THE PERCEPTION OF EMOTION THROUGH STATIC AND DYNAMIC FACIAL EXPRESSION IN CHILDREN WITH AUTISM SPECTRUM DISORDER

by

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ABSTRACT

The current project examined the ability of children with Autism Spectrum Disorder (ASD) to perceive and judge emotional information conveyed in facial expression when compared to typically developing peers. The purpose of this study was to (a) compare how children with ASD and children with typical development (TD) differ in their ability to perceive and judge the emotional information conveyed by happy, sad, angry, and scared static facial expression; (b) compare how static decoding abilities relate to decoding abilities of integrated dynamic facial expressions, prosody, and verbal content; (c) measure the ability of children with ASD and children with TD to perceive and judge emotional information based on the perceptual features of the speaker (cartoon vs. human); and (d) examine the role of timing in the perception and judgment of emotional information in children with ASD and children with TD.

DEDICATION

This thesis is dedicated to all the children and their families that shared their time, insights, and stories along the way to making this project a reality. Also, this project would not be possible with my incredible support system—my husband, family, friends, and classmates. Thank you all for lending your time and offering support when I needed it most.

LIST OF ABBREVIATIONS AND SYMBOLS

AS Asperger's Syndrome

ASD Autism Spectrum Disorder

HFA High-Functioning Autism

TD Typical Development

F Fisher's *F* ratio: A ration of two variances

M Mean: the sum of a set of measurements divided by the number of measurements in the set

SD Standard Deviation

p Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value

t Computed value of *t* test

$<$ Less than

$=$ Equal to

X^2 Chi-square

ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

Communication is multifaceted and requires partners to decode not only what is spoken, but also to perceive how it was spoken. Spoken messages frequently involve the perception and interpretation of underlying meaning. The task of decoding emotional messages can be a complicated and challenging task, especially for a person with Autism Spectrum Disorder (ASD). According to the most recent edition of the *Diagnostic and Statistical Manual of Mental Disorders,* one of the hallmark characteristics of ASD is significantly impaired social communication. Deficits in social communication can be manifested in many different ways such as difficulty with social reciprocity, a lack of understanding and utilizing nonverbal communication, and limitations with interpersonal relationships (American Psychiatric Association [APA], 2013).

Reducing social communication deficits is a frequent intervention target for individuals with ASD. Understanding and expressing emotions is integrally tied to expressing and interpreting social messages. In fact, the skill of decoding emotions based on facial expressions is linked to both increased social competence and increased ability to attribute and discriminate personal and interpersonal mental states, mentalizing, as it is referred to in Theory of Mind literature (Baron-Cohen, Leslie, & Frith, 1985; Custrini & Feldman, 1989; Wong, Beidel, Sarver, & Sims, 2012). Teaching the skills necessary to interpret and understand the emotions of others can be an arduous process. In 2001, the Committee on Educational Interventions for Children with Autism and the National Research Council published a report, *Educating Children with*

Autism, to provide guidelines for the assessment and treatment of children with ASD. The report recommends that children with ASD should receive at least 25 hours of intervention and services per week (National Research Council, 2001). Considering this recommendation, it is incredibly important to embed opportunities for learning within every day activities, and the research community has begun to investigate how to do that.

It was previously debated whether emotion recognition was a skill that could be trained in individuals with ASD; however, researchers have found that in a socially motivating context these skills can be taught. Simon Baron-Cohen and colleagues (2009; 2012) have begun to examine the role cartoons can play in emotion recognition intervention. A well-known product of Baron-Cohen's research is his cartoon series, *The Transporters. The Transporters* features animated vehicles with human faces as seen in Figure 1. A recent study evaluating the efficacy of teaching emotions to children with ASD using *The Transporters* showed that these cartoons were effective in improving young children with ASD's ability to judge emotions (Golan et al., 2010). These findings have important implications for the social motivation associated with cartoons and the variety of different ways the skill of emotion recognition can be embedded into regular activities. For young children, who may not be receiving the social communication services that they need in the classroom, cartoons could provide a motivating and easily accessible context to practice the recognition of emotions.

Figure 1. Example of *The Transporters* cartoon characters.

Facial Processing

The idea that cartoons can potentially be used as a powerful teaching tool is rooted in evidence showing that cartoons may be particularly fascinating for children with ASD (Grelotti, Klin, Gauthier, Skudlarski, Cohen, Gore & Schultz, 2005; Lindner & Rosen, 2006; Rosset et al., 2008, Rosset et al., 2010). Previous research has indicated that children with ASD process faces differently than children with TD. One technique that is frequently used in emotion recognition and facial processing literature is having participants perform tasks using inverted photographs. In these tasks either the whole face or important components only (such as eyes and lips) can be inverted. Previous studies have identified a pattern of typical facial processing called an "inversion effect." This effect refers to a difference in performance between recognition of upright and inverted faces (Valentine, 1988). In a 2010 study, Rosset and colleagues found an inversion effect when children with TD were presented with inverted human faces; however, this same processing pattern was not seen in peers with ASD. Interestingly, an inversion effect was seen when children with ASD viewed inverted cartoon faces. In this study, researchers found that the ability to discriminate between inverted and upright faces required two things: motivation and exposure. These findings show that children with ASD process cartoon faces similarly to how children with TD process human faces. This suggests that, for children with ASD, cartoon faces hold a significant, motivating status, not seen for human faces.

The emphasis placed upon cartoons has even been studied using neuroimaging research. Grelotti and colleagues (2005) published a single case study with an 11-year-old male with ASD who had a fascination with the cartoon, Digimon. Using Functional Magnetic Resonance Imaging (fMRI), researchers found that the subject's fusiform face area (FFA) was activated more when viewing Digimon characters than when he viewed both unfamiliar and familiar human faces. In fact, the activation patterns seen when the child viewed Digimon characters are similar to the activation patterns seen when children with TD view human faces. The FFA is a part of the brain associated with not only facial recognition, but also the recognition of items for which one has perceptual expertise. For example, this area of the brain is similarly activated when car experts identify cars (Grelotti et al., 2005). Due to the limited size of the sample in this study, results may not be generalizable to the larger population; however, these atypical activation patterns when viewing the cartoon Digimon do offer evidence as to the significant, motivating status of cartoons for some children with ASD. This could be due in part to development of perceptual expertise for cartoon stimuli that is not seen for human faces.

While several studies have shown that children with ASD experience difficulty in decoding emotions through isolated facial expression and tone of voice (Grossman & Klin, 2000; Kjelgaard & Tager-Flusberg, 2013; Lindner & Rosen, 2006), these studies have utilized stimuli composed of adult human facial expressions. In opposition to research indicating that children with ASD have difficulty decoding emotion, recent studies have found that individuals with ASD show an ability to decode emotion as well as TD peers when presented with a static cartoon stimulus (Lindner & Rosen, 2006; Rosset et al., 2008, Rosset et al., 2010). Many research studies have investigated the ability of children with ASD to perceive and judge emotion, but little research has been conducted to examine whether that ability differs when children are presented with cartoons as a stimulus as opposed to human faces. The present study hypothesizes that the ability of children with ASD to perceive and judge facial expressions will improve by utilizing a stimulus that is sufficiently motivating to participants. Previous studies have echoed this concern and suggested that future research investigate ways to improve studies on perception of emotion using facial expression (Lindner & Rosen, 2006; Rosset et al., 2010).

In addition to the call for future research to include sufficiently motivating stimuli, another gap found within the literature is the use of dynamic facial expressions. A vast majority of research conducted in the area of perception of emotion has utilized only static pictures of facial expression and has largely ignored the role of response time (Grossman & Klin, 2000; Rosset et al., 2010; Rosset et al., 2008; face, Da Fonseca, Esteves, & Deruelle, 2015). A recent formal meta-analysis by Uljarevic and Hamilton (2013) asserted that emotion recognition in ASD remains largely uncertain and cited the use of dynamic facial expressions and response time data as an important direction for future research in this area:

> "One important question is the role of timing in recognition of emotion—individuals with autism might be slower to recognize emotions, or might have more difficulty with dynamically moving faces which have a higher ecological validity than static photos.

Examining emotion recognition in dynamic, time constrained and realistic contexts will be an important focus of future research (Uljarevic & Hamilton, 2013)."

The diagnosis of ASD has been shown to be a factor in the ability to decode emotion (Lindner & Rosen, 2006; Kjelegaard & Tager-Flusberg, 2013). While most previous research in this area has examined the ability of children with ASD to decode emotion in the context of static expression, a study by Lindner and Rosen (2006) looked at the ability of children and adolescents with Asperger's Syndrome (AS) to decode emotions across five modalities: static facial expression, dynamic facial expression, prosody, verbal content, and combined (dynamic facial expression, prosody, and verbal content). The study found that participants with AS and age-matched TD peers performed similarly with decoding emotion in the combined modality of dynamic facial expression, prosody, and verbal content. The same study showed that participants with AS experienced more difficulty in decoding emotion in the context of isolated facial expression and isolated prosody (Lindner & Rosen, 2006). The observed increased accuracy suggests that decoding skills in children with Higher-Functioning Autism (HFA) and AS and children with TD might be more similar than previously thought with regard to perceiving emotions in a naturalistic context. This study provides support for the previous call for research that involves dynamic, naturalistic stimuli.

Combining modalities, for example facial expression and verbal content, does present additional challenges. When modalities are combined, performance effects may be seen that could be explained by extraneous factors rather than or in addition to emotion. With regard to children with ASD, verbal compensatory strategies have been a focus of research. Grossman and colleagues (2000) found that children with HFA performed significantly worse on a mismatched task than TD peers matched on age and IQ. During the task, participants viewed static facial expressions of happiness, sadness, anger, fear, and surprise. These facial expressions were paired with an emotion that was matching, mismatching, or irrelevant. Based on these findings, Grossman postulated that these children were "utilizing compensatory strategies" by relying primarily on verbal content in circumstances with conflicting stimuli (Grossman & Klin, 2000). These findings were in keeping with similar research that has shown that children with ASD use verbal content of emotional messages as a compensatory strategy (Lindner & Rosen, 2006). This may indicate that children with ASD focus on semantic content, rather than facial expression, when presented with static adult facial expressions and semantic content. While this has yet to be examined in a dynamic context—with combined voice, facial expression, and verbal content—it is possible that a more complex context could lead to the use of similar compensatory strategies. To compensate for any potential effects seen by verbal compensatory strategies, the present study utilized both matched and mismatched emotional expressions. An example of this would be a scene from *Inside Out* where Sadness says, smiling, "remember that funny movie where the dog died?" If a child were relying only on verbal compensatory strategies to decode the clip, they might incorrectly choose sadness. These kinds of clips provide opportunities for participants to full integrate the different components of the message, rather than relying on verbal content alone.

Familiarity with the particular stimuli has also been shown to have an effect on recognition. Spence, Rollins, and Jerger (2002) examined children with TD's ability to recognize and identify the voices of cartoon characters and found that children as young as three years old had the capability to store vocal attributes linking perceptual features in their long-term memory. The study found that the more frequently the participants had previously viewed the cartoons used in the stimuli, the more likely they were to not only recognize the character's voice, but also to recall perceptual features like the speaker's face and name. These findings also suggest that familiarity with the stimulus plays a key role in perception and memory of speech (Spence, Rollins, Jerger, 2002). The familiarity effect was taken into account in the design of the present study. Participants with increased salience might be primed to identify a character's emotion by the pictured character's name. In order to avoid this, clips were chosen that feature each of the characters displaying other emotions than their primary state (i.e. Joy experiencing "sad," Sadness experiencing "happy"). Because this study is consciously focusing on common, salient content rather than novel stimuli, the effect of salience on performance was considered.

Development of Emotion Recognition

When investigating emotion recognition in a pediatric population, difference in ability level can be brought about by several mediating factors. The primary factor that we investigated in the present study was clinical diagnoses, namely ASD; however, another important mediating factor in this population is age. The ability to recognize and discriminate different emotions emerges early in life (Barrera and Maurer, 1981; Durand et al., 2007; Walker-Andrews, 1997); however, adult-level proficiency in emotion perception and judgement does not appear to be acquired before the age of 10 (Chronaki et al., 2015; Durand et al., 2007; Rump, Giovannelli, Minshew & Strauss, 2009). In order to better understand the deficits in social competency seen in children with ASD, it is important to also understand the development of emotional and social skills in children with TD. The ability to discriminate emotions based using facial expressions develops early in children with TD. By the age of 4 months, infants have not only been shown to discriminate the emotions "anger" and "happy," but also display a preference for faces with positive facial expressions as evidenced by visual fixations and spontaneous emotional responses

(Chronaki et al., 2015; Oster, 1981). By 12 months of age, infants can recognize emotional facial expressions and adjust their social behavior per the emotional message conveyed (Hertenstein & Campos, 2004). Several studies have demonstrated that TD preschoolers can recognize and judge emotional facial expressions at above chance levels, but, when compared to adults, their performance is significantly less accurate (Markham & Adams, 1992; Russell & Widen, 2002; Widen & Russell, 2003). Research on emotion recognition is fairly mixed with regard to emotion development trajectories; however, a common finding is that among core emotions—happy, sad, angry, scared, disgusted—angry and sad are mostly commonly misidentified in childhood (Chronaki et al., 2015). This indicates that recognition of these emotions occurs later in childhood than other emotions like happy and scared.

For individuals with ASD, the same levels of proficiency in emotion recognition seen in the TD populations, do not appear to arise, even into adulthood (Rump et al., 2009). Some researchers have attempted to identify particular emotions that individuals with ASD struggle with. While different researchers code emotions differently, several studies have identified that individuals with ASD struggle more with emotions like "scared" and "angry" as opposed to "happy" (Howard, et al., 2000; Humphreys, Minshew, Leonard & Behrmann, 2007; Rump et al., 2009). Beyond this, there is not much consistent information in the literature regarding the order of acquisition of particular emotions.

For most healthy children, soon after birth the ability to attend to human faces becomes a vitally important factor in typical development. Throughout this developmental period, that is characterized by activity-dependent plasticity, human faces are frequent and salient visual stimuli. Some developmental models of the visual cortex take the early importance of human faces into account and "hypothesize that habitual patterns of fixation shape the long-term organization of face-processing cortical regions (Golarai et al. 2006)." These models could possibly provide additional insight in the findings of Grelotti and colleagues in their Digimon facial recognition study. The researcher hypothesized that the FFA demonstrated increased activation while the subject with ASD was viewing Digimon cartoons because these cartoons held more significant status than familiar and unfamiliar human faces. They posited that the subject had, in effect, become a Digimon "expert" leading to increased activation in the FFA. Whereas children with ASD might develop "expert" status with preferred stimuli, cartoons or inanimate objects, children with TD develop "expert" status with human faces due to the early exposure during a critical developmental window. Indications as to why children with ASD do not naturally develop perceptual expertise for human faces could relate to early social deficits.

Role of Social Motivation

For individuals with ASD, indications of abnormal emotion recognition abilities can be seen early in life. Prospective studies have identified a host of early indicators of social deficits, including a lack of appropriate gaze, lack of response to name, lack of warm, joyful expressions with gaze, and lack of eye contact observed in infants who were later diagnosed with ASD (Wetherby et al., 2004). The reduced attention to facial stimuli may impede the development of facial awareness that leads to "expert" status by limiting exposure to emotional facial expressions and, in turn, limiting the social learning opportunities. because exposure to emotional facial expressions is required to develop an understanding of their meaning.

Many of the previously mentioned early indicators of social deficits suggest decreased motivation to attend to socio-emotional stimuli. Many researchers suggest that these early deficits contribute to later social impairments (Mundy & Neal, 2001; Wetherby et al., 2007). Although decreased social motivation is thought to contribute to social impairments, the role of social motivation has largely been ignored in emotion recognition research (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012). If researchers could integrate social motivation theory into the design of emotion recognition tasks, it is possible that an improved performance could be seen in children with ASD. The present study sought to examine the role of social motivation in emotion recognition by utilizing stimuli for which individuals with ASD have developed perceptual expertise. Following the model proposed by Chevallier and colleagues (2012), an illustration of the role social motivation theory plays in emotion recognition for children with ASD can be found in Figure 2.

Figure 2. Role of social motivation in emotion recognition of human faces.

Figure 3. Proposed model of emotion recognition in cartoon faces.

Purpose

This project sought to fill the gaps in current literature with regard to emotion recognition in ASD by exploring the ability of children with ASD to judge and perceive emotions conveyed by cartoon characters in a dynamic context. While previous research studies have demonstrated differential processing of cartoon faces and increased accuracy in perceiving and judging emotions when expressed by a cartoon, these factors have not been previously investigated in a dynamic, naturalistic context (Grelotti et al., 2004; Rosset et al., 2008; Rosset et al., 2010). By utilizing stimuli that are socially motivating—cartoons—this study can accommodate for the role that social motivation plays in socio-emotional tasks like emotion recognition. In an effort to increase the ecological validity, the present study used common stimuli, which can be made easily accessible in the home or school environment. Potential implications could include parents and caregivers integrating emotional recognition practice into common activities (i.e. watching television and movies).

In the context of this study, dynamic refers to video clips featuring changing facial expression, prosody, and verbal content of one character. In the context of this study, static facial expressions consist of still images displaying one character. Additionally, common refers to the non-novel nature of the stimuli that will be presented. All stimuli presented are children's movies that are commercially available. The current study has selected common stimuli in an effort to increase the intrinsic motivation and ease of recognition (Spence et al., 2002). The present study addressed the following research aims:

1. *Do perceptual characteristics of the stimulus (cartoon vs. human) affect the ability of children with ASD to perceive and judge emotional content?*

- *Hypothesis 1: Children with ASD will have increased accuracy and decreased response time in cartoon conditions.*

2. *Does context (static vs. dynamic) affect the ability of children with ASD to perceive and judge emotional content?*
    1. *Hypothesis 2: Children with ASD will have increased accuracy and decreased response time in dynamic conditions.*
3. *Does a diagnosis of ASD affect the ability to judge emotional content when viewing cartoon faces?*
    1. *Hypothesis 3: With regard to accuracy and response time for children with ASD will not be significantly different than their TD peers for cartoon conditions.*

CHAPTER 2

METHODS AND PROCEDURE

Participants

Twenty children, ranging in age from 5 to 11 years of age, were recruited to participate in this study. Participants were categorized into either the ASD experimental group or the TD comparison group. Participants were recruited from The University of Alabama, Autism Spectrum Disorders Clinic, The University of Alabama, Speech and Hearing Center, The University of Alabama faculty and staff newsletter and the “Tuscaloosa Moms” Facebook page. The clinical group included children who were previously diagnosed with Autism Spectrum Disorder by a qualified professional using the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000), Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), or a clinical judgment using DSM-V criteria (APA, 2013). ASD symptoms were confirmed using the *Childhood Autism Rating Scale, Second Edition* (CARS-2) (Schopler, Bourgondien, Wellmand, & Love, 2010). The CARS-2 was administered to both experimental and comparison groups, in order to rule out the presence of ASD symptoms among the comparison group. To ensure that participants had the cognitive abilities necessary to effectively participate in the current study, the *Peabody Picture Vocabulary Test, Fourth Edition* (PPVT-IV) (Dunn & Dunn, 2007) was administered to all participants. Children with High-functioning Autism (HFA) were recruited due to the cognitive and behavioral requirements for the tasks.

Participants were not excluded on the basis of comorbid diagnoses provided that their diagnoses did not limit their ability to participate in tasks or respond appropriately. Lindner and Rosen (2006) found that individuals with comorbid diagnoses such as ADHD and anxiety appear to have similar ability with regard to decoding emotion as children with only a diagnosis of ASD. All twenty participants were selected for analysis, with all participants having a PPVT score within normal limits.

Materials

Apparatus. The stimuli were presented using *SuperLab 4.5* software and were run on an Apple iMac computer.

Measures.

Peabody Picture Vocabulary Test, Fourth Edition (Dunn & Dunn, 2007). The *Peabody Picture Vocabulary Test, Fourth Edition (*PPVT-IV) is a norm-referenced, non-verbal, multiple-choice test designed to assess the receptive vocabulary in both children and adults. While the PPVT-IV is not an intelligence test, it is considered to be an accurate screening of intellectual capabilities. The PPVT-IV has been shown to have high reliability and validity, and scores from the previous version of the test, PPVT-III, have been found to highly correlate (.82-.92) with measures of intelligence such as the Wechsler Intelligence scale for Children (Hodapp & Gerken, 1999). Although correlational information is not available for the most recent version of the test, the PPVT-III and the PPVT-IV have been demonstrated to be interchangeable. Correlations between the two versions were found to be consistently high, with ranges between .81 and .91 (Dunn & Dunn, 2007).

Social Responsiveness Scale, Second Edition (Constantino, 2005). The *Social Responsiveness Scale* (SRS-II) is a 65-item behavioral profile to be completed by a parent or caregiver. The parent reports on ASD symptoms as they relate to social settings by responding to items on a 4-point Likert Scale. The SRS-II can be used in adolescents, ages 4-18, to assess social competency and impairments. Subscales include Social Awareness, Social Cognition, Social Communication, Social Motivation, and Restricted Interests and Repetitive Behaviors.

Childhood Autism Rating Scale, Second Edition (Schopler, Bourgondien, Wellmand, & Love, 2010). The *Childhood Autism Rating Scale, Second Edition* is a 15-item scale that rates autism symptoms across functional areas such as Relating to People, Social-Emotional Understanding, and Emotional Expression and Regulation of Emotions. Using information obtained through interaction and observation, the *Childhood Autism Rating Scale High Functioning Version Rating Booklet* (CARS-HF) was rated by the experimenter.

Perception of Emotion Task. The participants were asked to view 64 unique scenes on a computer using *SuperLab*. *SuperLab* is software tool designed to build and facilitate computerized experiments. This software can present images, text, and video, and collect responses accurately from participants. It was used to present stimuli and collect responses. Half of the 64 scenes were brief, 5-second video clips featuring either a cartoon or a human dynamically expressing an emotion. The other half of the scenes contained still pictures of either a cartoon or a human in the midst of expressing an emotion statically. The four following experimental conditions were utilized in the study:

- Condition 1 (Static Cartoon)
    - 16 scenes containing happy, sad, angry, and scared emotional expressions
- Condition 2 (Dynamic Cartoon)

    - 16 scenes containing happy, sad, angry, and scared emotional expressions
- Condition 3 (Static Live Action)
    - 16 scenes containing happy, sad, angry, and scared emotional expressions
- Condition 4 (Dynamic Live Action)
    - 16 scenes containing happy, sad, angry, and scared emotional expressions

Cartoon video clips were taken from the film, *Inside Out,* and human clips were taken from the live-action film *Night at the Museum: Secret of the Tomb*. These clips are available for use in this project through Section 107 of the Copyright Act, also known as Fair Use, which allows for the use of brief portions of copyrighted materials for the purposes of scholarship and research.

The participants were presented four counterbalanced blocks, each block containing 16 scenes. Within each of the scenes, one character was expressing one of the following emotions: happy, sad, angry, and scared. Examples of static stimuli can be seen in Figure 4. Due to the fact that *Inside Out* characters are named for particular emotions, steps were taken to ensure that responses in the cartoon condition were not due to previous familiarity with the film. To account for the potential familiarity effect, characters from the film *Inside Out* were shown expressing their named emotion as well as other emotions.

Figure 4. Example of static stimuli.

Each of the scenes were presented as an individual media square on the computer screen for 5 seconds and the participant responded by identifying the emotion they perceived on a Cedrus RB-540 keypad. The response pad can be viewed in Figure 5.

Figure 5. Cedrus RB-540 keypad.

Response time was recorded through *SuperLab* software. Prior to the beginning of the study, the participants went through a series of training trials where they learned how to use the keypad. To accommodate participants who were not yet able to read, the keys were paired with a corresponding animal. For example, a cow was paired with happy, a cat was paired with sad, a duck was paired with angry, and a pig was paired with scared. Animal pairings are shown in Figure 6.

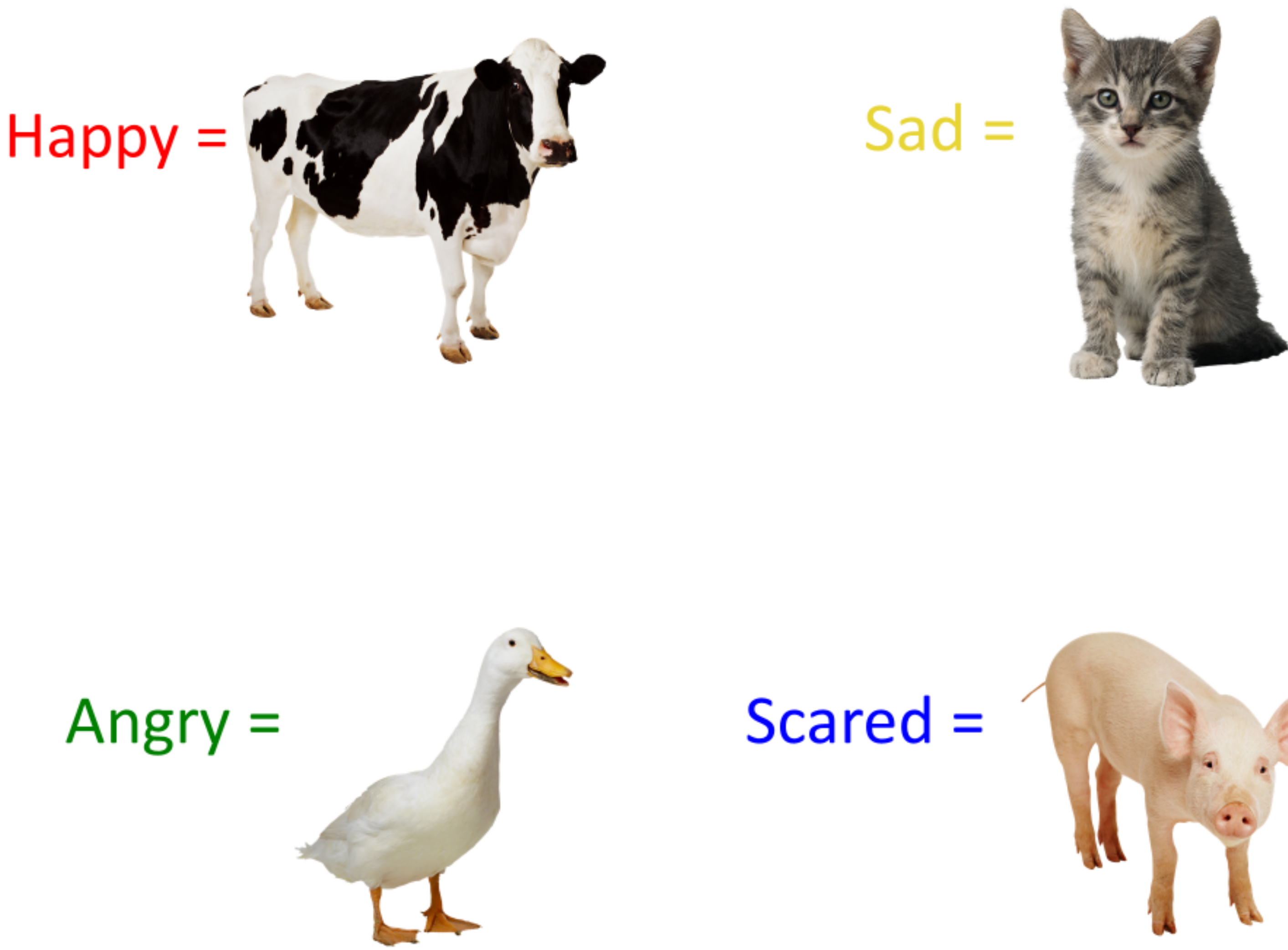

Figure 6. Animal and emotion pairings.

The relationship between emotion and animal were trained preceding the presentation of stimuli. To ensure that participants were able to appropriately use the keypad, the participants were presented with stimuli and informed of the correct emotion. The experimenter observed the participants' responses to ensure that they could effectively respond. Following the training trails, participants then went through a series of practice trials where they were presented with practice stimuli. Due to the novel nature of the current experimental task, stimuli were validated to confirm that stimuli were accurately coded for emotion.

Validation of Stimuli. The stimuli prepared for this study consisted of happy, sad, angry, and scared expressions of emotion. These stimuli were validated in a separate sample of 15 adult participants (M = 24.13, SD = 1.76). Adult participants were provided with the same instructions noted above. The aim of this validation process was to ensure that emotionality coding could be supported by additional judgments of emotions conveyed. Sixty-two of the clips utilized were initially validated. Two additional clips were discovered to be miscoded and were recoded based on adult participants' responses. Average accuracy for both the Cartoon Dynamic condition and the Cartoon Static condition was 93.75% and average accuracy for both the Human Dynamic condition and the Human Static Condition was 87.5%. Additionally, no individual clip received more than two incorrect responses. Consensus by the adult participants was reached for all clips, including those that were recoded following analysis of this sample.

Procedure

Upon arrival, caregiver(s) and participants were briefed about the tasks in a private room. The consent form was explained to caregivers and they were allowed time to review it and ask any questions. All paperwork, including consent forms, the SRS-II, and a demographics questionnaire, was completed by a custodial adult and were approved by the University of Alabama Institutional Review Board. The demographics questionnaire can be found in Appendix A. To collect written assent from the children was not appropriate for children at this developmental level. Instead, assent was collected verbally. Children were asked by the experimenter, “would you like to look at some pictures and videos with me?” Following an affirmative response, the experimenter instructed that “we’re going to look at the pictures and clips and guess how the characters feel. We’ll listen to their how their voice sounds, what they’re saying, and how their face looks. Then you’ll guess if they feel happy, sad, angry, or scared.” If the child verbally or physically agreed in any manner, this counted as having provided assent. For example, the child could say or nod “yes,” stand up and start following the examiner, or nod his or her head. Refusal was considered as tantruming, attempting to escape the testing environment, or verbally saying “no.”

After consent and assent was obtained, caregivers were given the demographics questionnaire and the SRS-II to complete. Caregivers and participants were taken to a private lab space in the UA Speech and Hearing Center. The space where participants completed the emotion recognition portion of the experiment can be found below in Figure 7. To account for fatigue in the testing process, experimental tasks were counterbalanced. Participants were equally divided into different testing conditions. In testing condition 1, the PPVT-IV was administered first, followed by the emotion recognition task. In testing condition 2, participants began with the emotion recognition task and then completed the PPVT-IV. The study took between 30 minutes and 1 hour to complete. Upon completion of the study, the participant and caregiver were debriefed and the caregiver was given a $10 Target gift card.

Figure 7. Participant during practice trials

CHAPTER 3

RESULTS

Prior to data analysis, Levene's test for homogeneity of variance was conducted to calculate equality of variances for all variables. Some variables fulfilled the assumption of homogeneity of variance, and some did not (CARS, SRS, human static accuracy, human dynamic accuracy, and number of times stimuli films were viewed). Due to the lack of homogeneity in our distributions, our sample did not meet fundamental assumptions for quantitative analysis. This likelihood was considered throughout experimental design and data analysis and was accounted for through specific exclusion criteria (i.e. PPVT score) and selection of analyses. It was concluded that the selected tests were robust enough to allow for some violation of assumptions of variance.

Of the 20 participants in the study, 19 had seen *Inside Out* at least 1 time. Far fewer participants (5) had been exposed to the other film *Night at the Museum*. Participants were limited with regard to racial diversity with 19 participants identifying as Caucasian and 1 participant identifying as African-American. The final sample of individuals with ASD ranged in age from 5 years to 11.33 years (M = 7.85, SD = 2.03) and consisted of 2 females and 8 males. The final sample of individuals with TD ranged in age from 5.58 years to 10.66 years (M = 8.35, SD = 1.69) and consisted of 6 females and 4 males. Please refer to Table 1 for demographic and descriptive information.

Several analyses were run to examine differences between ASD and TD groups in order to rule out alternative explanations for any differences found in emotion perception. An independent samples t-test was used to analyze the two groups' ages in order to demonstrate that any potential differences seen were not due to age. Participants with ASD (M = 7.85, SD = 2.03) were not found to be significantly different than participants with TD (M=8.35, SD=1.69) regarding age, $t(18) = 0.59$, $p = 0.56$. It is worth noting that this difference is trending toward significance. Additionally, to rule out differences due to gender, a Pearson's chi-square test was conducted. Gender was found to not be significantly different between the two groups, X^2 (2, N =20) = 3.33, p = .07. This p-value indicates a trend toward significance. Additional characteristics of the groups can be seen in Table 1.

Table 1

Participant Characteristics: Mean, Standard Deviation, Significance Levels (p), and Ratio of Variance (F)

	ASD (*n*=10)		**TD (*n*=10)**		***F***	***p***
	M	*SD*	*M*	*SD*		
Chronological Age (In Years)	7.85	2.03	8.35	1.69	--	.563
Gender						
Female	2	--	6	--	--	--
Male	8	--	4	--	--	--
Ethnicity						
Caucasian	9	--	10	--	--	--
African American	1	--		--	--	--
CARS (Raw Score)	33.15	4.05	15.2	0.48	193.16	.000*
PPVT (Standard Score)	100.3	11.58	120.3	8.60	19.20	.000*
SRS (Raw Score)	107.6	37.84	20.5	11.60	48.40	.000*

Note. PPVT scores above 85 are considered to be within normal limits and thusly cognitively capable to participate in the study. Raw scores, rather than T-scores, were used for the ASD specific measures (CARS, SRS) to demonstrate the full range of scores for each of the groups across the age ranges. CARS raw scores across both groups ranged from 15 to 60, with scores above 28 typically associated with ASD. SRS scores range from 0 to 260, with scores above 58 typically associated with ASD.

With regard to emotion, accuracy differed based on the particular emotion presented. Both groups demonstrated the highest rates for accuracy for happy (ASD M=14, TD M=16). Previous research has demonstrated that, for individual with ASD and TD, happiness is consistently the most accurately judged emotion (Chronaki et al., 2015; Howard, et al., 2000; Humphreys, Minshew, Leonard & Behrmann, 2007; Rump et al., 2009). This finding supports previous work that happiness features more salient facial cues, while other emotions like sadness are more ambiguous and more closely related to a neutral facial expression (Chronaki et al., 2015). All participants in the TD group correctly responded on all "happy" scenes presented. More variability was seen in the ASD group for "happy" accuracy; however, four participants accurately responded on all 16 "happy" scenes, 2 participants responded accurately on 15/16 scenes, and 2 participants responded accurately in 14/16 scenes. Both groups were most accurate for happy and sad scenes. The largest difference between group means was observed for scared (ASD M=10.6, TD M=13.6). The lowest means were observed for angry and scared for both groups. Additional information can be found in Figure 8.

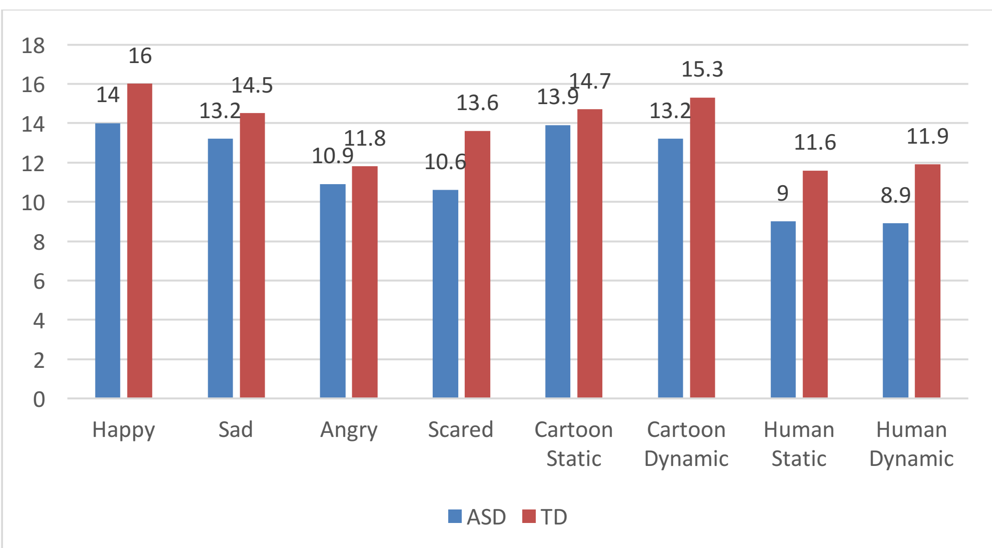

Figure 8. Accuracy for emotion categories and context and perceptual categories. *Note. Accuracy scores are out of total of 16.*

Both group had their longest response time for “sad” scenes. Both groups had similar means for “angry” and “scared” emotion categories. The largest difference in means between the two groups was seen for “happy.” Fastest response times for the TD group were seen for the “happy” category, which is in line with the group’s highly accurate performance on that category. Fastest response time for the ASD group was observed for the “scared” category, which was the ASD group’s least accurate emotional category. A representation of response times for the ASD and TD groups can be found in Figure 9.

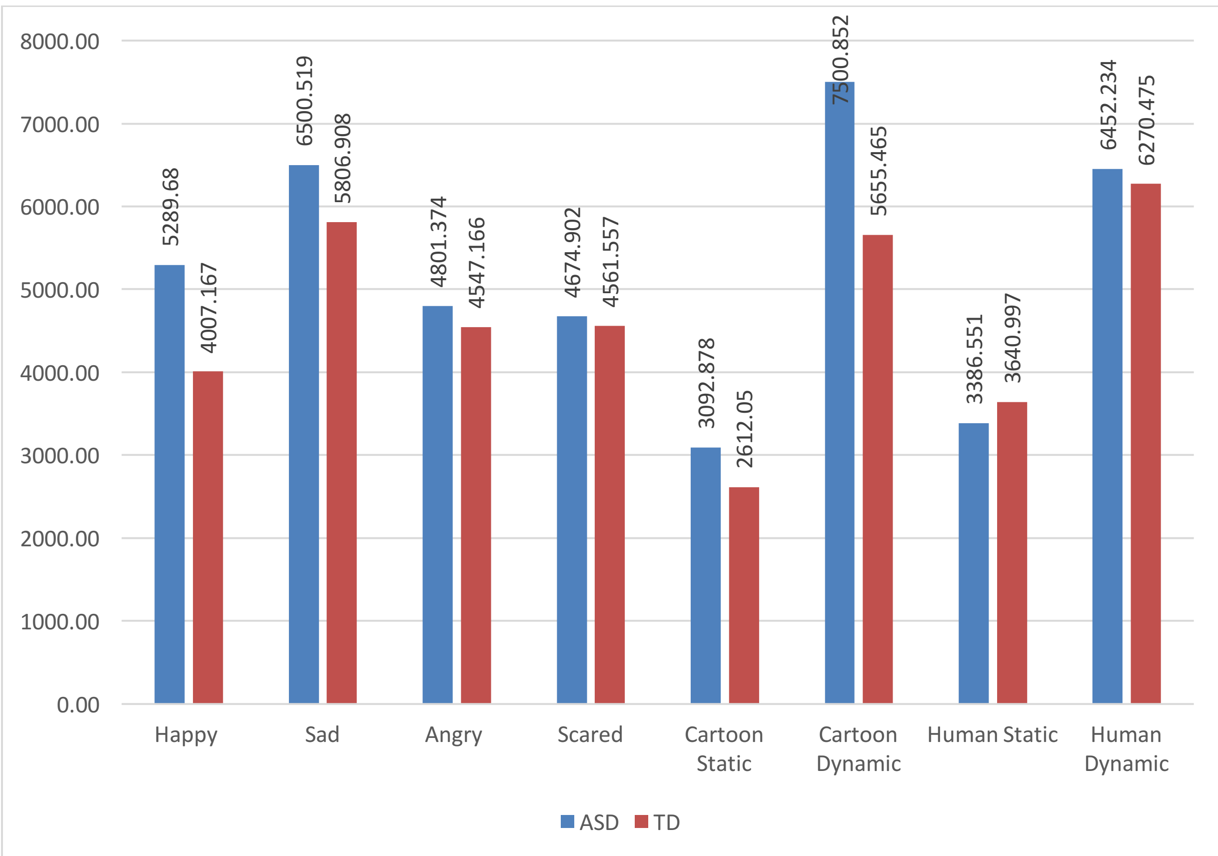

Figure 9. Response time for emotion categories and context and perceptual categories.

In order to address research question 1 (*do perceptual characteristics of the stimulus (cartoon vs. human) affect the ability of children with ASD to perceive and judge emotional content?*) paired samples t-tests were used. These t-tests compared the accuracy and response time respectively on cartoon (static and dynamic) and human stimuli (static and dynamic) for the ASD group. Children with ASD were statistically more accurate in judging cartoon faces (*M*= 27.1) compared to human faces (*M*=17.9), *t*(9)=6.91, *p*<.001. No difference in response time when comparing cartoon conditions (*M*=5296.87) and human conditions (*M*=4919.39), *t*(9)= 0.81, *p*=0.44. Results are shown in Table 2.

Table 2
Results of t-test and Descriptive Statistics for Cartoon and Human Conditions

	ASD Group				
	Cartoon	Human			
	M	*M*	*t*	*df*	*p*
Accuracy	27.1	17.9	6.91	9	<.001*
Response Time	5296.87	4919.39	0.81	9	0.44

Note: Correct responses are out of 32.
* Denotes significance.

To address research question 2 (*does context (static vs. dynamic) affect the ability of children with ASD to perceive and judge emotional content?)* paired samples t-tests were used. These t-tests compared the accuracy and response time respectively on static (cartoon and human) and dynamic (cartoon and human) stimuli for the ASD group. Context did not affect the accuracy of children with ASD when comparing dynamic scenes (*M*=22.10) and static scenes (*M*=22.90), *t*(9)= 1.15, *p*=0.28. However, children with ASD took significantly longer to process dynamic scenes (*M*= 6976.54) than static scenes (*M*=3239.71), *t*(9)= 6.92, *p*<.001. Similarly, context was not found to significantly affect accuracy when comparing accuracy on cartoon dynamic (*M*= 13.20) and cartoon static scenes (*M*= 13.90), *t*(9) = 1.14, *p*= 0.28.

Table 3
Results of t-test and Descriptive Statistics for Static and Dynamic Context

	ASD Group				
	Static	Dynamic			
	M	*M*	*t*	*df*	*p*
Accuracy	22.90	22.10	1.15	9	0.28
Response Time	3239.71	6976.54	6.92	9	<.001*

Note: Correct responses are out of 32.
* Denotes significance.

To address research question 3 (*does a diagnosis of ASD affect the ability to judge emotional content when viewing cartoon faces?*), independent samples t-tests were used. These t-tests compared the accuracy and response time on cartoon scenes (static and dynamic) for the ASD and TD groups respectively. Between the ASD group (M=27.10) and the TD group (M=30.00) significant differences were not found for cartoon conditions, $t(18)= 1.64$ p=0.12. Response time was found to be marginally different between the two groups for cartoon conditions (ASD M= 5296.87, TD M= 4133.76, $t(18)= 2.10$, $p= 0.05$).

Table 4
Results of t-test and Descriptive Statistics for Both Groups in Cartoon Conditions

	ASD	TD			
	M	*M*	*t*	*df*	*p*
Accuracy	27.10	30.00	1.64	18	0.12
Response Time	5296.87	4133.76	2.10	18	0.05*

Note: Correct responses are out of 32.
* Denotes significance.

In the initial data analysis proposal, 3-way ANOVAS were proposed to look at interactions between diagnoses, perceptual characteristics, and context; however, this proposal assumed a larger sample size. Due to current sample size and concerns regarding power, t-tests were chosen to address within and between group research questions. These analyses mirror those seen in other studies in with similar sample sizes comparing ASD and TD groups (Dapretto et al., 2006; Oberman et al., 2005; Oberman et al., 2008).

Children with ASD had statistically lower accuracy on human stimuli than children with TD, for both static [ASD M=9.0, TD M=11.6, $f(1,18)$= 5.72, p=0.03] and dynamic [ASD M=8.9, TD M=11.9, $f(1,18)$= 8.46, p=0.009] stimuli.

Children with ASD did not have significantly lower accuracy than children with TD on cartoon stimuli for either static [ASD M=13.9, TD M=14.7 $f(1,18)$=1.28, p=0.27] or dynamic [ASD M=13.2, TD M=15.3, $f(1,18)$= 3.32, p=0.085] stimuli, although the difference between ASD and TD for dynamic was trending toward significance. It should be noted that assumption for homogeneity of variance was violated for human accuracy (both static and dynamic), and cartoon dynamic trended towards violation.

Overall, the TD group was more accurate in identifying scared and happy. The primary differences in accuracy between the ASD group and TD group were significant for scared, (p=0.023), and marginally significant for happy, (p=.056).

Response times were marginally longer for the ASD group than the TD group for cartoon dynamic stimuli (p=.051), but not for cartoon static or either type of human stimuli. Response times for the ASD group were significantly longer for happiness (p=.040), but not for other emotions.

CHAPTER 4

DISCUSSION

To our knowledge, this is one of the few studies that has examined emotion recognition in children with ASD with regard to both accuracy and response time. An additional focus of this research was the theoretical impact of social motivation and whether perceptual characteristics affected emotion recognition. Reviewing the results from research question 1, it appears that social motivation does in fact play a role in emotion recognition. Children with ASD were significantly more accurate in judging cartoon faces than human faces. This finding is in line with previous research that has found that cartoons hold a significant status for individuals with ASD and are perceived differently than human faces (Grelotti et al., 2004; Lindner & Rosen, 2006; Rosset et al., 2008, Rosset et al., 2010). While a difference was found for accuracy, a difference between cartoon and human conditions was not observed with regard to response time. These results partially support hypothesis 1, because improved accuracy, but not improved response time was observed for cartoon conditions. Previous studies have not investigated response time for emotion recognition tasks, so little is known about this aspect of emotion recognition and should be further explored.

Research question 2 examined within group differences seen for static and dynamic stimuli. The effect of context was evaluated for all scenes (cartoon and human), as well as, only cartoon scenes. Context (static or dynamic) did not affect accuracy for combined cartoon and human conditions or cartoon only conditions. While accuracy was not affected by context, participants with ASD had significantly longer response times for dynamic scenes than static scenes. These findings suggest that emotion recognition is not wholly context dependent in this experiment. These results do not support hypothesis 2.

Research question 3 examined the difference between the ASD and TD groups with regard to judging cartoon stimuli. As hypothesized, for accuracy, no difference was found between the two groups. However, response time was marginally significant. These results partially support hypothesis 3. This finding suggests that with cartoon stimuli, children with ASD can perform as accurately as TD peers on basic emotion recognition tasks. While many previous studies have indicated that children with ASD have difficulty in decoding emotion, this finding illustrates that children with ASD show an ability to decode basic emotion as well as TD peers using cartoon stimuli (Grossman & Klin, 2000; Kjelgaard & Tager-Flusberg, 2013). This finding confirms previous studies that have found improved performance on emotion recognition tasks when cartoon stimuli were used (Lindner & Rosen, 2006; Rosset et al., 2008, Rosset et al., 2010). These findings also support the theory that children with ASD develop a perceptual expertise for cartoons that allows for improved emotion recognition.

To our knowledge, previous similar studies have not obtained response time data. Due to the novel nature of this dependent variable, the present study sought to look at the role of response time in an exploratory manner. Participants were all informed that they should respond as quickly possible; however, during administration of the study some participants in the ASD group reacted to stimuli in ways that affected their response time (i.e. laughing at scenes, stopping to talk to experimenter). It is unclear whether these reactions are due to challenges with encoding the scenes or secondary causes.

While PPVT scores were significantly different, both means were well within normal limits. These scores indicate cognitive ability to meet expectations of experimental tasks.

Because of this, it is likely that differences between the two groups were not due differences in cognitive ability or receptive vocabulary. Additionally, CARS and SRS scores were found to be significantly different between the two groups, with higher scores found for the ASD group. This indicates that the experimental group was different from our comparison group as intended. Higher scores on these measures indicates the presence of symptoms and social deficits characteristic of ASD.

The similar patterns of performance observed between the two groups suggest that emotion recognition for different emotion types are acquired in a similar order for children with ASD and TD. This is evidenced by similar rates of accuracy for the different emotion categories. For example, for both groups, happy was the most accurate emotion, followed by sad.

Another consideration is whether participants in the ASD group had previously received relevant therapies. The research of Simon Baron-Cohen (2009, 2012) has demonstrated the emotion recognition skills can be taught to individuals on the spectrum. For children and adolescents with ASD, emotion recognition and other social skills are likely targets for therapy. Although data is not available for the present sample, future studies could gather information regarding previous relevant treatments. This information could provide valuable information about the effect of treatment on emotion recognition abilities.

Limitations

The sample size used to answer these research questions is the primary limitation of this study. Each group had 10 participants, with a total of 20 participants in all. The limited sample size affected the power to detect differences using analyses run in the present study. It is possible that with larger sample sizes, greater effects could be seen. Additionally, with such a small sample size and multiple comparisons, risks for type II are greater. Larger sample sizes were initially proposed; however due to time limitations and access to participants with ASD this goal was not able to be accomplished.

As reflected in Table 1, both the ASD and TD groups were comprised mostly of Caucasian, male participants. Limited diversity observed is a consideration in the present sample. The demographic make-up of the present sample is consistent with much of the research on children with ASD. West and colleagues (2016) recently examined the demographic considerations of studies conducted using individuals with ASD and found that a vast majority of studies utilized participants that were young, Caucasian, and male.

The fact that most of the participants were male is also worth noting because research has shown that females may have improved performance than their age-matched male peers in judging emotional facial expressions (McClure, 2000). While some studies have indicated that females out perform their male counterparts in childhood, there is some evidence that these performance differences decrease as emotion recognition rates reach adult levels (Lee et al., 2002). There were differences in the gender makeup of the two groups; however, these differences were not found to be significant. Because of this, there is decreased likelihood that any differences between the groups were due to gender.

Clinical Implications

The findings of this study suggest that cartoons could be used for emotion recognition training in a variety of different contexts. Due to socioemotional deficits inherent in ASD, socioemotional skills are a frequent target in therapy. Using cartoons could be a way to for therapists to use a socially motivating context to facilitate engagement and emotion recognition training. The results of this study illustrate that children with ASD can have improved success in judging the emotions of cartoons. In addition to being a motivating context for emotion recognition training, using cartoons can provide an opportunity for children with ASD to feel successful in the task of recognizing emotions.

Using the model of Simon Baron-Cohen's *The Transporters*, emotion recognition training could potentially be extended into the home. Future research could investigate the use of cartoons in parent-mediated interventions within the home. Researchers have demonstrated the that specialized cartoons can improve emotional understanding (Golan et al., 2010). Considering these findings, along with the findings from the present study, questions of application are raised. Can the effects seen for *The Transporters* be applied to more easily accessible cartoons like *Inside Out*? This is a valuable question that could potentially lead to improved access to socioemotional training opportunities. The wide range of emotions demonstrated in the film *Inside Out* would likely lend itself to an intervention model similar to that seen for *The Transporters*. In addition to the opportunity to practice emotion recognition, this kind of model would also facilitate discussion of causes and consequences and understanding of personal and interpersonal emotional states. These valuable social skills could be worked on in a variety of settings with parents, peers, or relevant professionals.

Another potential avenue for research could be the role that social cognition plays in emotion recognition. Previous research has assumed that all individuals diagnosed with ASD share an atypical processing pattern for faces (Grelotti et al., 2005; Rosset et al., 2010); however, new research has suggested individuals with ASD who have higher levels of social cognition actually demonstrate typical processing patterns (Chronaki et al., 2015). Future research could incorporate measures of social cognition in order to discover if typical facial processing in individuals with ASD leads to typical emotion recognition. This could help to identify which individuals with ASD would benefit from exposure to cartoon stimuli.

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Appendix A

Research ID #________________

Please indicate the following information regarding your child. Circle or fill-in the appropriate answer.

Sex **Female** **Male**

Child's DOB _____________

Race/Ethnicity **African American** **Caucasian** **Hispanic** **American Indian** **Asian**

Pacific Islander **Other (Specify):______________**

How aware do you think your child is of your emotions?

Not Very Aware **Somewhat Aware** **Very Aware**

How aware do you think your child is of the emotions of peers?

Not Very Aware **Somewhat Aware** **Very Aware**

Has your child seen the film "Inside Out"? **Yes** **No**

If yes, please indicate the approximate number of times.

1-2 **3-10** **11+**

Has your child seen the film "Night at the Museum: Secret of the Tomb"? **Yes** **No**

If yes, please indicate the approximate number of times.

1-2 **3-10** **11+**

Approximately how many hours does your child spend viewing cartoons per week?

0 **1-5** **6-10** **11-15** **15+**

Appendix B

THE UNIVERSITY OF ALABAMA | Office of the Vice President for Research & Economic Development
Institutional Review Board for the Protection of Human Subjects

June 27, 2016

Angela Barber, PhD
Department of Communicative Disorders
College of Arts & Sciences
Box 870242

Re: IRB Application #: 16-007
Application Title: "Perception of Emotion in Static and Dynamic Facial Expression in Children with Autism Spectrum Disorders"

Dear Dr. Barber:

The University of Alabama IRB has received the revisions requested by the full board on 6/17/16. The board has reviewed the revisions and your protocol is now approved for a one-year period. Please be advised that your protocol will expire one year from the date of approval, 6/17/16.

If your research will continue beyond this date, complete the IRB Renewal Application by the 15th of the month prior to project expiration. If you need to modify the study, please submit the Modification of An Approved Protocol Form. <u>Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants</u>. When the study closes, please complete the Request for Study Closure Form.

Please use reproductions of the IRB approved stamped consent/assent forms to obtain consent from your participants.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number.

Good luck with your research.

Sincerely,

[redacted]

Stuart Usdan, PhD
Chair, Non-Medical Institutional Review Board

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