Linguistic Support for the Acquisition of Emotion Adjectives

Honors Thesis

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Abstract

Children with Autism Spectrum Disorder have been documented to face challenges on facial recognition tasks and emotion identification tasks in comparison to their typically developing peers. Is this difficulty a result of an inability to recognize emotion expressions, or a lack of pertinent linguistic support to recognize that emotion is the relevant property? We hypothesize that linguistic structures might support the acquisition of emotions and emotion adjective meaning for a population who struggles to recognize emotions through facial expressions. We test this hypothesis by first turning to a neurotypical population to examine the role of structure in supporting the acquisition of emotion adjectives in this population, extending it to autistic individuals.

In this experiment, neurotypical and autistic children were presented with images of people displaying a variety of emotions and accessories, and asked to sort them into categories. We manipulated the presence/absence of language to guide category formation, and the linguistic context in which a novel adjective appears. The results indicate that neurotypical participants are more likely to sort faces by emotion rather than other attributes when provided with a novel adjective label, an even more so when provided with a novel adjective label followed by a syntactic complement, curing emotion/mental states. If this finding also extends to autistic individuals, it demonstrates a key source of support for word learning and emotion recognition in a population that otherwise struggles with social cues.

1. Introduction

One of the common behaviors associated with Autism Spectrum Disorder is difficulty picking up on social cues related to emotion. Difficulties in recognizing the emotional states of others can lead to social isolation, as well as impaired communication. It may be the case that individuals with autism struggle to pick up on emotion because they lack a proper understanding of emotion vocabulary (particularly adjectives), or do not have access to the types of information that would make emotion recognition easier for them. Emotion recognition tasks performed in clinical settings have proved more difficult for autistic individuals in comparison to neurotypical individuals. While some studies suggest that children with autism lack the cognitive capacity to perform these tasks sufficiently, others indicate that children with autism may require a different subset of information, apart from facial stimuli, to be successful on these tasks. There is a possibility that autistic individuals could more successfully recognize emotions if researchers leveraged linguistic information in emotion recognition tasks. Emotion adjectives appear in predictable linguistic contexts, and for individuals who have difficulty with facial recognition, manipulating this linguistic information could prove to be an effective strategy.

In this study, we manipulate linguistic structure to determine how the syntactic environment in which a word appears might support emotion word acquisition, and the recognition of emotions. Can the syntactic environment in which a word appears support emotion word learning for autistic individuals? Our research aims to study how children acquire emotion adjectives. Our findings may be applicable in educational and clinical settings to better support populations with language and cognitive disorders through the implementation of intervention techniques.

2. Background

Children with Autism Spectrum Disorder tend to perform poorly on tasks that require the participant to identify particular emotions in comparison to their typically developing peers, (Uljarevic & Hamilton, 2010), (Rump et al., 2009). Children with ASD appear to have the easiest time recognizing anger and happiness and struggle most to identify sadness and fear (Davidson et al., 2019), (Shanok et al., 2019). Typically developing children experience relative ease in recognizing the core emotions used in scientific studies: happiness, sadness, and anger. Neurotypical children have a very similar struggle to children with ASD when it comes to identifying fear, (Uljarevic & Hamilton, 2010).

2.1. Potential Reasons for Differences in Emotion Recognition between Neurotypical and Autistic Individuals

Some suggest that autistic children may lack the cognitive capacity to excel at emotion recognition. In Baron-Cohen (1991), neurotypical and autistic children were presented with stories about a doll where the doll possessed the desire for something which then either met her expectations or did not. The results of this study suggested that neurotypical children had an easier time with the task and autistic children struggle with emotions associated with belief. Emotions resulting from a violation of expectation were more difficult for autistic children to grasp. Difficulties with tasks pertaining to complex emotion in comparison to simple desire tasks supports the theory that autistic children may have difficulties in conceptualizing metarepresentations.

While Baron-Cohen (1991) entertains a struggle with metarepresentations, other studies suggest a disinterest in facial expressions, resulting in a lack of attentiveness. The work done by Weeks and Hobson (1991) was designed with the expectation that autistic children would disregard the facial expressions displayed in the task. The study presented neurotypical and

autistic children with a task where they were asked to organize photos. The stimuli presented could be sorted by age, sex, hat or facial expression. The children were tasked with organizing the photos in whatever manner they deemed appropriate, and each time they finished the task they were asked to sort in a different way. Statistical results indicate that a majority of the children in both groups sorted by gender first. 20 out of 30 participants, 10 out of 15 in each group, began their sorting process with gender. Following gender, 75% of participants with autism sorted by hat before emotion expression. Salience in the non-autistic group was emotion expression followed by type of hat, with 66% of children sorting in this manner. Each of the fifteen children in the non-autistic group sorted by emotion expression without prompting, while only six autistic children were able to sort emotion expression without being told to do so. Of these children, only four were able to sort successfully after having the task explained to them. Age proved to be the least salient factor for both groups, as many of the children did not conclude that age was a sortable category; some of the participants required guidance from the experimenter to sort by age. The study demonstrated that children with autism were not as inclined to sort by emotion as their non-autistic peers, though a majority of autistic subjects managed to sort using emotion by the third round.

Teh et al. (2018) examined the spontaneous productions of children when presented with pictures displaying varying levels of social engagement and emotion valence. The pictures displayed individuals participating in activities alone and in groups to account for social engagement. In the images, individuals were engaged in positive experiences, such as winning an award, and negative experiences, such as a boy dropping his ice cream, to measure emotion valence. This type of research helps provide insight into what children are noticing when examining a scene without putting direct emphasis on emotion during the task. The study found

that children with Autism Spectrum Disorder were less likely to produce adjectives that express emotions in comparison to their typically developing peers. As social engagement in the photos grew, emotion descriptions reduced by nearly half in comparison to low social engagement images for the positive valence condition. The data suggests a negative valence attentional bias for both sets of participants, as both groups attended to negative valence situations more than positive valence situations in their descriptions.

2.2. Factors Influencing Social Engagement Beyond Facial Cues

Begeer et al. (2006) suggests that autistic children may be considering other factors, rather than emotion, to be more valuable in social situations. In one such study, children were first asked to sort four photos based on which images were the 'most similar;' children with autism performed significantly worse than their peers on this task. Only 32% of children with autism were able to identify emotion as a similarity after being given four attempts at the task. In comparison, 55% of non-autistic children identified emotion as a sorting criteria within the four attempts. In the other condition, emotion recognition became an important stake in hypothetical scenarios that involved the children interacting with the individuals pictured. In this case, children with autism matched the level of success that typically developing children attain. 57% of autistic children were able to sort by emotion expression on the first try for this task, and all children successfully sorted by emotion expression by the fourth attempt. Autistic children only attended to emotion when they were required to "interact" with the individuals pictured, suggesting that perhaps emotion recognition is similarly accessible for children with Autism Spectrum Disorder, but it is not a factor that they often feel the need to attend to (Begeer et al., 2006).

In a task conducted by Celani et al. (1999), children of typical and atypical development were presented with a series of photos depicting facial expressions. The children were asked to pick out the photo that displayed a target emotion. Amongst neurotypical children, children with Down syndrome and children with autism, the autistic children performed the lowest of the three groups on the emotion condition and struggled most with positive valence items. In the emotion situation condition, children were presented with photos of favorable or unfavorable situations and they were asked to select from a happy or sad individual for each scene. There were no significant differences between groups for this condition. From this data, the authors suggest that children with autism may not use the typical happy facial expression as an indicator for the general disposition of an individual, which supports the lack of attentiveness discussed in other experiments.

Research shows that children with autism match facial expressions in animals with the same ease as typically developing children, suggesting that disinterest in facial expressions may only pertain to human faces (Davidson et al., 2019). Despite a potential disinterest in facial expressions, fMRI imaging indicates that autistic children have more activation in the fusiform face area than neurotypical children. Research suggests that children with autism tend to favor objects over people (Whyte et al., 2016) and the mouth region of the face over the eyes (Gross, 2004). This may account for some of the discrepancies in identifying facial expressions, as full facial analysis of a person, and particularly the eye region, is important in facial identification for typically developing children. The work of Guarnera et al. (2015) establishes that children have the easiest time recognizing anger and sadness from the eye region alone. Fear, sadness and surprise were deemed particularly difficult to identify from the mouth region alone. Previous

work has found that children are often more successful at emotion recognition tasks when presented with a full face for analysis.

Research suggests that while typically developing children display no difference in recognizing the emotions of familiar and unfamiliar people, autistic children are more successful in tasks displaying familiar faces than unfamiliar faces (Shanok et al., 2019). Shanok et al. (2019) supports the idea that autistic children are more perceptive to the emotions of their mother. In their task, autistic children were able to match the success of non-autistic peers when identifying the emotions of their mother. They were significantly worse in comparison to non-autistic peers when identifying the emotion expressions of strangers. This may indicate that autistic children are capable of applying typical emotion recognition skills in cases where they have a close social relationship with another individual.

In support of this result, children tend to have more activation in the fusiform face area to familiar faces than unfamiliar faces (Whyte et al., 2016). The fusiform face area is the part of the brain that is primarily responsible for recognition of human faces. Children with autism have more activation in the fusiform face area when viewing objects of interest than when viewing familiar human faces. It is common for children with autism to have hyperfixations. A hyperfixation is an interest or fascination that a person becomes excessively focused on. Over attending to these interests results in the children being quicker to interactions with these things rather than human faces. Overall, the fusiform face area is more attuned to familiarity, but children with autism have a different experience than neurotypical children. Grelotti et al. (2005) entertains the possibility that the fusiform face area supports a different function for children with autism, experiencing only minimal activation for human faces.

2.3. Contextual Support Influencing Emotion Recognition

Widen and Russell (2010) suggests that children may be gaining input about emotion categories through events and behaviors associated with emotion. Their study demonstrated better performance naming complex emotions when presented with a story condition, as opposed to basic photo stimuli. This suggests that children are more accurate at identifying emotions when presented with context for the situation. Loveland et al. (1997) focused on how low and high functioning children with autism interpreted short videos of people talking and displaying emotion. The videos varied in use of verbal and nonverbal cues indicating emotion. The study found that the autistic individuals were using both verbal and nonverbal cues to analyze emotion, as the results were more accurate with the use of more cues. When the facial expression and tone of voice conveyed emotion, children had an easier time correctly identifying the target stimuli. In comparison to their performance when face and tone of voice did not convey emotion. High functioning individuals experienced the most difficulty when nonverbal information was excluded, suggesting that they are using all information available to them to come to the most accurate conclusion. The study cites verbal mental age as a potential indicator of an individual's ability to use both nonverbal and verbal cues effectively.

Given these results, it is reasonable to question whether children are more reliant on facial stimuli or linguistic input when coming to conclusions about emotion recognition. If linguistic stimuli is more informative for language learners, there may be drawbacks to using categorical stimuli for teaching emotion concepts, particularly given the noncategorical nature of emotions. Solely relying on concrete representations of emotion may not be adequate for children to grasp the complexity of these mental states, thus informing more effective educational strategies for emotion development.

2.4. Emotion Adjective Acquisition

Emotion adjectives are words that express how a something or someone is feeling. These types of adjectives are considered to be abstract, as emotions are linked to an internal mental state that does not have a reliable outward physical correlate. Abstract words are a complex part of language development that every child is faced with learning. While words like *jump* and *run* have physical correlates that allow children to pick up on their meanings based on visual cues, words like 'think' and 'believe' lack the concrete visual perception cues that assist children in their language acquisition journey.

The difficulties children have in acquiring verbs can be extended to adjectives. Adjectives that express color and shape correspond to properties that have reliable external and physical correlates (much like jumping or running). By contrast, adjectives for emotions and mental states correspond to properties that abstract and not reliably detectable (like thinking or believing). Emotions can be expressed inwardly and outwardly and consist of a variety of complex inner feelings, regardless of presentation. Children not only have to learn to grasp these concepts, but also must understand these emotions in other people and the ways to communicate these emotions appropriately. It is difficult to represent the varying intensity and complexity of emotions using concrete representations.

Widen and Russell (2003) postulate that infants interact with emotion based on valence. At the beginning of their lives, infants understand experiences as pleasant and unpleasant. Children begin by processing emotions in broad categories that consist of positive emotions and negative emotions. The work of Nencheva et al. (2023) suggests the positive or negative content of emotion adjectives bootstrap a child's learning. The study found that caregivers often used language with children that linked emotion labels to other similarly valanced words. As children build a vocabulary of positive and negative concepts, they can construct their vocabulary to more

easily include novel emotion labels. Nencheva et al. (2023) also postulates that when caregivers provide more valanced language, the children are set up to develop stronger semantic connections between emotion labels and similarly valanced language, which will boost their language development in emotion categories.

Research suggests that children begin to grasp happiness, sadness and anger, early on, followed by emotions such as fear and surprise. Their list of emotion target words grows as children get older and their language continues to develop. This is supported by Widen and Russell (2003), as their study demonstrates an improvement in the recognition and use of target emotion words in older subjects, at five years of age, in comparison to younger peers, age three. The older children also exhibited more expansive vocabulary.

One may argue that representations such as the "smiley face" do an adequate job at depicting happiness and other emoticons of a similar sort can capture other emotions. However, these depictions are a concrete set of images attempting to illustrate an immeasurable scale of emotions that are abstract to physical representation. These concrete representations may not be satisfactory in the process of emotion adjective acquisition, as they cannot capture the experience associated with emotion.

Many children with autism struggle to convey emotions and communicate about how they are feeling. Teenagers with autism are prone to experiencing anxiety and depression and have difficulty understanding and coming to terms with their emotions. Cases of anxiety and depression in otherwise neurotypical teenagers can be difficult to manage, as these children do not always know how to seek help when met with these new emotions and feel the need to withdraw. Given that many autistic individuals struggle with communication and emotion regulation, managing anxiety and/or depression can prove difficult. It becomes challenging to

address feelings of anxiety, depression, jealousy, remorse, and shame, amongst others, when no images can be applied to the feeling. If physical representations are not enough for children to grasp the complexity of these adjectives, it is important to consider how children are picking up on this kind of information. Developing a better understanding of the linguistic environments that support word learning will allow researchers and educators to better aid in language acquisition.

2.5. Supporting Adjective Learning

Gleitman et al. (2005) proposes the idea of a "general learning procedure that can extract, combine, and coordinate multiple probabilistic cues at several levels of linguistic analysis." Along with this learning capability, they postulate an innate understanding of complex structures and an unlearned ability to map and apply these structures to speech processes. It is suggested that we require the acquisition of concrete words before we begin to conceptualize the meaning of abstract words. Fisher et al. (1994) brings particular attention to the zoom-lens hypothesis, which supports the idea that the linguistic environment of a particular word provides a level of salience that will narrow the possible outcomes for a given word. Sentence structure provides a smaller scope for listeners, allowing them to use their prior syntactic knowledge to make sense of unfamiliar terms. General knowledge of sentence structure assists children in learning novel words. Given that language is rule-governed, the surrounding words give an individual cues about what properties the novel word may possess.

It is postulated that the linguistic environment in which an emotion adjective appears supports word learning. As children employ syntactic bootstrapping, they learn new words by noting the contexts in which those words are used and evaluating prior linguistic experience. This process, known as lexical mapping, helps them establish an understanding of novel words

(Gleitman et al. 2005). While much of the research supporting syntactic bootstrapping is applied to the acquisition of verbs, particularly of the more abstract nature, it is possible that this concept can also be applied to adjectives. This concept is supported in the work of Syrett and Becker (accepted). A combination of innate syntactic and semantic knowledge allows these children to come to conclusions about the argument-taking properties of the given word. In this case, children may be developing an understanding of new adjectives based on the surrounding linguistic environment.

Language learners can gain support for adjective meaning based on the syntax in which an adjective appears. The structure of (1) does not provide much insight into the type of adjective being used. The structure of (2) allows the reader or listener to infer more about the properties of the adjective.

(1) The monster is [daxen].

(2) The monster is [daxen] about something.

In (1), we are presented with a novel word that could a noun, a verb or an adjective. There are many ways of interpreting this novel word, given that there is no other context surrounding it. Adjectives frequently follow a copula verb. With this knowledge, children could assume that the monster is red, happy, small or round, amongst many other potential properties of the monster. In (2), the novel word is followed by a syntactic complement. Not every adjective can take such a complement. Emotion and mental state adjectives can. In their extensive analysis of child-directed speech, Syrett and Becker (accepted) demonstrate that emotion and mental state adjectives occur with a syntactic complement between 24% and 30% of the time in child directed speech. A word learner who is equipped with this knowledge could constrain the space of

possible meanings. In this case, the meaning of *daxen* is most likely not a color or shape. Instead, it may indicate that the monster is happy, surprised, or mad about something.

Given that there is considerable evidence for the syntactic bootstrapping of verbs, and the potential for the similar syntactic bootstrapping when it comes to adjectives, we turn to the present experiment to investigate how the linguistic environment surrounding a novel adjective supports word learning. Our task uses a similar sorting structure to that of Weeks and Hobson (1987), with the addition of novel adjectives and syntactic complements to explore the types of input that individuals are using to discover the meaning of new words.

3. Experiment

3.1. Stimuli

The visual stimuli consisted of photographs of individuals wearing or not wearing different accessories (baseball cap, winter hat, visor, cowboy hat, glasses) and at the same time showing different emotions (angry/disgusted, sad, happy, surprised). Each emotion was depicted with an open and closed mouth. Eight college-age adult females and seven college-age adult males were photographed. One series of photos were taken against a black background and each subject wore a black shirt. Another series of photos were taken against a white background and the subjects wore different solid color shirts. Photos were cropped so that the foreground and background were of a consistent proportion. The photographs were reviewed by lab members to ensure that the individuals successfully conveyed the intended emotions.

3.2. Design

Participants were randomly assigned to one of three between-subject conditions. Each condition had the same structure. The study was divided into four parts. Within each part, the structure was the same. In the Familiarization Phase, participants were shown 15 photographs in

two horizontal rows, and told, “Look at all of these! Do you see how they’re different?” This prompt invited visual inspection of the photographs. An odd number of photographs was chosen so as not to influence the participants to think that later on, when they sorted the images into two groups, the final number of pictures on each side had to be even or balanced. Within the set were males and females, and among them, individuals with and without hats, with and without glasses, and wearing different color shirts. The images were pseudorandomized to include a variety of positive and negative valence emotions. The number of individuals displaying each emotion (angry/disgusted, sad, happy, surprised) varied by trial.

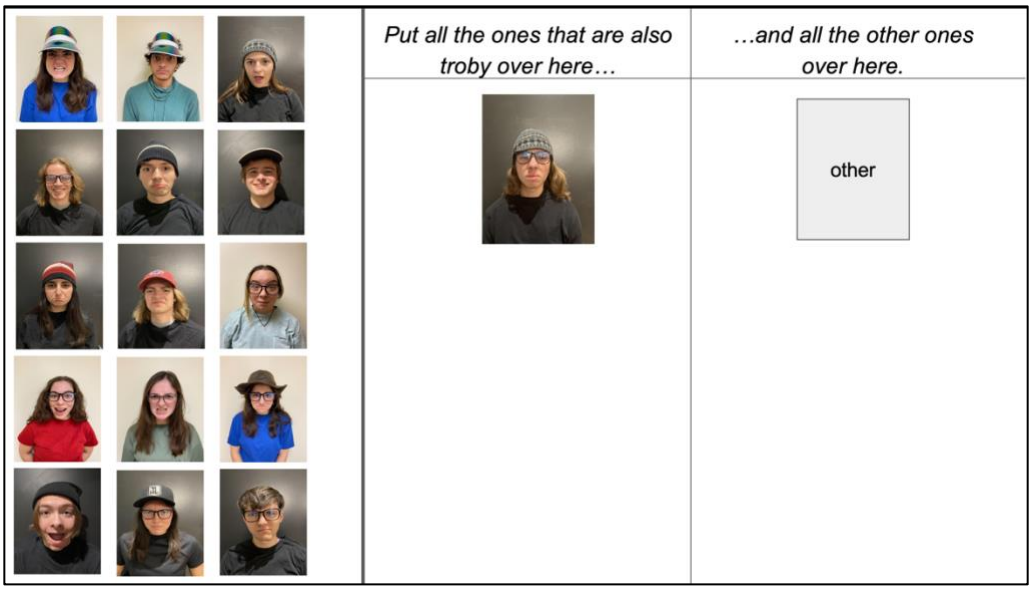
In the Exemplar Phase, participants were shown a 16th photograph and told to look at it. The prompt accompanying the photograph depended on the condition. In the Baseline condition, the participants were told, “Look at this one! Do you see? Look at this one!” In the Adjective condition, the participants were told, “Look at this one! This one is ADJ! Do you see? This one is ADJ!” In the Adjective+Complement condition, they were told, “Look at this one! This one is ADJ+complement! Do you see? This one is ADJ+complement!”

In the two ‘Adjective’ conditions, there were four different novel adjectives (troby, larpy, spoovy, wilpy), all of which have been featured in other adjective learning studies (see e.g., Syrett & Becker, accepted) and conform to English phonotactic constraints. In the Adjective+Complement condition, there were four different complements, each of which was compatible with the emotion and corresponding emotion adjective (troby at someone: angry, larpy to do something: happy, spoovy that something happened: surprised, wilpy about something: sad), and which were selected based on Syrett & Becker’s (accepted) corpus search, demonstrating their frequent appearance with emotion adjectives in child-directed speech. The

content of the complement was bleached, following Syrett & Becker (accepted), so as not to influence interpretation with semantic content.

Following the Exemplar Phase, participants were then told, “It’s time to sort!” They then proceeded to the Sorting Phase. In the Sorting Phase, all 15 photographs were shown in three columns of five on the left side of the screen. On the right side were two columns, one headed by the photograph from the Exemplar Phase and the other headed by a rectangle with “other” in it. See Figure 1. The language of the sorting phase depended on the experimental condition. In the Baseline Condition, participants were instructed to, “Put all the ones that are like this one here, and all the other ones over here.” In the Adjective condition, participants were instructed to, “Put all the ones that are also ADJ over here, and all the other ones over here.” In the Adjective+Complement condition, participants were instructed to, “Put all the ones that are also ADJ+complement over here, and all the other ones over here.”

Figure 1. Example of sorting phase from one trial in the Adjective condition



3.3. Participants

The study was conducted online with neurotypical and autistic populations. 21 neurotypical college-aged students and three autistic individuals ages 9-19 participated. There were eight neurotypical participants in the Baseline condition, six neurotypical participants in the Adjective condition and seven neurotypical participants in the Adjective+complement condition. In the autistic group, there was one participant in each of the three conditions. Two participants from the neurotypical population were excluded due to failure to perform the task sufficiently. One participant from the Baseline condition was excluded due to failure to complete the sorting of one of the trials. One participant was excluded from the Adjective condition due to believing that the adjective was an explicit reference to the exemplar and failing to sort any of the images for three of the four trials. Written consent was obtained by all participants and consent was contained by both child and guardian when necessary. Along with the consent form, their guardian was responsible for filling out demographic information and any information pertaining to their child's diagnosis if the child was part of the autistic participants. Approval for this study was attained under the IRB protocol, "Language in neurodiverse populations."

3.4. Procedure

Participants viewed the study on a computer with a parent present to assist in delivering instructions to the child. Parents and guardians were asked to give no further instruction to their children than was provided by the prompts of the presentation. Participants sorted the images by dragging the images to the preferred side of the screen. Following the conclusion of sorting for each trial, participants were asked to explain how they sorted.

3.5. Results

3.5.1. Data Analysis

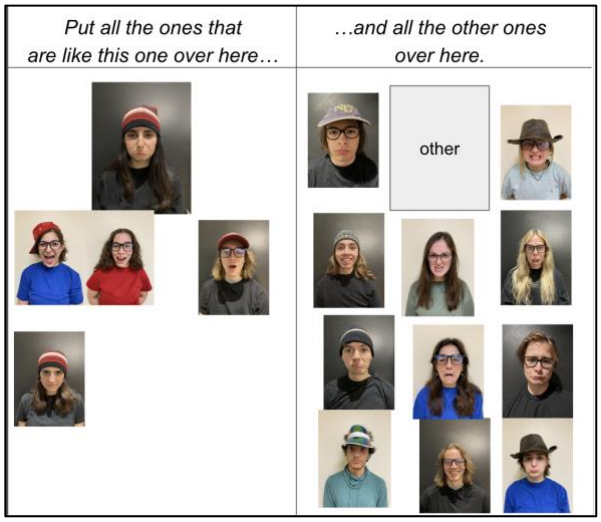
We analyzed the data using signal detection theory. Responses were coded as a 'hit,' 'miss,' 'correct rejection,' or 'false alarm' depending on the criteria of the stimuli. A 'hit' refers to cases where there is an emotion match between the exemplar and the image being sorted and the participant has sorted correctly. A 'miss' represents a emotion stimulus match with the exemplar emotion that was incorrectly sorted into the 'other' category. A response was as a 'correct rejection' if a non-emotion-match was sorted into the 'other' category. A response was a 'false alarm' when a non-emotion-match stimulus was sorted in the same category as the exemplar. The results were analyzed for a d' score representing sensitivity, and a c score representing bias to sort by emotion. d' prime measures sensitivity on a scale of 0 to 3, with scores closer to zero indicating chance performance and values closer to three indicating that the participant is more attuned to the difference between signal presence and signal absence (target emotion presence or absence). c scores exist in a range between -1 and 1, representing a participant's willingness to sort in a particular direction, specifically, by emotion. Higher scores indicate that a participant is more comfortable sorting by emotion, while lower scores indicate more hesitancy towards sorting in that manner.

3.5.2. Neurotypical Population

The average d' prime in the Baseline condition was 1.532 and the error rate was 21.7%. In the Adjective condition, the average d' score was 2.031 and the error rate was 13.9%. The average d' prime for the Adjective+complement condition was 2.487 and the error rate was 9.8%. The d' prime of the Baseline condition was closest to chance. A decrease in error percentage and an increase in d' prime was observed from Baseline condition to Adjective condition to Adjective+complement condition. c scores for each condition were also reported. The c scores for the data are as follows: Baseline = 0.05, Adjective = 0.355,

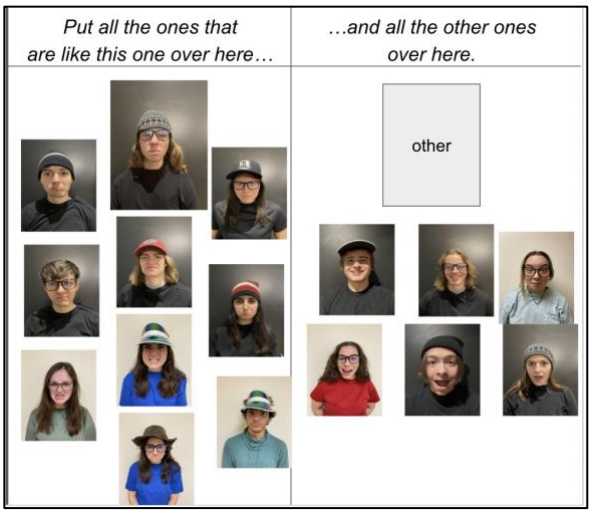
Adjective+complement = 0.209. While participants demonstrated an ability to sort by emotion in the Baseline condition, participants also sorted by gender, shirt color, type of hat and presence of glasses and/or hats. One participant in the Baseline condition sorted trial four based on whether or not each person was wearing red in any capacity (See Figure 2).

Figure 2: Baseline, Neurotypical Population



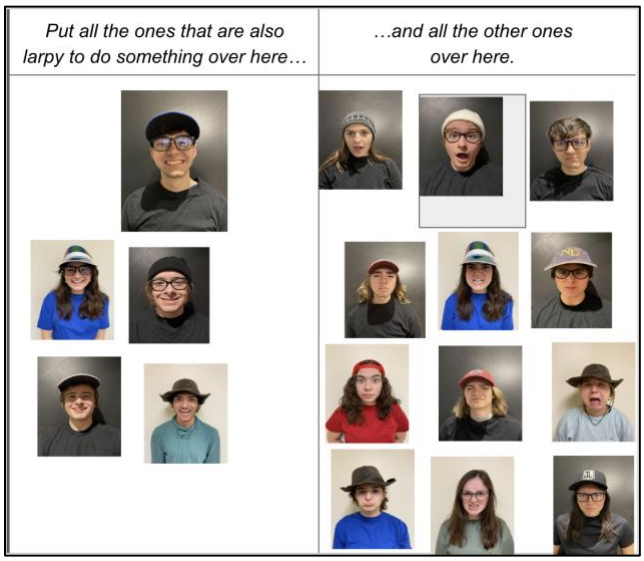
A majority of subjects cited the sentence structure as an indicator of an adjective. In the Adjective condition, subjects were more likely to sort by valence than individual expression. As can be seen in Figure 3, where the participant sorted all images of negative valence into the exemplar category.

Figure 3: Adjective Condition, Neurotypical Population



The d' scores observed in the Adjective+complement condition (d' prime = 2.487) indicate that sorting for emotion was high above chance level compared to the other two conditions. As participants were given more linguistic cues, the error rate decreased. In the Adjective condition, many participants sorted based on valence, but participants were more likely to be specific about the emotion when a complement was provided. In trials where Adjective condition participants sorted negative emotions and positive emotions separately, participants in the Adjective+complement condition separated the angry and sad stimuli. Subjects were able to use the novel word in the Adjective+complement condition to deduce the possibility of a novel adjective. In Figure 4, the participant delivered the following reason for sorting: "I used the sentence and word to define "larpy," as the adjective happy or excited, and then matched the picture of those who looked excited/happy."

Figure 4: Adjective+Complement Condition, Neurotypical Population

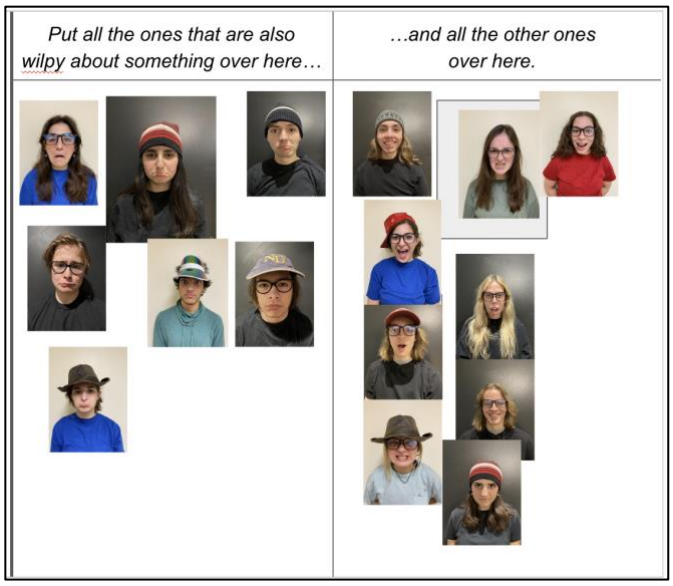


In the Adjective+complement condition, participants were more likely to sort by specific emotion and less prone to separating the photos based on valence.

3.5.3. Autistic Population

For this particular section of the data, there were only three usable participants to report. The following are the statistics reported from one participant in each of the three conditions. d' prime for the Baseline condition participant was 1.03. For the Adjective condition participant, the d' score was -0.568, indicating the participant was at chance level for sorting. The d' prime for the Adjective+complement participant was 1.798. C scores for each condition were also reported. The c scores for the data are as follows: Baseline = 0.179, Adjective = 1.336, Adjective+complement = -0.353. The participant in the Baseline condition factored in facial expression, glasses and hats when sorting the stimuli. The participant from the Adjective condition sorted based on the type of hat the participant was wearing and the length of their hair. Figure 5 demonstrates the sorting of the adjective+complement participant, wherein the participant noted that they sorted based on which photos were sad.

Figure 5: Adjective+Complement Condition, Autistic Population



3.6. Discussion

The neurotypical data suggests that language learners use the presence of syntactic cues to develop an understanding of novel words. Participants were more likely to sort by emotion when provided with a novel word in comparison to when the participant was simply asked to sort the stimuli. When presented with a novel adjective followed by a syntactic complement, the participants were far more likely to sort by emotion, as is reflected in the d' score and error rates presented in the results section. Participants were able to infer more about the state of the stimulus based on the further context provided by the Adjective+complement condition. The results of this study indicate that language learners are using linguistic input to evaluate the meaning of new words.

More participants are needed to create a proper set of data for the autistic population. The data presented above represents one participant in each of the three conditions and is not a reflection of the general population. That being said, the d' prime for the Adjective+complement participant is higher than that of the baseline participant. This result supports the findings cited in the neurotypical population.

4. General Discussion

The goal of this study was to examine the syntactic cues used by word learners in deciphering the meaning of novel adjectives. Understanding how syntactic cues influence category formation and emotion recognition can provide valuable insights into the cognitive processes involved in word learning and social cognition. Syntactic cues provide important contextual information that improves the semantic understanding of words. By observing how words are used within sentences or phrases, children can infer their meanings and relate them to specific emotions. By incorporating syntactic cues into language intervention programs, educators and therapists can potentially enhance children's language skills and emotion literacy.

5. Conclusion

This study aims to examine the use of syntactic bootstrapping in the process of learning novel adjectives. This work serves as pilot data for future research on this topic. The present data suggests that the linguistic context surrounding a novel adjective supports word learning. The assistants provided by syntactic cues allow the individual to map a novel word to meaning within the given context. With continued data collection, we hope to provide further support for the idea that syntactic cues assist in the acquisition of adjectives.

As research into the syntactic bootstrapping of adjectives continues, we can better support emotion learning in neurotypical and autistic populations. If this sensitivity to linguistic context extends from neurotypical to autistic individuals, it could offer a crucial avenue for supporting their language development and emotion understanding, addressing challenges they face in interpreting social cues. The structure that is found in the language framework may be useful in providing contextual support for children as they acquire abstract adjectives. Many individuals with autism struggle to grasp emotion. It may be the case that evolving the

curriculum surrounding emotions to incorporate more linguistic input could help these individuals to better grasp these concepts.

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