may perform similarly to their NA peers who often utilize these biases. There is much variability, however, that may lead to the utilization, or lack thereof, of these word learning strategies, and many studies average across children with ASD who do and do not have difficulty with language skills. This may lead to generalized conclusions of children with ASD showing or not showing the biases, without mention of the variability of the performance of children with ASD on these tasks. Furthermore, it remains unclear why some children with ASD have smaller vocabularies relative to their peers or what kinds of skills are being utilized in children with smaller and larger vocabularies. Since these word learning strategies may be important to some aspects of word learning, it is possible that these strategies may be exhibited in children with ASD with higher language abilities in the current study.

Research Questions and Hypotheses

This project answers the following questions: 1) Do children with ASD exhibit a taxonomic bias and/or whole object bias, and 2) do children with ASD perform differently than their non-autistic peers on taxonomic and whole object bias tasks? The former research question was chosen due to the lack of research examining these two word learning biases in the context of children with ASD. The second question stems from previous findings that children with ASD tend to direct more attention to particularly salient features of objects and that they have more varied receptive and expressive language abilities (De Marchena et al., 2011; Johnson & Rakison, 2006). To answer these questions, we have the same group of children with ASD participate in two different tasks: one addressing the taxonomic constraint and the other addressing the whole object constraint. We assess these children's receptive vocabulary and distractibility skills (e.g. does not pay attention to details or makes careless mistakes, does not seem to listen when spoken to directly, has difficulty organizing tasks and activities, is easily distracted by noises or other stimuli, etc.) to see if these factors relate to performance on the two tasks.

We hypothesize that children with ASD will more often choose the taxonomically similar object over the other object choices in both the labeling and no-label conditions due to many children with ASD's special interests. Because many children with ASD often have focused interests on specific categories (e.g. animals, TV shows, airplanes, etc.), they may be able to think in a more categorical way, thus rendering labeling less impactful (Nowell et al., 2020). Thus, these children may exhibit a preference for the taxonomically similar objects, especially if it aligns with their special interest, regardless of if there is a label for the object or not. Furthermore, we believe that children with ASD will perform similarly to their non-autistic peers for the taxonomic task and differently in the whole object bias task due to some children with ASD's enhanced focus on perceptually salient attributes of objects—they may become more intrigued with the perceptually salient part compared to their non-autistic peers—and their varying language abilities.

Methods

Participants

39 children participated in this study, ranging from 2 years 1 month to 10 years 9 months. The participants were divided into two groups: Children with autism (ASD) (N = 13) and non-autistic children (NA) (N = 26). 23 participants were male and 16 were female. 67.6% (N =

28) identified as White, 17.1% (N = 6) as Black/African American, 8.6% (N = 3) as Asian, and 8.6% (N = 3) as mixed.

One participant was excluded from data analysis due to incompleteness of the experimental tasks. Four additional children participated but insisted on testing together and thus their data was excluded. 34 participants were included in data analysis.

Children were recruited from daycares, preschools, parent groups, inclusive community events, and word of mouth in the DMV area. The experiment was approved by the University of Maryland Institutional Review Board (IRB).

Materials

To assess the taxonomic bias, picture cards of objects were used. Picture cards were chosen over tangible objects because pictures of objects open up more possibilities for representing a wider range of objects (e.g. animate objects and objects too large to fit in a testing room, such as a truck) that, with real objects, would not be feasible or practical in a research environment. Additionally, children with ASD are able to conceptualize that symbolic representations via pictures represent objects in the real world (Hartley & Allen, 2014; Wainwright et al., 2020). Objects were chosen and adapted from D’Entremont and Dunham (1992) and Markman and Hutchinson (1984). Ten sets of objects were employed; in each set, a standard object, taxonomically similar object, thematically similar object, and unrelated object were included, for a total of 40 pictures. All the pictures were printed in color on 5x7 index cards. For the label condition, five one-syllable, consonant-vowel-consonant (CVC), nonsense words were used: *bif, dax, neb, gam, tal*. Markman and Hutchinson (1984) reported that it is better to avoid word-based biases and, thus, we have chosen to use nonsense words.

Table 1

Objects Utilized During the Taxonomic Task

Set	Standard	Taxonomic	Thematic	Unrelated
1	Australian Kelpie	Labrador Retriever	Bone	Lamp
2	Silver key	Gold key	Lock	Envelope
3	Suitcase with wheels	Trunk suitcase	Airplane	Vacuum
4	Plastic cup	Glass	Pitcher	Eggs
5	Tennis ball	Volleyball	Net	Couch
6	Large paintbrush	Thin paintbrush	Easel	House
7	Rose	Sunflower	Vase	Bicycle
8	Engagement ring	Wedding band	Hand	Umbrella
9	Sedan	Pickup truck	Road	tree
10	Tennis shoe	High heel	Foot	Bed

Note. Each set revolves around a central theme that links the standard object to the taxonomically related object. The themes are *dog, key, suitcase, cup, ball, paintbrush, flower, ring, car,* and *shoe*, respectively.

To assess the whole object bias task, ten objects with detachable parts whose labels are expected to be unfamiliar to young children were selected. One part of each object was decorated with craft items (fabric ribbon, glitter paper, paint, etc.) to enhance its saliency. Some of the objects were manipulable (e.g. the ball on the magnet toy could be spun around the stick and the silicone bristles of the basting brush are pliable), while others were unable to be adjusted (e.g, the citrus juicer consists of a metal reservoir and juicing cone that cannot be manipulated). In order to be able to present both parts of the object separately and together, simultaneously, two identical versions of each item were obtained and created. Ten new one-syllable, CVC, nonsense words were utilized: *kiv, pob, shihk, lig, mof, heg, dap, rel, nid,* and *jit*.

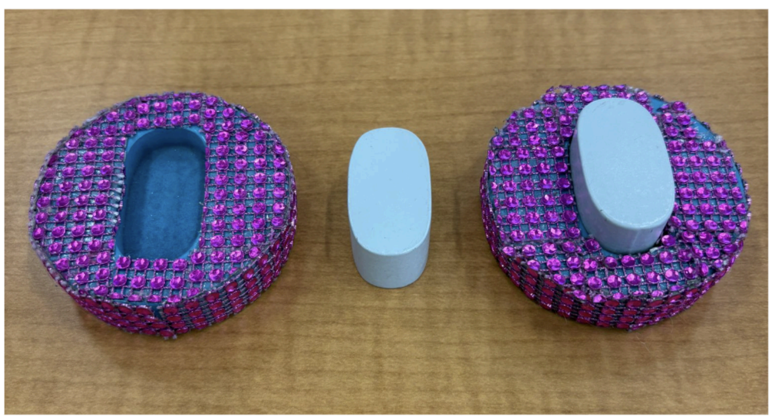
Table 2

Objects Utilized During the Whole Object Task

Set	Whole Object	Part 1	Part 2
1	Magnet toy	Ball	Magnetic stick
2	Basting brush	Handle	Brush
3	Citrus juicer	Reservoir	Juicing cone
4	Pasta grabber	Base	Circular insert
5	Pinwheel-like toy	Wooden stick	Spin top
6	Suction toy	Green base	Red top
7	Butter dish	Base	Lid
8	Spatula	Handle	Head
9	Block toy	Base	Cylindrical insert
10	Salt and pepper shaker	Base	Perforated top

Figure 1

Example Object Utilized During the Whole Object Task



Note. When two parts above are connected together, they make up a whole object (the object to the right).

Procedure

Questionnaires

Informed consent was obtained from all participants. Caregivers then filled out biological information, language and developmental history, distractibility, and receptive language questionnaires upon arriving at the study location. Questions on the distractibility questionnaire were derived from the NICH-Q Vanderbilt Assessment Scales, which screens for ADHD

("NICHQ Vanderbilt Assessment Scale", 2002). Receptive language was obtained by compiling words tested via the Peabody Picture Vocabulary Test - 4th edition (PPVT-4) and having parents circle the words their child understands. Subsequently, the Social Communication Questionnaire (SCQ) was then administered as a relatively easy form of assessing social communication skills that will vary along a continuum (Rutter et al., 2003).

Play time

A three-minute play session was implemented at the beginning of each session to introduce the child to the puppet that will be utilized later in the experiment and build rapport. The child and the experimenter were able to converse about a topic of the child's choosing and play with the puppet.

Taxonomic Task

The taxonomic task procedure was adapted from Markman and Hutchinson (1984).

Novel Word Condition. A camera was set up on a tripod facing the table and chairs and will record each session. The child and the researcher moved to sit across from or beside one another at a table or on the floor in the experimentation room. Children were first introduced to a hand puppet and told, "The puppet's name is Mr. Gerry. He talks in bunny language. Listen to the silly words he uses." On each trial, the puppet (acted out by the experimenter) placed the standard object picture in front of the child on the table and told that child, "See this? Isn't it nice? It's a [novel label]." The puppet then moved the picture of the standard object to the top of the table and placed the taxonomic, thematic, and unrelated object pictures in a line below the standard picture. The order of the taxonomic, thematic, and unrelated pictures was randomized with every trial and participant to avoid the child associating a place on the table with the related type of picture. The puppet then asked the child to "find another [novel label]." This process was repeated for all five Novel Word condition trials. Children's choices were marked on a scoresheet utilized for later analysis.

No-Word Condition. The materials and procedure for this condition were identical to those of the Novel Word condition, with one change. Children in this condition were not introduced to a novel label, but were instead asked to "find another one." Once the standard object picture was shown, the puppet said, "Look at this! Isn't it nice?" Once the other three pictures of objects were randomly placed below the standard object picture, the child was told to "find another one." This process was repeated for all five No-Word Condition trials. Children's choices were marked on a scoresheet utilized for later analysis. Novel Word condition trials and No-Word condition trials were counterbalanced.

Whole object

The whole object task procedure was loosely based on Hollich et al. (2007). The child and the researcher continued to sit across from or beside each other at the table or on the floor in the experimentation room with the camera recording each child's session. Children were reintroduced to a hand puppet and the puppet told the participant, "Mr. Gerry can talk in bunny language. Listen to the silly words he uses."

Familiarization. Children first completed a ten second play session with a novel object as the novel label was introduced. The puppet told the children, "This is a [novel label]. Do you see the [novel label]" as the novel object was simultaneously pulled apart into individual pieces and put back together. This process was repeated for all ten novel objects and labels. A familiarization was followed by a test phase for each object.

Test. The puppet placed the two novel parts and the whole object side by side in front of the child on the table. The order of the parts and whole object was randomized for each trial. The children were asked by the puppet, "Can you find a [novel label]?" They then were told to "point to a [novel label]." This was completed for all ten trials. Children's choices were marked on a scoresheet for later analysis.

Data Analysis

For the taxonomic bias task, a difference score was calculated to determine how many more times children chose the taxonomically similar object in the label condition than the non-label condition. For the whole object bias task, a percentage score was calculated to determine the number of times each child chose the whole object versus one of its parts. A two-sample unpaired t-test was used to analyze the difference scores from the taxonomic bias task in children with ASD and NA children. For the whole object bias task, a two-sample unpaired t-test was utilized to compare the number of times children with ASD select the whole object choice compared to the number times NA children who make this same choice.

A correlation between each task and vocabulary outcomes was conducted, collapsing across groups. We predicted that, in either group, children with more robust language abilities will exhibit the biases more often than children with lower language abilities. Additionally, a correlation between parent-reported distractibility scores and performance on the individual tasks was conducted in order to determine if distractibility affects task performance. Additional correlations were conducted between social communication scores and task performance to determine whether enhanced social communication affects task performance.

We hypothesize that the percentage of choices towards the taxonomically similar object will be larger than the percentage of choices towards the other object choices for children with ASD in both the labeling and no-label conditions. Additionally, we hypothesize that children with ASD will have similar percentages of choices towards the taxonomically similar object over the other object choices for the labeling and no-label conditions to their NA peers. We assume that children with ASD will have a higher percentage of part-object choices than whole object choices compared to their NA peers, who will have a higher percentage of whole object choices on the whole object bias task.

Results

Test of Assumptions

As a first pass, we wanted to see if NA children performed similarly to children in the literature. For the taxonomic assumption, Markman and Hutchinson (1984) tested 41 children ages 2 years 5 months to 3 years 11 months and determined that children in the no-word condition selected the taxonomic choice over the thematic choice 51% of the time and chose the taxonomic choice more often in the label condition: 69% of the time. This study only provided children with two choices: a taxonomic choice and thematic choice. Additionally, they decided to test younger children due to their hypothesis that young children are able to shift their attention from thematic relations to taxonomic relations (Markman and Hutchinson, 1984). A study that more accurately represents the current one is by D'Entremont and Dunham (1992), in which children saw a taxonomic, thematic, and unrelated choice during each trial of the testing phase. They tested 56 children within 2 months of their third birthday. They found that children more often chose the taxonomic choice in the label condition than in the no-label condition: mean frequency of 4.36 and 2.28, respectively.

We employed a larger age range in the current study to account for the variety in both children with ASD and NA children's language abilities. 22 NA children's results from the current study were included in data analysis. Children's ages ranged from 2 years 1 month to 10 years 7 months (mean age of 4 years 5 months). 77.3% (N = 17) identified as White, 9.1% (N =

2) as Black, 4.5% (N = 1) as Asian, and 9.1% (N = 2) as mixed. 45.5% (N = 10) were male and 54.5% (N = 12) were female; 45.5% (N = 10) were monolingual and 54.6% (N = 12) were bilingual.

For the taxonomic label condition, NA children in the current study chose the taxonomic choice 83.3% of the time ($t(20) = 4.07$, $p = .99$). Children chose the taxonomic choice 83.3% of the time for the no-label condition ($t(20) = .49$, $p = .68$), contrary to the results of Markman and Hutchinson (1984), in which children selected the taxonomic choice in the no-label condition an average of only about 50% of the time. This drastic difference in taxonomic choices could be due to the wider age range employed in this study compared to previous studies. Given that other studies tested children below four years of age (D'Entremont & Dunham, 1992; Markman, 1990; Markman, 1991; Markman & Hutchinson, 1984), the experimenter decided to explore the choices of all children compared to age in the current study (N = 34). A correlation between age and percentage of taxonomic choices in the no-label condition was performed ($r(32) = .30$, $p = .08$) (see Figure 2), showing that there is a weak positive relationship between these variables. Thus, as children get older they sometimes make more taxonomic connections in the no-label condition and older children show no difference between the label and no-label condition, contrary to previous studies.

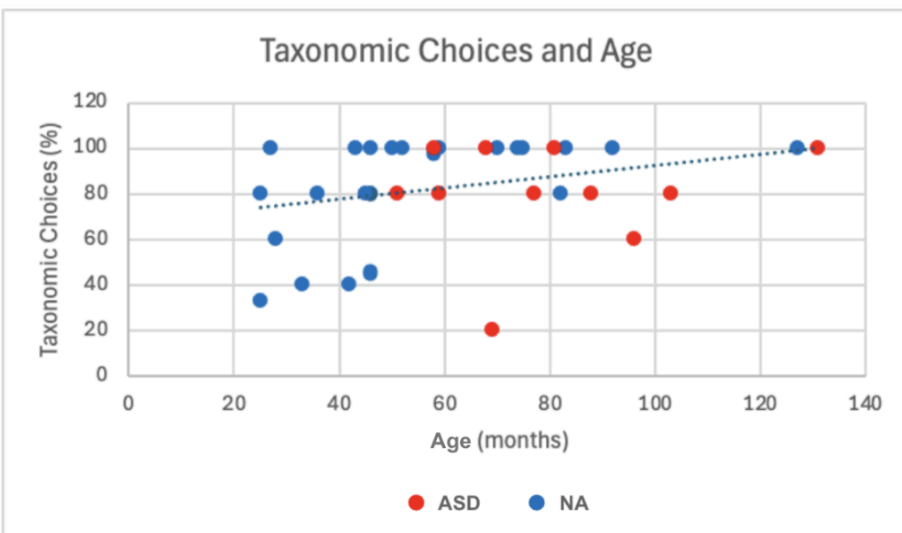


Fig 2. Correlation of percentage of taxonomic choices in the no-label condition and age of all participants.

For the whole object task, Markman and Wachtel (1988) observed that children ages 3;0 to 4;3 choose the whole object 80% of the time (chose the part 20% of the time) when no label was provided. In the current study, NA children chose the whole object choice over the part choices 63.5% of the time ($t(19) = -.52$, p = .3) (two children were unable to complete this task). Thus, while the current participants are significantly older, they are showing a similar pattern.

Performance of Children with ASD - Language Match

An analysis of performance on the experimental tasks was then completed between children with ASD and their NA peers, matched for receptive language. Receptive language scores were obtained from a parent-reported questionnaire created by the researchers from words presented on the Peabody Picture Vocabulary Test (PPVT). 12 children with ASD were tested; one child had very low language skills and thus could not be matched with a non-autistic peer. 11 children with ASD and 11 NA children were matched for receptive language. Of these 11 children with ASD, their ages ranged from 4 years 3 months to 10 years 11 months (mean age is 6 years 8 months). 36.4% (N = 4) identified as White, 36.4% (N = 4) as Black, 18.2% (N = 2) as Asian, and 9.1% (N = 1) identified as mixed; 72.7% (N = 8) were male and 27.3% (N = 3) were female. 81.8% (N = 9) of the children were monolingual and 18.2% (N = 2) were bilingual. Of the NA children, 63.6% (N = 7) identified as White, 9.1% (N = 1) as Black, 9.1% (N = 1) as Asian, and 18.2% (N = 2) as mixed; 72.7% (N = 8) were male and 27.3% (N = 3) were female. 59.1% (N = 13) were monolingual and 40.9% (N = 9) were bilingual.

Figure 3 shows the participants' performance on the taxonomic task in the label condition and Figure 4 illustrates the performance in the no-label condition. For the label and no-label conditions, there were no statistically significant effects: $t(32) = -.0004$, $p = .99$) and $t(32) = -.41$, $p = .68$, respectively. This means that children with ASD and NA children performed similarly on this task in each condition. For the label condition, children with ASD chose the taxonomic choice on average 83.3% of the time and NA children 83.3% of the time. For the no-label condition, children with ASD chose the taxonomic choice on average 80% of the time and NA children 83.3% of the time. Both groups made more taxonomic choices than thematic or unrelated choices regardless of if an object was given a label or not, suggesting that both groups of children exhibit a taxonomic bias.

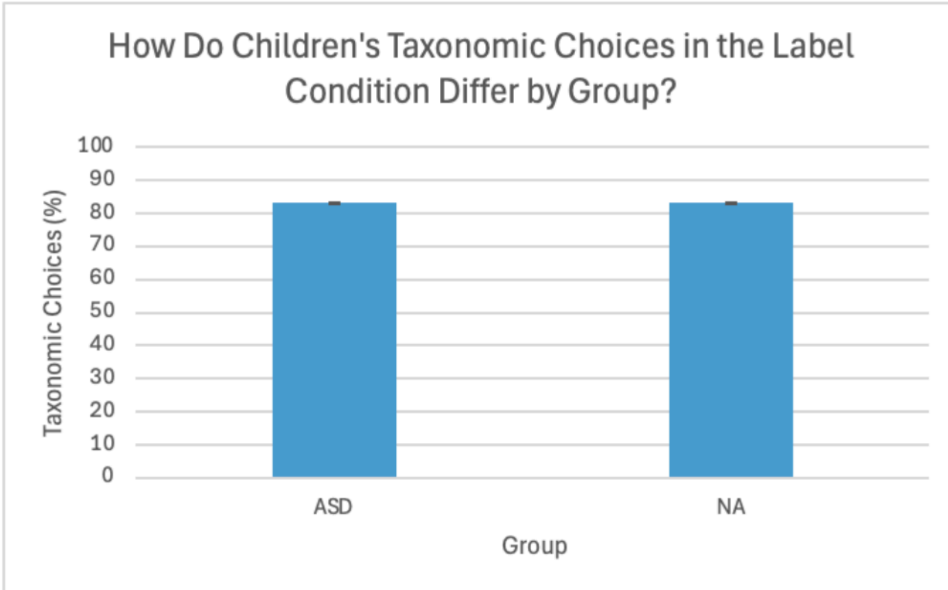


Fig 3. Percentage of taxonomic choices in the label condition between ASD and NA participants.

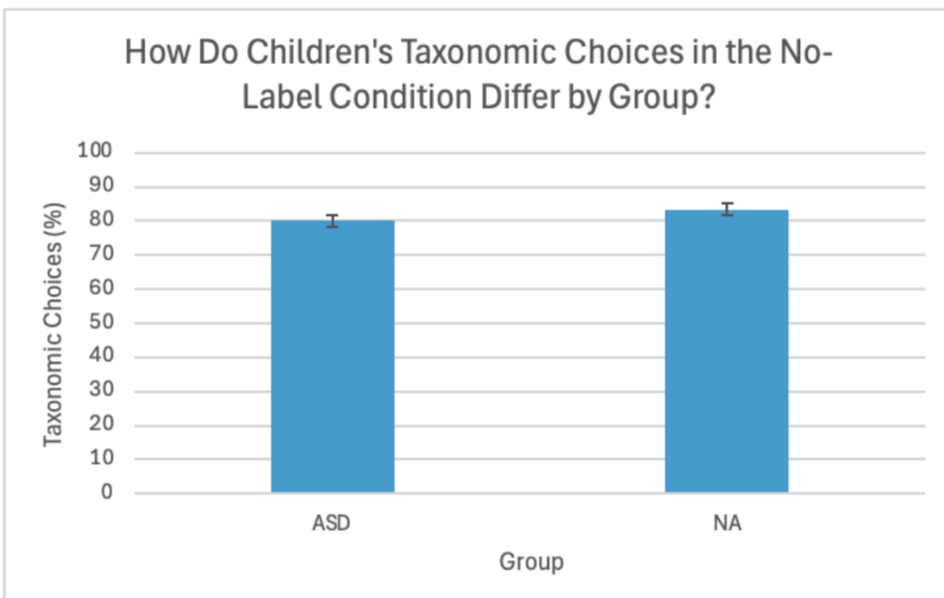


Fig 4. Percentage of taxonomic choices in the no-label condition between ASD and NA participants.

Figure 5 illustrates the participants' performance on the whole object task. Results indicate that there was no statistically significant effect of group ($t(28) = .99$, $p = .33$), suggesting that children with ASD and NA children performed similarly on the whole object task. Children with ASD chose the whole object choice over the individual parts on average 72% of the time and NA children chose the whole object choice on average 61% of the time. The number of whole object choices convey that children with ASD and NA children both exhibit a whole object bias, even despite added salience to part objects.

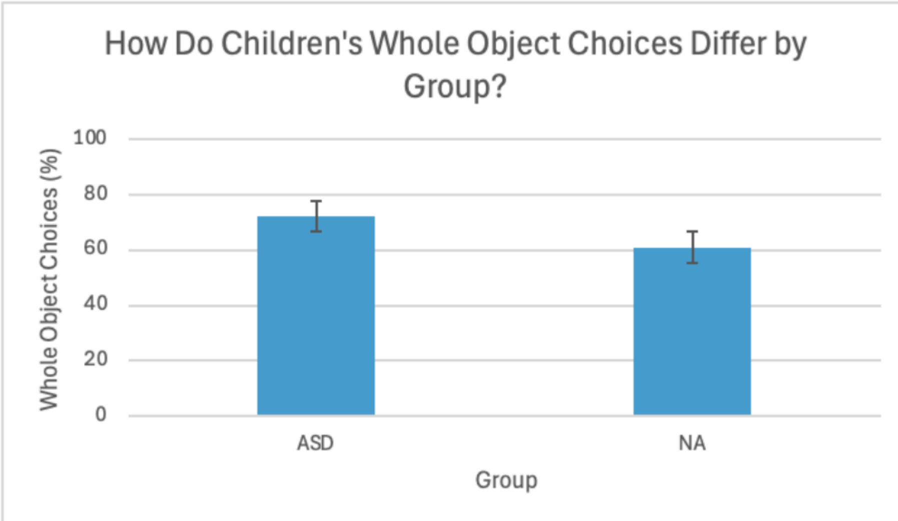


Fig 5. Percentage of whole object choices between ASD and NA participants.

Performance on Questionnaires

Participants' performance on parent-reported questionnaires are illustrated in Table 3. For the distractibility questionnaire, the researcher scored the number of times a parent circled a two or three for each question from a Likert scale of Never (0) to Most Likely (3) from a total of 15 questions. Results indicated that NA participants (N = 20) had a mean score of 1 and range of 0 - 4, meaning that the vast majority of children did not exhibit high rates of behaviors that indicate attention difficulty. Children with ASD (N = 11) had a mean score of 5 and range of 0 - 15, indicating that some children exhibited behaviors that indicate attention difficulty. Receptive language was assessed via 50 words that parents indicated if their child understood. The average number of words NA children (N = 20) understood was 43, with a range of 31 - 50 words understood, indicating high receptive language abilities. Children with ASD (N = 11) had a mean number of 36.36 words understood and range of 6 - 50, suggesting more variability in receptive language abilities. Finally, the Social Communication Questionnaire was administered, with the maximum score one could receive being 25 (the higher the score, the more indicative of social communication difficulties one has). The mean score for NA children (N = 20) was 3.45 and the range was 0 - 7, indicating that the vast majority of children did not exhibit behaviors indicative of social communication difficulties. Children with ASD (N = 11) had a mean score of 6.82 and range of 4 - 10, suggesting that some children experience social communication difficulties.

Table 3

Performance on Parent-Reported Questionnaires

Questionnaire	NA		ASD	
	Mean	Range	Mean	Range
Distractibility questionnaire	1	0 - 4	5	0 - 15
Receptive language questionnaire	43	31 - 50	36.36	6 - 50
Social Communication Questionnaire	3.45	0 - 7	6.82	4 - 10

Correlation Between Task Performance and Receptive Language

Correlations between our ASD and NA children's receptive language abilities—based on a parent-reported questionnaire—and task performance were conducted to further examine how individual differences contribute to task performance. All NA children and children with ASD were utilized (N = 31, as two children did not have completed questionnaires). The label condition of the taxonomic task indicated a negligible relationship ($r(29) = .04$, $p = .83$) (see Figure 6); thus, there is no relationship between taxonomic task performance and receptive language. For the no-label condition of the taxonomic task, a moderate positive relationship ($r(29) = .27$, $p = .14$) (see Figure 7) with receptive language scores arose, indicating that as receptive language increases, performance on the task generally increases as well. Because of the very small sample size, however, this correlation may be misleading as it is only driven by one or two children. For the whole object task, there was a negligible correlation ($r(26) = .14$, $p = .48$) (see Figure 8), suggesting that there is no relationship between whole object task performance and receptive language.

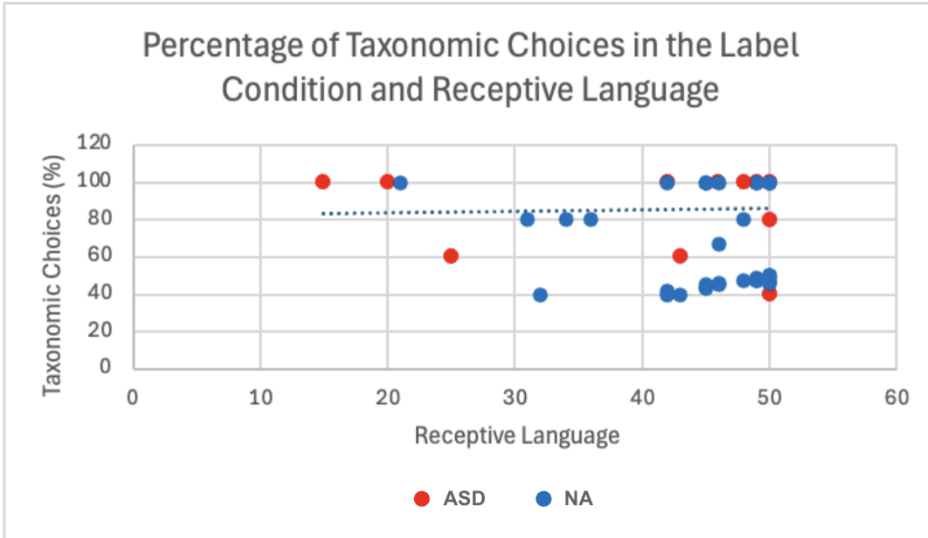


Fig 6. Correlation of percentages of taxonomic choices in the label condition and receptive language scores for participants with ASD.

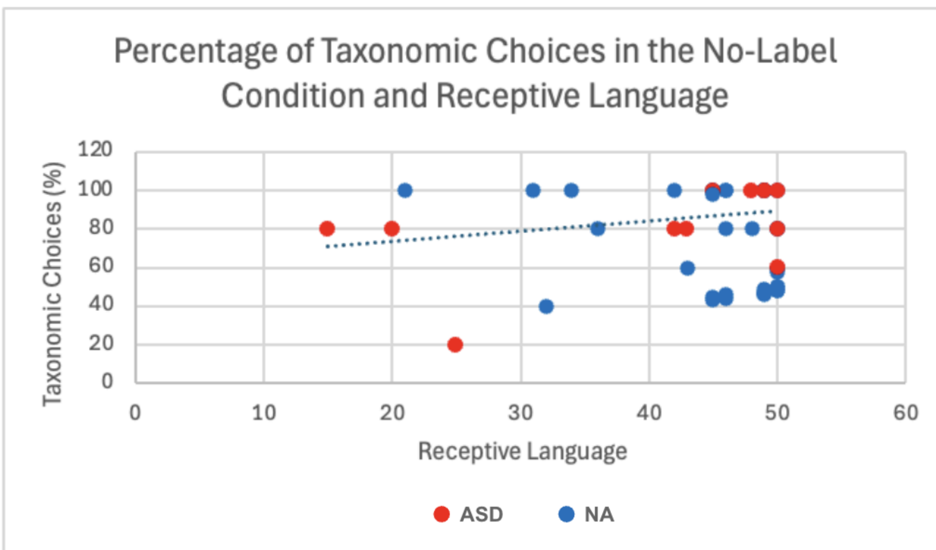


Fig 7. Correlation of percentages of taxonomic choices in the no-label condition and receptive language scores for participants with ASD.

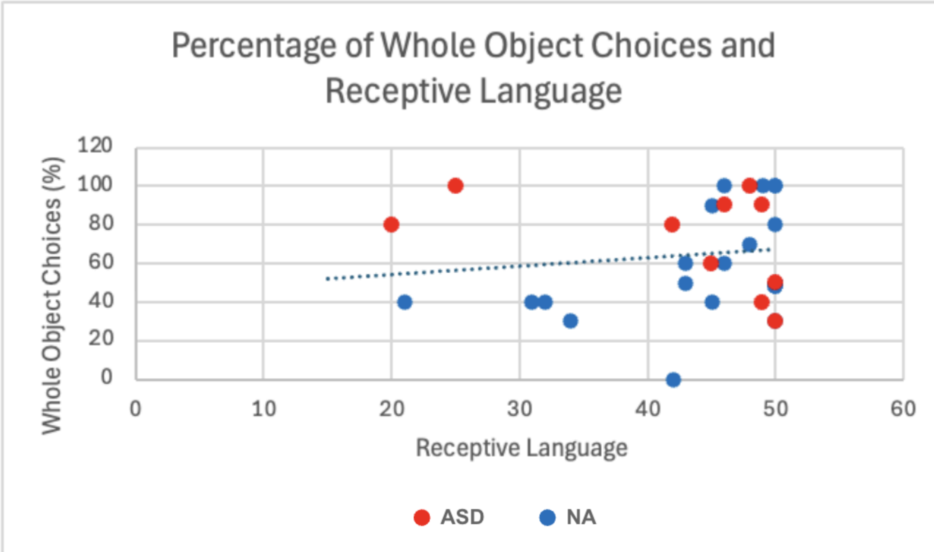


Fig 8. Correlation of percentages of whole object choices and receptive language scores for participants with ASD.

Correlation Between Task Performance and Distractibility

We were further interested in how individual differences in distractibility might contribute to task performance. To explore these potential effects, a correlation between performance on the experimental tasks and children's distractibility based on a parent-reported questionnaire was conducted for all ASD and NA children (N = 31, as some children did not complete distractibility questionnaires). We decided to test the effects for all children because we wanted to determine relationships between these variables beyond merely matching NA children and children with ASD for similar distractibility scores. For the label condition of the taxonomic task, no apparent relationship ($r(29) = 0$, $p = .99$) arose (see Figure 9), suggesting that there is no relationship between children's performance and their distractibility score. The no-label condition produced a negligible relationship ($r(29) = .04$, $p = .83$) with distractibility scores (see Figure 10), indicating that task performance does not affect the child's distractibility. For the whole object task, a weak negative correlation ($r(26) = -.19$, $p = .34$) was found between performance on the task and children's overall distractibility scores (see Figure 11). This means that as children's distractibility scores increase, their task performance sometimes decreases. However, these results are not statistically significant, so it is unclear if there is a real relationship or it is spurious.

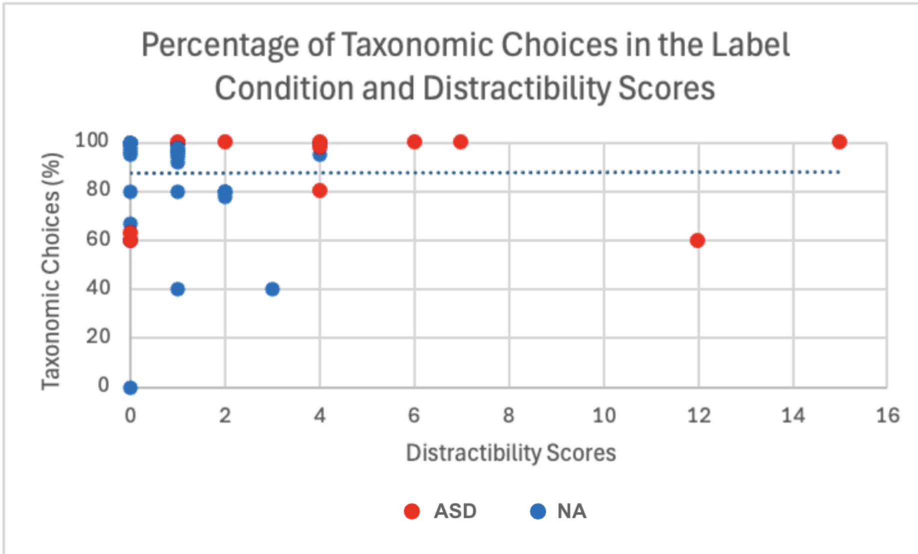


Fig 9. Correlation of percentages of taxonomic choices in the label condition and distractibility scores for all participants.

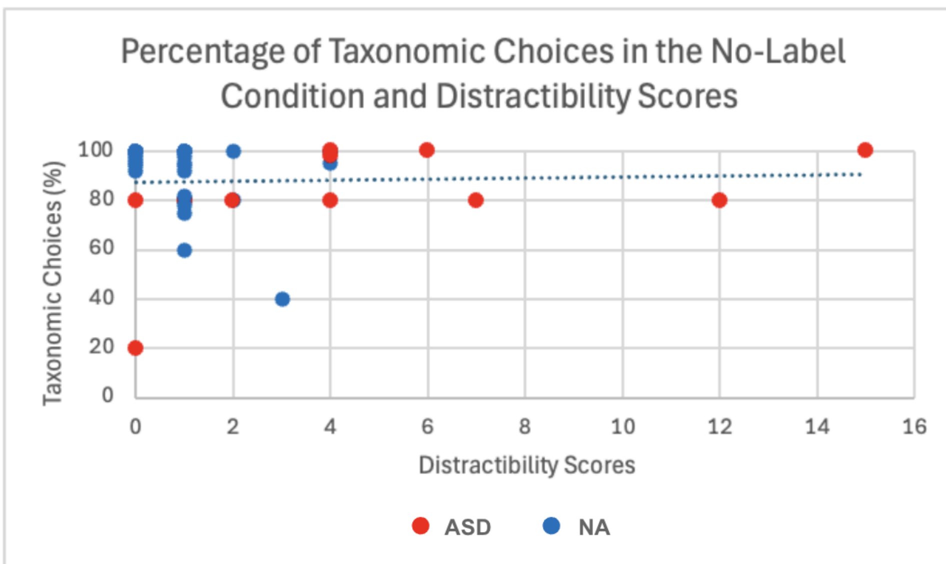


Fig 10. Correlation of percentages of taxonomic choices in the no-label condition and distractibility scores for all participants.

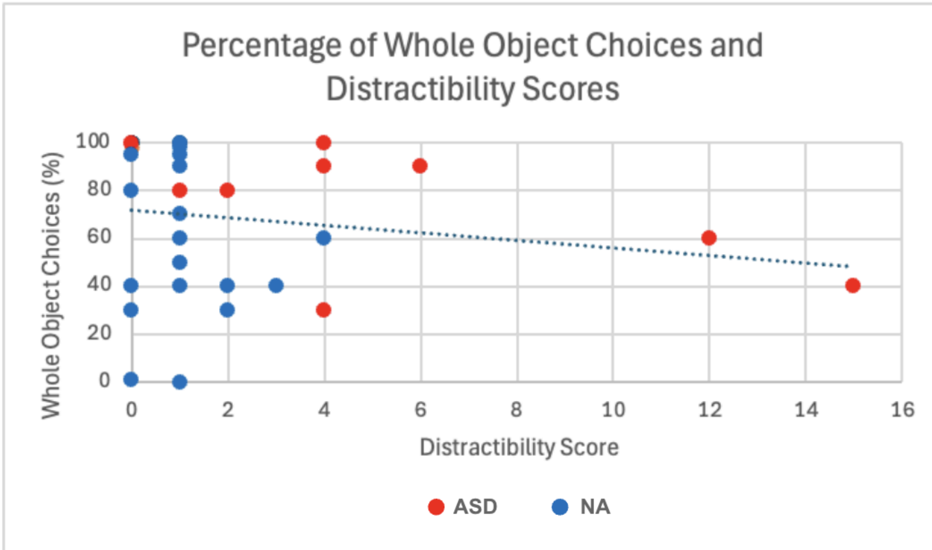


Fig 11. Correlation of percentages of whole object choices and distractibility scores for all participants.

Correlation Between Task Performance and Social Communication

Correlations between NA and ASD children's social communication skills and task performance were conducted to better understand how social uses of language contribute to task performance. Similar to distractibility, we decided to test the effects for all children because we wanted to determine relationships between these variables beyond merely matching NA children and children with ASD for similar social communication scores (N = 31, as some children did not complete Social Communication Questionnaires). All items of the Social Communication Questionnaire were utilized in these correlations, including those pertaining to spontaneous initiation of interaction, affection and peer interaction, sharing interest, facial expressions, turn taking, empathy, social responses and engagement, restrictive and repetitive behaviors, and verbal and nonverbal communication. The label condition of the taxonomic task illustrated a negligible relationship ($r(29) = .01$, $p = .96$) (see Figure 12), suggesting that there is no relationship between social communication and task performance in the label condition. The no-label taxonomic condition produced a weak negative relationship ($r(29) = -.26$, $p = .16$) (see Figure 13), conveying that as social communication becomes less reflective of social communication disorders, task performance sometimes increases. For the whole object task, a negligible relationship arose ($r(29) = -.08$, $p = .68$) (see Figure 14). This relationship conveys that there is no relationship between social communication and whole object task performance.

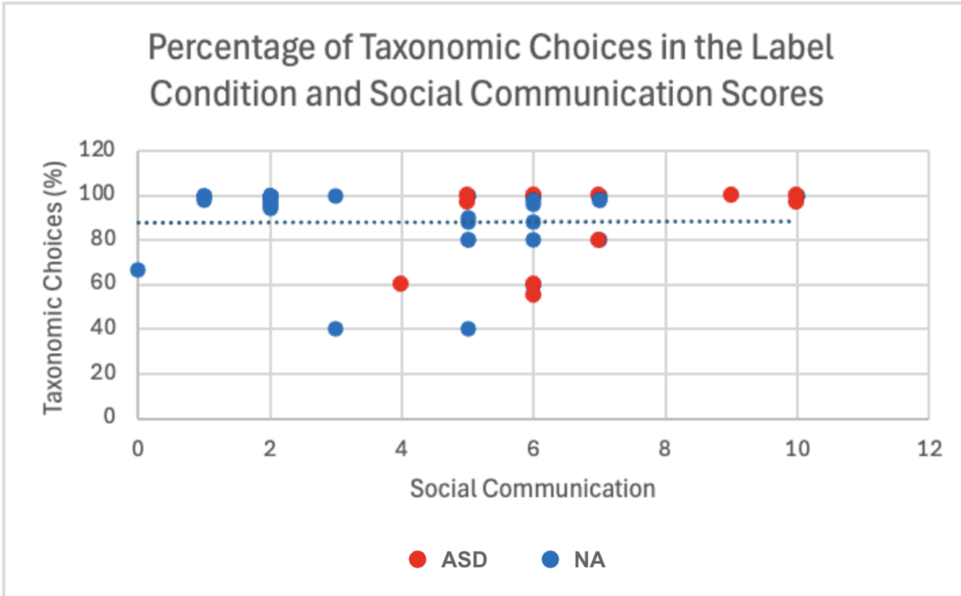


Fig 12. Correlation of percentages of taxonomic choices in the label condition and social communication scores for all participants.

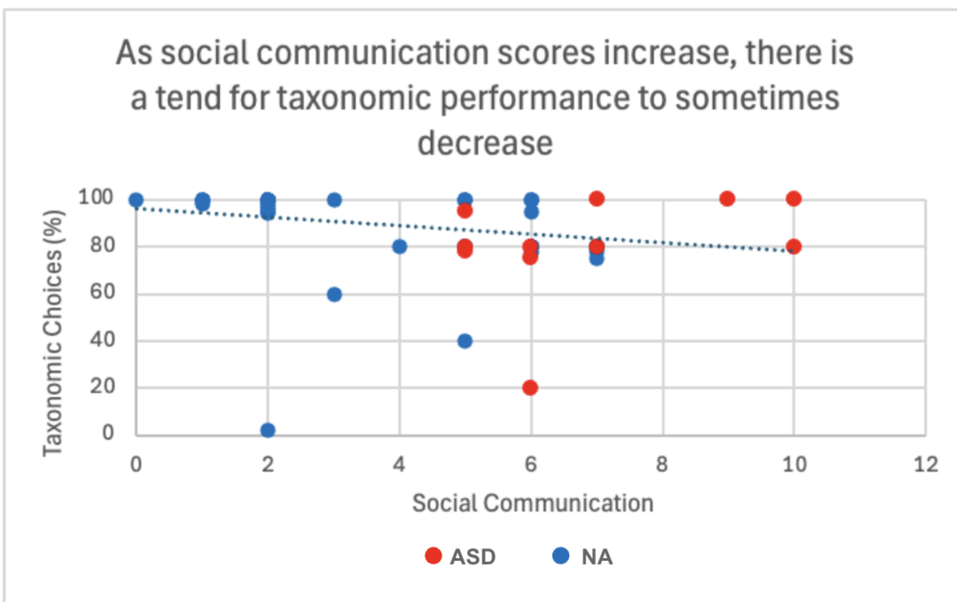


Fig 13. Correlation of percentages of taxonomic choices in the no-label condition and social communication scores for all participants.

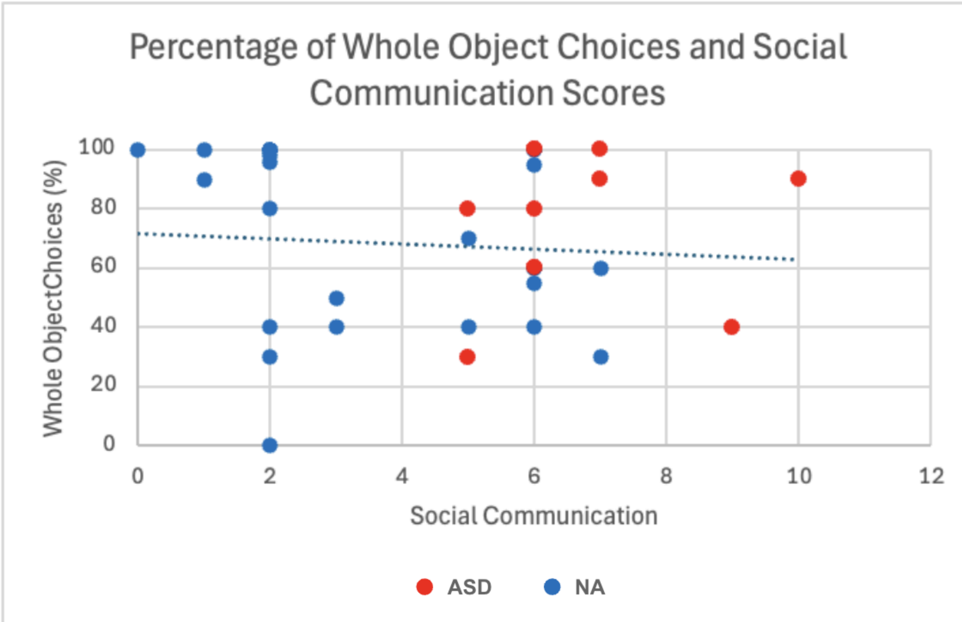


Fig 14. Correlation of percentages of whole object choices and social communication scores for all participants.

Discussion

General Trends

This study explored whether children with ASD exhibit a taxonomic and/or whole object bias compared to their NA peers. We hypothesized that children with ASD would more often choose the taxonomically similar object over the other object choices in both the labeling and no-label conditions, and that children with ASD would perform similarly to their NA peers for the taxonomic task and differently in the whole object bias task. Results were consistent with our first hypothesis and inconsistent with our second hypothesis, conveying that children with ASD exhibited a taxonomic bias in both the label and no-label conditions, and that they performed similarly to their non-autistic peers in both the taxonomic and whole object tasks.

We first wanted to determine if NA children in our study performed similarly to children in other studies with taxonomic and whole object tasks. For the taxonomic task, D'Entremont & Dunham (1992) found that children exhibited a taxonomic bias in the label condition compared to the no-label condition when three choice options were presented (taxonomic, thematic, and unrelated). In the current study, we found that NA children chose the taxonomic choice the same amount for the label and no-label conditions (83.3%), conveying that NA children exhibit a taxonomic bias regardless of presentation of a label or not. A possible explanation for this could be the wider age range employed in this study compared to D'Entremont and Dunham (1992).

Participants in previous studies ranged from 2 years 5 months to 3 years 11 months (D'Entremont and Dunham, 1992; Markman, 1990; Markman, 1991; Markman & Hutchinson, 1984), while participants in this study ranged from 2 years 1 month to 10 years 7 months. We found a weak positive correlation between taxonomic task performance in the no-label condition and age for our participants, suggesting that older children are sometimes more likely to make more taxonomic selections without the presence of a label and that trends are similar to that of previous research. Due to the larger breadth of children's ages, children may have understood the concept that objects and their labels are housed in larger categories due to the more language and experience at their disposal. As a result, they could understand just from visual information that an Australian Kelpie and labrador retriever both share the broader conceptual and naming category of 'dog,' for example.

In terms of the performance of our ASD participants, they performed similarly to their NA peers on the taxonomic task, regardless of condition, and the whole object task. Both children with ASD and NA children overall made more taxonomic and whole object choices, despite the added salience to one of the parts. One possibility for the abundance of whole object choices could be what Hollich et al. (2007) refers to as *guided distributional learning*. They explain that children need to have learned necessary word-to-word mappings to extend a word on the basis of shape, category, etc. (Hollich et al., 2007). Thus, children with more robust vocabularies are more likely to extend words. Many of our ASD participants had higher receptive language abilities, which could explain their tendency to extend labels to objects of the same category and to objects as a whole.

Correlations between the taxonomic task in the no-label condition and receptive language suggests that as receptive language increases, task performance improves. This is in line with past research, as Hollich et al. (2007) reported more robust language abilities contributing to greater task performance. Children in the current study tended to have more robust receptive language and overall exhibited a taxonomic bias in the no-label condition. Interestingly, a correlation between the whole object task and receptive language, and the taxonomic task in the label condition and receptive language, demonstrates no relationship. The negligible relationship may be due to the small sample size utilized, which reduces the ability to detect a meaningful relationship.

Correlations between task performance and distractibility scores indicate surprising results for the taxonomic task. The label and no-label conditions of the taxonomic task produced no apparent relationship between task performance and distractibility. This is quite surprising, as one would expect task performance to decline with more difficulty attending to a task. A potential explanation for this lack of relationship could be that a Pearson correlation only detects linear relationships. The current sample may have produced a nonlinear pattern instead of a linear one, especially because some participants had moderate distractibility that may or may not have affected task performance. As a result, there may actually be a relationship between these variables despite a Pearson correlation not showing a linear relationship. Yet, if the task was very easy to the child, potential distractibility may not play a factor in performance if the test seems very intuitive. Another possibility could be the small sample size utilized and thus the unreliable relationship, or lack thereof, that was found. More research is needed to determine if there is a distinct relationship between taxonomic task performance and distractibility when there are more participants.

Correlations between the whole object task and distractibility reveals that as children's distractibility scores increase, their task performance sometimes decreases. This is not surprising because higher attention scores lead to more difficulty with attending to a task. It is predictable that difficulty with attending to the experimental task would likely produce poorer task performance, as the child has difficulty focusing on what the experimenter is communicating, looking at the objects, and making a selection throughout the task. These results combined with the correlation between the taxonomic task and attention begs the question, why does poorer attention lead to better performance on one experimental task but not the other? Perhaps replication of this study with a larger sample size of both ASD and NA participants would help clarify these results.

Final correlations were conducted between social communication skills derived from the Social Communication Questionnaire and task performance for participants with ASD and NA participants. In both the label condition of the taxonomic task and the whole object task, no apparent relationship arose. Once again, this could be due to the small sample size producing unreliable results, requiring future studies to reexamine this relationship. The no-label condition of the taxonomic task suggests that as social communication becomes less reflective of social communication disorders, task performance sometimes increases. One would expect social communication to assist with task performance, as they are able to better communicate any conflicts with the task (e.g. misunderstanding directions), active listening, and better rapport with the experimenter. Effective task completion could be reliant on utilizing social communication skills via verbal and nonverbal cues to ensure the communicative intent and message is correctly understood by the participants.

Limitations, Future Directions, and Implications

A limitation of this study includes the limited sample size. Only 22 NA participants were included in the test of assumptions data analysis, and 31 participants in correlations between task performance and distractibility and between task performance and social communication. 11 participants with ASD and 11 NA participants were matched for task performance and correlations between task performance and distractibility. Because of the small sample size, we were unable to complete a strong test of correlations and generalize results to the greater population. More research is needed to determine if more children with ASD utilize a taxonomic and whole object bias at various ages. Additionally, a vast majority of ASD participants had more robust receptive language skills, so future studies could determine if children with ASD who have more limited receptive language utilize these biases. Furthermore, potential confounding variables could have resulted in poorer attention scores being correlated with improved taxonomic task performance. Potentially a larger sample size of ASD participants with varying levels of attention could help provide more clarity.

We now understand that some children with ASD perform similarly to NA children on taxonomic and whole object bias tasks. Yet, more research is needed to understand if these trends hold up in the greater population. Hopefully, this research can pave the way for a greater understanding of the word learning strategies utilized by children with ASD and help inform educators, parents, and healthcare professionals of the unique cognitive pathways and learning strategies of children with ASD.

Conclusion

The findings of this study show that children with ASD utilize taxonomic and whole object biases similar to their NA peers, and that they perform similarly on the taxonomic task regardless of presentation of a label or not, and on the whole object task. Additionally, receptive language scores and task performance were positively correlated for the taxonomic task—suggesting that as language abilities increase, children with ASD are more likely to exhibit these word learning biases and perform similarly to their NA peers—and negatively for the whole object bias task. Correlations between task performance and distractibility revealed more varying results, with participants with more severe distractibility performing better on the whole object task. Correlations between task performance and social communication suggest that enhanced social communication does not yield better task performance for the taxonomic task only in the label condition and has no effect on the no-label condition or whole object task. These results need to be further studied to determine trends, however, they provide a strong foundation for how children with ASD learn new words.

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