Special Interests and Anthropomorphism

By

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Abstract

This study investigated the extent to which animals and objects of special interest to the participant were reported to have anthropomorphic or 'humanlike' qualities. It is a natural human tendency to be inclined toward faces and social activities. Deficits in face recognition and social processing are characteristic of Autism Spectrum Disorder (ASD). Another major characteristic of this disorder is preoccupation with objects or topics of interest. This preoccupation with 'special interests', and their co-occurrence with communication deficits may be indicative of a compromise between the two. The hypothesis of this study is that social cognitive systems have been repurposed in ASD to represent objects of special interest. A prediction of this hypothesis is, individuals with ASD may show more evidence of (potentially inappropriately) mixing social and special interest stimuli. This thesis structured a questionnaire aimed at quantifying the mixing of intense special interests, in individuals with ASD in comparison to NT individuals. Participants (N = 68) responded to questions about personal interests including categories in which those interests fell. For this thesis, mixing was examined for object and animal interests. Of the fifteen participants who met this criterion, none of indicated an ASD diagnosis. This thesis instead characterized the extent of anthropomorphization in individuals who were above and below threshold on an autism-screening questionnaire. Results did not support the hypothesis of this thesis. This may be explained by the limited number of responses available for analysis. Future work will include additional data collection.

Introduction

Special Interests and Anthropomorphism

Adaptively, and because of their unavoidable presence, social signals receive high priority. In developmental research, neurotypical (NT) neonates show preference for faces supporting an evolutionary argument for the importance of faces. When tested within an hour after birth, neonates recognize specific information about the composition of the human face, including features and arrangement (Johnson, Dziurawiec, Ellis & Morton, 1991). Evidence shows that as the NT neonate brain perceives faces in a holistic manner rather than by parts, it utilizes neural mechanisms specific to face processing and recognition (Hershler & Hochstein, 2005).

In line with this view, neurological research has shown that in NT individuals, emotional information from faces is detected rapidly (100 milliseconds) after stimulus onset, and facial expressions are successively recognized with the same efficiency (Eimer & Holmes, 2007; Palermo & Rhodes, 2007). Dynamic face stimuli, which provide us with information about other's emotional states, add further meaning and significance to faces (Hoehl & Striano, 2008). Bentin and colleges observed a large potential change when participants viewed images of isolated eye regions. In NT individuals, attention is preferentially directed toward the region of the face surrounding and encompassing the eyes. The stimuli provided by eye regions are rich in information and can reveal beliefs, intentions, needs and concerns of others (Bentin, Allison, Puce, Perez & McCarthy, 1996).

NT face processing and identification of others' emotional states, constitutes the basis of the social construct of theory of mind (ToM). ToM refers to a high-level social-cognitive process for mental state recognition, mentalizing, which allows NT individuals to imagine and attribute

the mental disposition of others (Pinkham et al., 2003). Cullen and colleagues (2014) found that individual differences in attributing mental states to non-human animals correlated with the grey matter volume of the left temporal-parietal junction, a brain area involved in mentalizing (Cullen, Kanai, Bahrami, & Rees, 2014). Additional exploration of NT perceptual processing, involving non-human objects, suggests that the number of facial features present on an object and dimensions of humanlike features, influences the perception an object's humanness (Disalvo et al., 2002). Social information is typically preferentially processed, possibly through unique neural mechanisms that have selected for larger brains, to help an individual navigate and prosper in an uncertain environment filled with other social agents (Dunbar, 1998).

Anthropomorphism

NT specialization toward social information provides unique mechanisms to interpret other aspects of our environment by viewing them as, in some way, human. The viewing of non-human agents as human in some way is referred to as anthropomorphism. An understanding of anthropomorphism informs both the burgeoning investigation of nonhuman agents, and conceptual issues underlying social perception. Unique ways in which individuals anthropomorphize, as well as the extent to which one does, is thought to be consistent throughout life (Waytz et al., 2010). This suggests it is an enduring behavioral trait, which is also reflected in the degree of structural variance in brain regions linked with an individual's social cognition capability (Cullen, Kanai, Bahrami & Rees, 2013). Individual differences in anthropomorphism predict the degree of moral care and concern afforded to an agent, the amount of responsibility and trust placed on an agent, and the extent to which an agent serves as a source of social influence on the self (Waytz et al., 2010). An increased tendency to anthropomorphize or

attribute humanlike processing to a non-human object is linked to situational unpredictability and the motivation for predictability (Epley et al., 2008) and depends on the nature of the thing being anthropomorphized: objects moving at speeds similar to humans are more readily anthropomorphized (Morewedge et al., 2007).

Deficits in Social Cognition in Autism

Deficits in face recognition and social processing are characteristic of Autism Spectrum Disorder (ASD) and seem to disengage individuals with ASD from typically developing peers (Bal, Harden, Lamb, Van Hecke, Denver, & Porges, 2010; Riby & Hancock, 2008; Riby & Hancock, 2009; Wallace, Case, Harms, Silvers, Kenworthy, & Martin, 2011). ASD is diagnosed in 1 in 68 children (The Centers for Disease Control and Prevention), representing a large percentage of people who experience social communication deficits; it is thus a major concern amongst parents, educators, scientists, and policy makers. Efforts to define and understand ASD have contributed to a complicated constantly evolving process that spans years of research across a variety of fields. A diagnostic criterion for ASD as well as the term itself has changed dramatically over time. The Diagnostic and Statistical Manual of Mental Disorders (DSM), used by clinicians and researchers to classify and diagnose disorders, including ASD, has undergone many revisions leading to the most recent edition (DSM-5), released by the American Psychiatric Association (APA) in May 2013.

This edition of the manual no longer defines ASD as grouped with Asperger's Syndrome, Pervasive Developmental Disorder—Not Otherwise Specified (PDD-NOS), and Childhood Disintegrative Disorder, but rather highlights the notion that ASD is a spectrum disorder and that each individual’s condition is unique. ASD is currently considered an overarching term under

which there are many levels of severity. Asperger's syndrome is an autism spectrum disorder considered to be on the "high functioning" end of the spectrum. Affected children and adults have difficulty with social interactions and exhibit a restricted range of interests and/or repetitive behaviors. Compared with those affected by other forms of ASD, however, those with Asperger syndrome do not have significant delays or difficulties in language or cognitive development. Some even demonstrate precocious vocabulary – often in a field of interest. ("Asperger Syndrome," 2013). The DSM-5 diagnostic criteria for ASD require a demonstration of characteristics in two main categories rated across three levels of severity.

1) Impairment in social communication and interaction.

Characteristics may include the following:

- Deficits in reciprocity
- Deficits in nonverbal communication
- Difficulty developing peer relationships

2) Presence of restricted or repetitive patterns of behavior.

Characteristics may include the following:

- **Preoccupation with objects or topics of interest**
- Inflexibility
- Repetitive movements or speech
- Hyper- or hypo- reactivity to sensory stimulation

Level 1: requiring support

Level 2: requiring substantial support

Level 3: requiring very substantial support

For the current study, 'ASD' is used to describe individuals who have indicated through self-report that they either have been given an ASD diagnosis or believe that they may have Asperger's syndrome or some form of ASD. We focus here on the two aspects of ASD highlighted in bold above: 1. Social communication impairment and 2. A preoccupation with

special interests. ‘Special interests’ a term commonly used by the ASD community, refers to the characteristic involving “preoccupation with objects or topics of interest.”

These special interests are often considered atypical in content (e.g., World War II airplanes; see Asperger, 1991; Winter-Messiers, 2007) and are frequently observed to be intense and restricting for individuals in the ASD population. Generally, the interests significantly inhibit interpersonal functioning, and when pulled away from such interests, excessive frustration and anxiety becomes a detriment to performance in daily life (e.g., Klin, Danovitch, Merz, & Volkmar, 2007). Through other problematic behaviors lessen in intensity with age; special interests do not (Fecteau, Mottron, Berthiaume, & Burack, 2003). Previous studies suggest that, beyond seemingly trivial repetitive behavior, special interests reflect a greater cognitive capacity and information processing style occurring in ASD (Baron-Cohen, 2002). The preoccupation with these special interests, and their co-occurrence with communication deficits may be indicative of a trade-off. That is, consumption of brain capacity and mental “currency,” by special interests seemingly compromises the NT cognitive investment in social proficiencies; including emotional face interpretation, internalized social practices and socially charged games and fantasies (Klin et al., 2007).

More specifically, these atypical characteristics, paired with highly prioritized processing of non-human interests could occur through a repurposing of these social regions toward special interests. Previous fMRI studies have found evidence suggesting a repurposing of social cognitive brain regions. In a 2005 study by Grelotti and colleagues, the authors demonstrated activation of brain regions typically involved in face processing, when a child with ASD viewed images of a special interest, a Digimon character, but to a lesser extent to his mother’s face, unknown faces, or random objects (Grelotti, Klin, Gauthier, Skudlarski, Cohen, Gore, & Schultz,

2005). The study found that when viewing images of the special interest activation increased in the child's fusiform gyrus (i.e., the location of the would-be FFA) and amygdala.

This co-opted facial processing system, activated by the presence of special interest as opposed to NT activation for social stimuli, could contribute to deficits in more complex social cognition processes like ToM, and emotion recognition tasks (e.g. Reading the mind in the eyes task (RMET: Baron-Cohen et al., 2001). Moreover, in NT development anthropomorphism is believed to arise in part to fulfill 'effectance motivation' (the motivation to acquire mastery of one's environment). Waytz and colleges (2010) found that NT participants were more likely to attribute a mind to gadgets described as unpredictable than those described as predictable. Extensive evidence shows that individuals with ASD prioritize their special interests over social stimuli, possibly contributing to the significant challenge faced by individuals with ASD while attempting to predict outcomes in social situations. This trade-off in multiple levels of social cognition toward preoccupying interests forms the basis of my hypothesis.

The hypothesis of this study is *that typically developing social cognitive systems have been repurposed in ASD to represent and process objects of special interest*. A prediction of this hypothesis is that, if these same neural substrates are directly repurposed that individuals with ASD may show more evidence of (potentially inappropriately) mixing of social and special interest stimulus features.

The most effective way to investigate these hypotheses might be directly observing brain activity but conventionally, fMRI studies are expensive and difficult to run with a large sample. To test the hypotheses for the current study, a questionnaire was built with the intention of quantifying the occurrence and degree to which individuals, across the Autism Spectrum, mix human and non-human features and/or behaviors with other items. This mixing is quantified as

the extent of reported anthropomorphic insertion in individual's special interests. The questionnaire aims to gather information about both frequency and degree of mixing occurring for individuals with ASD throughout the spectrum in comparison to anthropomorphism experienced in NT cognition. This study has a design aimed at characterizing the relationships between ASD (severity of ASD symptoms) determined by the Social Communication Questionnaire (SCQ: Rutter et al., 2003), high-level social ability evaluated by the Reading the Mind in the Eyes test (Baron-Cohen et al., 2001) and the qualities of individual's special interest, revealed by a combination of original and modified questions from the Yale Special Interests Survey (Klin et al., 2007). Our expectations are that typically-developing individuals will anthropomorphize things that are more like humans (e.g. animals) and that individuals with autism will mix anthropomorphic features to a greater degree with special interests that share fewer features with humans (e.g. objects like trains and computers).

Materials and Methods

Participants

Participants were recruited through the University of Colorado Boulder SONA subject pool and university community email lists. Participants were also invited from public and private schools around the greater Denver area via outreach programs centered on neurodiversity and ASD awareness. Flyers advertising opportunity for participation in the study were posted around the greater Denver and Boulder areas, in networking locations and on social media websites. Individuals under 10 years were not allowed to participate in this study and individuals under 18 were not provided with the option to personally respond to the questionnaire. Participants 10-17 years old were instead offered an alternate version of the questionnaire for a guardian to respond

to. Additionally, participants 18 and older who live with a caretaker were asked to have their caretaker respond to the survey with their support.

Materials

Study data was collected and managed using REDCap (Research Electronic Data Capture). REDCap is a secure web application designed to support data capture for research studies, providing user-friendly web-based case report forms that are often helpful for those with ASD, and a de-identified data export mechanism to common statistical packages. REDCap includes a powerful tool for building and managing online surveys. The system was developed by a multi-institutional consortium, which includes University of Colorado–Denver and was initiated at Vanderbilt University. The database is hosted at the University of Colorado–Denver Development and Informatics Service Center (DISC). REDCap data collection projects rely on a thorough study-specific data dictionary defined in an iterative self-documenting process by all members of the research team with planning assistance from the DISC. This iterative development and testing process results in a well-planned data collection strategy for individual studies (Harris, Taylor, Thielke, Payne, Gonzalez, & Conde, 2009).

Procedures

Recruitment materials included a link or website address to the online questionnaire. Participants were asked to complete one of two versions of the questionnaire (participant or guardian). Before the experimental sections of the questionnaire became accessible, consent was required. For willing individuals under the age of 18, consent provided by a parent or guardian was required and parent response will be requested. Upon attempt to participate, for an

individual under the age of 18 without a parent or guardian available to consent, the questionnaire would automatically present a completion screen before any data was collected. Each version of the questionnaire consisted of the following sections:

Consent/Parental Permission and Assent

–Consent to participate and re-contacted for follow up.

Caretaker

–Determine is a guardian is available to respond.

Demographic Information

–Information of the demographics of the participant and contact information.

Autism Spectrum Diagnosis

-Self-report of ASD diagnosis or reason to believe one might have ASD

Report of Interests and Characteristics of Interests

– Self-report of top 5 interests and anthropomorphic insertions for top special interest.

Intensity Rating of Top Interest

–Measure of how intensely the participant experiences the top special interest.

Reading the Mind in the Eyes Test (RMET: Baron-Cohen et al., 2001)

–Measure of ability to determine intent/emotion from images of human eyes.

Social Communication Questionnaire (SCQ: Rutter & Lord, 2003).

–ASD diagnostic screening.

Variables of interest

The qualities of individual's special interest are determined by a combination of original and modified questions pulled from the Yale Special Interests Survey (Klin et al., 2007). An

example of a modified YSIS question is: "*How much of your free time do you spend on your interest ('Special Interest')? For example: reading, memorizing, drawing or talking about the special interest."* (See Table 1 for additional examples).

Along with modified YSIS questions, other novel questions concerning anthropomorphism were added to the "Report of Interests and Characteristics of Interests" section of the questionnaire. As we expected anthropomorphic insertions to consist of both cognitively prioritized variables, characters related to special interests and qualities of the human face and other socially informative insertions, novel questions needed to be developed. Here, we analyze five such questions: *1. Are any of the parts of your interest like the body parts of people?* (Body parts) *2. Does your interest have parts that seem like a face?* (Faces) *3. Does it seem like your interest has feelings?* (Feelings) *4. Does it feel like your interest is a friend of yours?* (Friend) *5. Do you ever think about what your interest is thinking?* (ToM). Question responses were made using a slider analog scale, on which participants responded by dragging a button across a slider. Each of the metrics (Body parts, Face, Feelings, Friend, and ToM) was quantified by slider analog rating from 0-100 percent provided by participants. The value from each special interest slider analog scale served as the dependent variable. The mean quantity was examined as a dependent variable across two independent variables with two categories; the first being participants with an object interest and participants with an animal interest and the second being the presence of ASD.

As object interest and animal interest are the only two categories of interest examined in this study; participants who did not select either of these categories or those who selected both of these categories for their interest were not included in this analysis. The sample eligible for full analysis was 15 in total.

Social Communication Questionnaire

Additionally, participants were categorized based on individual risk for ASD determined by one of the most widely used and studied ASD screening instruments, the Social Communication Questionnaire (SCQ: Rutter & Lord, 2003). It was designed as a screening questionnaire to be filled out by primary caregivers of individuals with ASD. It was originally derived from the revised Revised Autism Diagnostic Interview (ADI-R; Lord, Rutter, & LeCouteur, 1994) and DSM-IV (American Psychiatric Association, 1994). As well as being derived from the ADI-R, the SCQ has established validity for the diagnosis of ASD. The agreement between SCQ and ADI-R scores is high and substantially unaffected by age, gender, language level, and performance IQ. This indicates that the SCQ is a valid screener, providing a reasonable picture of symptom severity. In addition to its screening and educational applications, the SCQ can also be used to compare symptom levels across various groups—those with developmental language disorders or medical conditions commonly comorbid with ASD. The SCQ has a well-documented history of psychometric studies from its inception as it is based on three highly important areas of functioning: Reciprocal Social Interaction, Communication, and Restricted, Repetitive, and Stereotyped Patterns of Behavior. It is a 40-item questionnaire that asks about behavior that is thought to be characteristic for individuals with ASD. Each item is scored 0 or 1, with 1 endorsing a known symptom of ASD. The maximum possible score is 39. Investigators defined an SCQ score of 11 points or higher as an indicator of risk for ASD (Allen et al., 2007; Lee et al., 2007; Wiggins et al., 2007). Thus, in the current study, we define individuals with an SCQ score of 11 points or greater as participants with potential risk of ASD and refer to these individuals as the potential ASD (pASD) group.

Analysis

In order to examine the extent to which individuals with ASD anthropomorphize objects of special interest in comparison to NT individuals, a factorial analysis of variance (ANOVA) was conducted with the anthropomorphism ratings from two between groups factors: 2 SCQ score (pASD vs. NT) x 2 type of special interest (Object vs. Animal).

Results

Sixty-eight participants completed the questionnaire, from which a subsample was examined. As the hypothesis of this thesis was focused on the difference between those who reported a special interest in an animal or object, we were left with fifteen participants who matched our criterion (Fig. 1), 53% female and 47% male. The racial/ethnic distribution of the sample was White (14, 93%), More than One Race (1, 7%), and Hispanic or Latino (2, 13%), Not Hispanic or Latino (12, 80%), Unknown (1, 7%), or Not Reported (2, 3.0%). Participants had a mean age of 26.7 years (SD = 9.3, range = 18 – 51).

Two factors hypothesized to affect anthropomorphization of an interest were examined: 1. Special interest type (Animal vs. Object) 2. Potential risk for ASD (SCQ ≥ 11 vs SCQ < 11). Participant ratings for each anthropomorphic metric (Body parts, Faces, Feelings, Friends, and ToM) were averaged across participants within each cell (see Fig. 3). For each metric, a two-way ANOVA was conducted to determine whether there were differences in average anthropomorhization ratings depending on SCQ score and special interest type. For the body-parts metric (*Are any of the parts of your interest like the body parts of people?)*, there was no significant main effect of risk for ASD $F(1,11) = 0.00$, $p = .967$, nor was there a significant main

effect for interest type $F(1,11) = 0.34$, $p = .572$, nor was there a significant interaction effect between the two factors $F(1,11) = 0.45$, $p = .515$. For the faces metric (*Does your interest have parts that seem like a face?*), there was no significant main effect of risk for ASD $F(1,11) = 0.04$, $p = .854$ nor was there a significant main effect for interest type $F(1,11) = 3.35$, $p = .854$, nor the interaction between the two factors $F(1,11) = 0.42$, $p = .510$. For the feelings metric (*Does your interest ever seem like it has feelings?*), there was no significant main effect of risk for ASD $F(1,11) = 0.01$, $p = .931$, nor was there a significant main effect for interest type $F(1,11) = 2.73$, $p = .127$, nor the interaction between the two factors , $F(1,11) = 0.05$, $p = .827$. For the friend metric (*Does it feel like your interest is a friend of yours?*), there was no significant main effect of risk for ASD $F(1,11) = 1.65$, $p = .225$ nor was there a significant main effect for interest type $F(1,11) = 1.18$, $p = .301$, nor the interaction between the two factors, $F(1,11) = 1.57$, $p = .236$. For the ToM metric (*Do you ever think about what your interest is thinking??*), there was no significant main effect of risk for ASD $F(1,11) = 0.78$, $p = .396$ nor was there a significant effect of the interaction between the two factors $F(1,11) = 0.17$, $p = .692$. There was, however, a significant main effect of interest type on the ToM anthropomorphization ratings, $F(1,11) = 6.88$, $p = .024$. Individuals with animal interests reported higher ToM ratings compared to those with object interests.

Discussion

The hypothesis of this thesis predicted that individuals with ASD anthropomorphize objects of interest more than NT individuals do. Analysis of the current results did not support this hypothesis. One effect (a main effect of interest type for the ToM question) was significant, however this may be a matter of the number of tests conducted. This significant main effect, if

not found simply by chance, suggests that individuals with animal interests, think more about their interests thoughts than those with object interests. This finding aligns with existing research on attributing mental states to non-human animals (Cullen et. al., 2014) and NT perceptual processing, involving non-human objects, (Disalvo et al., 2002). The findings of these studies suggest that NT individuals anthropomorphize animals in brain regions, active for social cognitive processing, and perceive objects as more humanlike when they have an increased number of features that are similar to human features. The main effect found in the current study offers that participants in both the pASD group and the NT group with animal interests thought about the thoughts of their interest more often than participants with object interests. As the number of humanlike qualities is relatively high for animals, this finding contributes to the existing literature.

Average ratings of anthropomorphism for each metric (body parts, face, feelings, friend, and ToM) for interests (Animal or Object) for participants in both groups (pASD and NT) are displayed in Figure 3, and mean ratings and standard deviations are listed in Table 2. Though differences were not found to be significant, the plot for each metric seems to show a similar pattern across variables. NT individuals generally reported a higher rating across metrics for both animal and object interests. Though differences in groups were not significant, this pattern suggests that NT individuals in general anthropomorphize interests more often than individuals in the pASD group.

If this pattern holds for future studies with additional participation, the prediction by the hypothesis of the current study may be disproved and further a reverse claim may uphold: *NT individuals anthropomorphize objects of interest more than individuals with ASD do*. Individuals with potential risk of ASD may actually have lower anthropomorphism precisely because of

social impairment. Perhaps individuals with potential risk for ASD do not anthropomorphize objects because it isn't as fulfilling or meaningful in the way that it is for highly social NT individuals.

One explanation for this reversed claim might be suggested by existing literature. Epley and colleges claim that an increased tendency to anthropomorphize or attribute humanlike processing to a non-human object is linked to situational unpredictability and the motivation for predictability (Epley et al., 2008). An important reconsideration for this research might be the unpredictability factor. It is possible that report of anthropomorphized special interests by individuals at risk for ASD was lower than that for NT, because these interests are understood well enough to be predictable. Rather than being the unpredictable component of ones environment, an object of special interest might be the most familiar or predictable component of the environment for an individual with ASD; therefore, the agent from which understanding is pulled for attribution to other unpredictable agents. Mixing might occur in ASD due to attribution of ones special interest features to unpredictable human and social stimuli. Additional data collection and further investigation needs to be done to test this prediction.

The negative results documented here may be due to several factors but the largest and most easily addressable is the sample size. Current enrollment in this study (68 total, 15 meeting selection criteria) is well below the target set prior to the initiation of the study (600 total participants). Data collection will continue as part of a summer project. In addition to sample size, other factors limiting the interpretation of the study include: 1. Lack of ASD diagnosed participants. 2. The length and complexity of the questionnaire. The potential impact of these concerns is detailed below.

Limitations

The first major concern with these results is that analysis did not include data from any participants with ASD. In order to test the given hypothesis only data from eligible participants (those with either animal or object interests) was examined. Within this eligible group, there were zero reports of a previous ASD diagnosis. In response to this shortcoming, for this thesis the SCQ was utilized as a determining measure for risk of an ASD. Based on the findings of previous researchers (Allen et al. 2007; Lee et al. 2007; Wiggins et al. 2007), a score of 11 points or greater was considered an indication of potential risk for ASD. As such, the results found in this thesis do not include any participants who have actually had a professional diagnosis of ASD. Further, results may support the authors in their suggestion that the SCQ not be used as a stand-alone diagnostic screening for ASD, but rather that it is used as an indication of risk but not evidence of disorder. As such, the analysis conducted in the current study was performed entirely on NT individuals. Thus, the results indicating only small differences between pASD and NT groups, if not by chance, suggest a reliable NT control for future studies with participants with a clinical ASD diagnosis.

The questionnaire used for this study was long and consisted of questions that are somewhat complicated; as such many began the questionnaire but did not complete it, which resulted in a deleted report. One way to moderate this concern would be to use only relevant sections of the questionnaire in studies similar to this thesis, to gain more participation and avoid concerns with lengthy and time-consuming measures. Participants were asked to list their top special interests, but anthropomorphism was only examined in relation to the top interest. There is substantial evidence suggesting that special interests observed in ASD are not typically restricted to one, thus, asking for information about interests other than the top interest may be a

more effective strategy. The metrics used to measure levels of anthropomorphism were created by an NT individual and as such, may not be sensitive to the way individuals with potential risk for ASD are anthropomorphizing.

Additionally, participants were asked to categorize their interests as person, animal, object, topic, or procedure. Participants who selected animal or object were asked additional questions about anthropomorphization of their interests. This approach seemingly limited this study, as some of those who responded to the survey could not provide data that could have been useful in testing the current study's hypothesis. Further, those who selected both animal and object were disqualified for data analysis here. A question that remains unanswered is whether individuals at risk for ASD experience anthropomorphism differently for objects, animals, and humans. In this case, there may be differences in how high risk individuals think about features of people AND humans versus objects compared to NT individuals, due to conditioned responses to social items. One way to avoid this limitation may be to ask all participants, all of the questions, and limit selection to a single category. This setback resulted in a small sample size, which likely contributed to null results.

Further Research

For the future, I plan to further investigate the hypothesis explored in this thesis. As the lack of data used for analysis in this study-demonstrated limitation, I plan to expand recruitment efforts in order to collect more data with the questionnaire used in this study. I plan to further recruitment by reaching out to supporters of the current study who are active members in ASD communities, including Temple Grandin School, Imagine! Program, Joshua School, and other individuals who have supported this project.

In moving forward, I plan to investigate certain questions that remain unresolved including: How often and to what extent does mixing of special interests and a *physical* vs. behavioral human features occur? To what extent does deviant activation happen in ASD individuals? What impact does this mixing have on overall social function across the social spectrum of people?

Importance

Gathering information about social experiences and identifying relationships within that information contributes to an overall understanding of social heterogeneity. This investigational process offers significant evidence for variable relationships, which would not be easily attainable otherwise. A better understanding of social and non-social mixing is expected to be useful for betterment of the lives of the participants and the greater population. The benefits of understanding social deficits are not only for those living with deficits, but also for those who fall across the broader range of neurodiversity.

Please list any special interests you have.
What is your most important special interest? 'Trains.'

Please rate the intensity of your special interest (Trains).

1 - Not very interested 50 100 - Extremely interested

Is your interest (Trains) a person? Yes No
* must provide value
Is your interest (Trains) an animal? Yes No
* must provide value
Is your interest (Trains) an object? Yes No
* must provide value
Is your interest (Trains) a topic? Yes No
* must provide value
Is your interest (Trains) a procedure? Yes No
* must provide value

How much of your free time do you spend on your interest (Trains)?
For example: reading, memorizing, drawing or talking about the special interest.
* must provide value 0% None Quite a bit 100% All

How much of your interaction and conversation with your family is related to your interest (Trains)?
* must provide value 0% None Quite a bit 100% All

How much of your interaction and conversation with peers/friends is related to your interest (Trains)?
* must provide value 0% None Quite a bit 100% All

How much of your interaction and conversation with other adults is related to your interest (Trains)?
For example: When meeting new people or with parents' acquaintances.
* must provide value 0% None Quite a bit 100% All

Figure 1 - Modified Yale Special Interest Survey (YSIS: ***Klin et.*** al., 2007) questions in the "Report of Interests and Characteristics of Interests" section of the questionnaire were as shown ("Trains" is inserted for example).

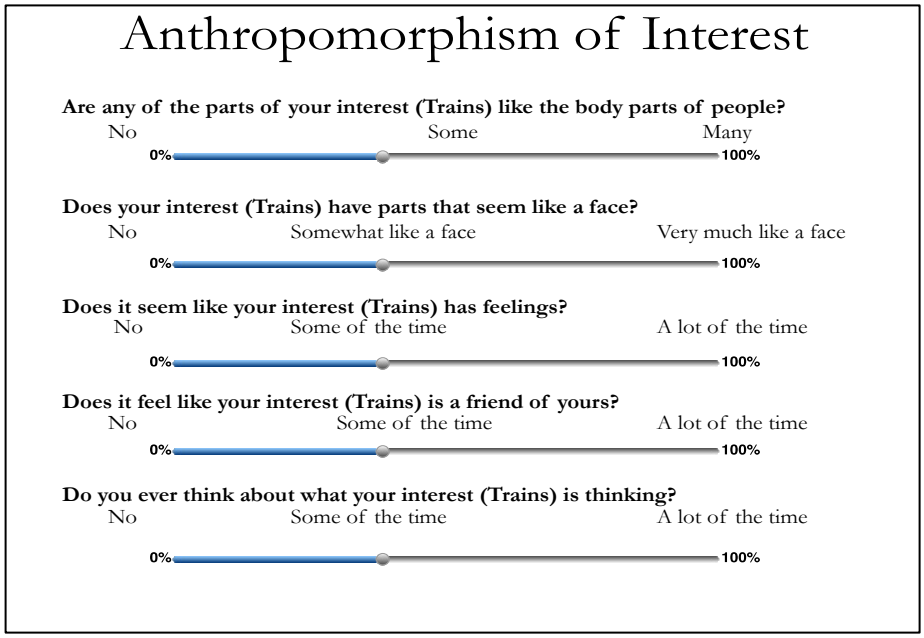

Figure 2 - Anthropomorphism metrics examined for level of anthropomorphism in one's special interest for neurotypical (NT) individuals and those at risk for autism (pASD) who have interests in either animals or objects.

	Category of special interest	Number of participants	Duplicates of Animal and object?	Total of Animal and object
	Person	x	-	-
	Animal	8	2	6
	Object	11	2	9
	Topic	x	-	-
	Procedure	x	-	-
Total		68		15

Table 1 – Number of participants who reported their interests belonged to each category.

Anthropomorphism Metric	NT/Animal	pASD/Animal	NT/Object	pASD/Object
Body Parts	16.67, (28.87)	29.33, (50.81)	16.67, (40.82)	2.33, (4.04)
Face	56.67, (51.32)	62.67, (54.60)	27.17, (43.68)	2.67, (4.62)
Feelings	66.67, (57.74)	64.00, (55.57)	29.50, (46.28)	15.33, (26.56)
Friend	82.67, (30.02)	64.33, (55.73)	26.17, (42.49)	22.00, (38.11)
ToM	64.67, (33.25)	64.00, (55.57)	8.50, (20.33)	23.33, (40.41)

Table 2 – Means and Standard deviations for all anthropomorphism metrics.

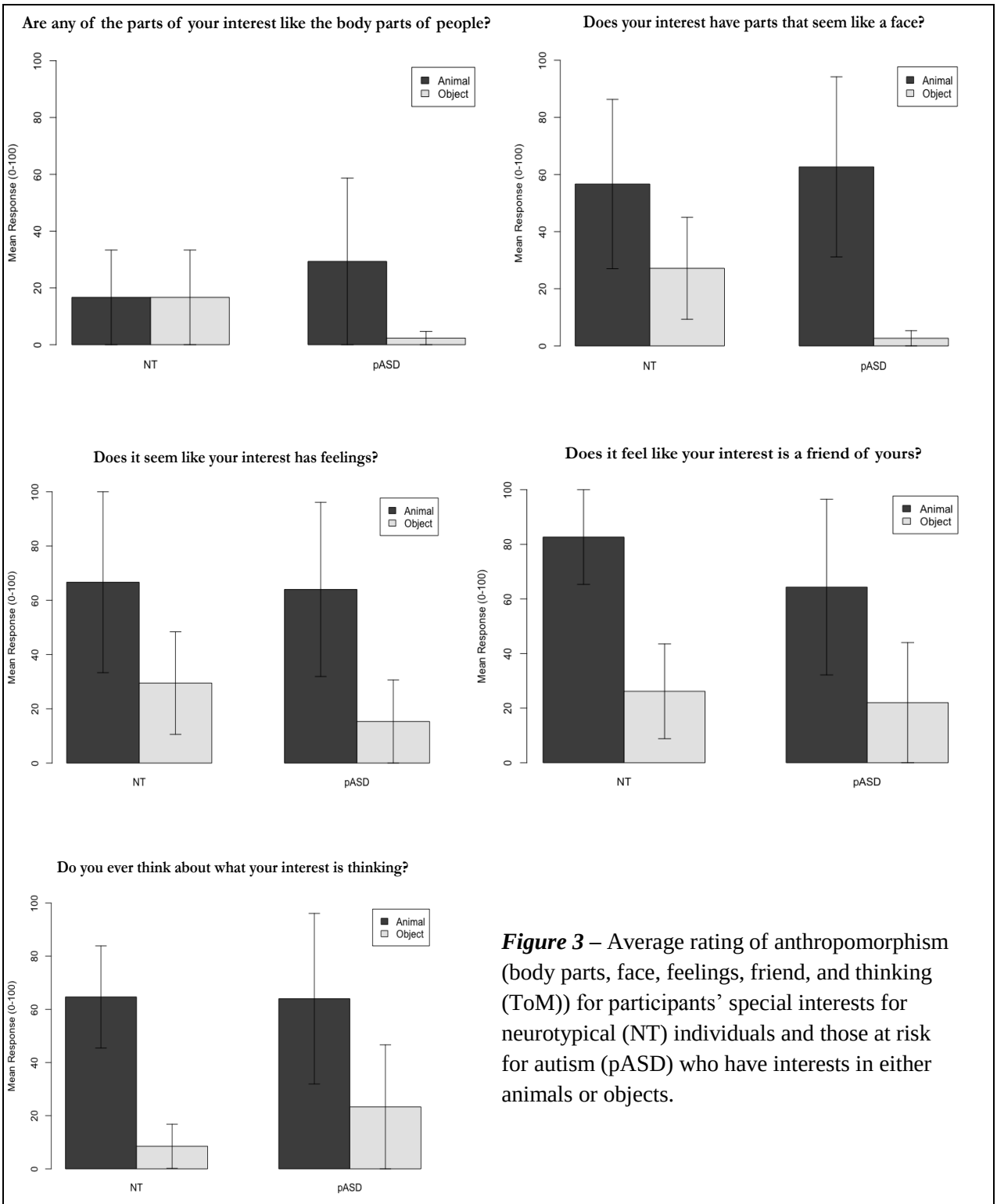

Figure 3 – Average rating of anthropomorphism (body parts, face, feelings, friend, and thinking (ToM)) for participants' special interests for neurotypical (NT) individuals and those at risk for autism (pASD) who have interests in either animals or objects.

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