FACIAL EMOTION RECOGNITION IN CHILDREN WITH ASPERGER'S DISORDER AND IN CHILDREN WITH SOCIAL PHOBIA

By

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B.A. Cornell University, 2007

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Science in Clinical Psychology
in the Department of Psychology
in the College of Sciences
at the University of Central Florida
Orlando, Florida

Spring Term
2010

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ABSTRACT

Recognizing emotion from facial expressions is an essential skill for effective social functioning and establishing interpersonal relationships. Asperger's Disorder (AD) and Social Phobia (SP) are two clinical populations showing impairment in social skill and perhaps emotion recognition. **Objectives:** The primary objectives were to determine the uniqueness of facial emotion recognition abilities between children with AD and SP relative to typically developing children (TD) and to examine the role of expression intensity in determining recognition of facial affect. **Method:** Fifty-seven children (19 AD, 17 SP, and 21 TD) aged 7-13 years participated in the study. Reaction times and accuracy were measured as children identified neutral faces and faces displaying anger, disgust, fear, happiness, and sadness at two different intensity levels. **Results:** Mixed model ANOVAs with group and emotion type revealed that all children responded faster and more accurately to expressions of happiness, but there were no other group differences. Additional analyses indicated that intensity of the displayed emotion influenced facial affect detection ability for several basic emotions (happiness, fear, and anger). Across groups, there was no pattern of specific misidentification of emotion (e.g., children did not consistently misidentify one emotion, such as disgust, for a different emotion, such as anger.) Finally, facial affect recognition abilities were not associated with behavioral ratings of overall anxiety or social skills effectiveness in structured role play interactions. **Conclusions:** Distinct facial affect recognition deficits in the clinical groups emerge when the intensity of the emotion expression is considered. Implications for using behavioral assessments to delineate the relationship between facial affect recognition abilities and social functioning among clinical populations are discussed.

This manuscript is dedicated to my sisters.

“Our full range of emotions is our palette with which we bring color to our lives.” (A. Copeland)

ACKNOWLEDGMENTS

It is my pleasure to extend sincere gratitude to all the people who believed in me and helped bring this project to life. I am indebted to my committee chair and mentor, Dr. Deborah C. Beidel, for her patience and invaluable feedback throughout each step of the process. Her encouragement and persistent mentorship is inspirational. To my committee members, Dr. Mark D. Rapport and Dr. Valerie Sims, thank you both for your time, expertise, and constructive perspectives. It was truly an honor for me to learn from this committee. Collectively, your enthusiasm for scientific research was immeasurable and positively contagious. To my family and friends, thank you for your endless support and confidence in my ability to achieve my career goals. Finally, to the parents and children who completed this study, thank you all for participating in our clinical and scholarly pursuits.

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LIST OF ACRONYMS/ABBREVIATIONS

AD	Asperger's Disorder
ADHD	Attention-Deficit/Hyperactivity Disorder
ADIS-C/P	Anxiety Disorders Interview Schedule – Children/Parent
AS	Asperger's Syndrome
APA	American Psychological Association
BAT	Behavioral assessment of social skills
CBCL	Child Behavior Checklist
CDI	Children's Depression Inventory
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders – 4th edition
FSIQ	Full Scale Intelligence Quotient
GADS	Gilliam Asperger's Disorder Scale
HFA	High-Functioning Autism
IRB	Institutional Review Board
K-BIT	Kaufman Brief Intelligence Test
RT	Reaction Time
SAM	Self-Assessment Manikin
SDT	Signal Detection Theory
SP	Social Phobia
SPAI-C	Social Phobia and Anxiety Inventory for children
TD	Typically developing children
UCF	University of Central Florida

CHAPTER ONE: INTRODUCTION

The ability to recognize and accurately interpret nonverbal social cues, such as detecting emotion from facial expressions, is critical for effective social communication. Facial affect communicates internal emotional states and serves as a vital source of information in reciprocal social exchanges. Children's ability to recognize facial expressions develops prior to the first two years of life (Nelson, 1987), and matures with age depending on the emotion (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007; Herba, Landau, Russell, Ecker, & Phillips, 2006; Widen & Russell, 2008). By 5 years of age, typically developing children recognize happiness and sadness with adult accuracy; and by 11 years of age, children recognize more complex emotions such as fear, anger, neutrality, and disgust (Durand et al., 2007). However, the ability to accurately detect emotion is not evenly distributed across children and may be one factor that accounts for awkward social interactions.

Two clinical populations known to have social skill deficits and awkward social interactions are children with Asperger's Disorder (AD) and children with Social Phobia (SP). Despite both groups behaving awkwardly in social interactions, their behaviors are distinct. Children with AD have difficulty interpreting nonverbal communication, lack spontaneous social or emotional reciprocity, and fail to engage in age appropriate behavior. They may intrude into other children's conversations or become frustrated if other peers do not share their restricted areas of interest. In contrast, children with SP may desire friendships, but avoid and hesitate to engage in social interactions because they fear embarrassment. They may isolate themselves and not know how to respond when they are approached by peers. It is unclear whether facial affect recognition abilities contribute to these social interaction difficulties. Therefore, the primary goal of this study is to determine whether children with either AD or SP differ in their ability to recognize facial emotions as compared to typically developing children (TD), and if so, whether these deficits are similar or unique across clinical disorders. This study further aims to delineate the relationship between facial affect recognition performance and behavioral observer ratings of anxiety and overall social effectiveness.

CHAPTER TWO: LITERATURE REVIEW

Asperger's Disorder

Asperger's Disorder (AD) is a pervasive developmental disorder characterized by restricted repetitive and stereotyped patterns of behavior, interests, and activities, and qualitative impairment in social interactions (APA, 2000). Social impairments include: (1) marked deficits in the use of nonverbal behaviors such as eye gaze, facial expressions, or gestures to regulate social interaction, (2) failure to develop age-appropriate peer relations, (3) lack of spontaneous interaction, and (4) lack of social or emotional reciprocity. AD is differentiated from autism by the absence of clinically significant delays in cognitive skills, communication, or overall language development (APA, 2000). Although AD is considered a distinct disorder under the broad domain of pervasive developmental disorders, the existing literature includes an assortment of labels for autistic populations with high levels of functioning [e.g., Asperger's Syndrome (AS) or High-Functioning Autism (HFA)]. These terms are often used interchangeably with AD and become indistinguishable from each other because diagnostic criteria, clinical presentation, and current treatments are nearly identical. Therefore, this review will examine studies that reference any of these conditions.

A thorough review of the potential nuroanatomical and neurophysiological data related to facial affect recognition are beyond the scope of this paper. However, an upsurge in neuroimaging research within the last decade indicates that people with autism have impaired facial processing abilities (cf. Sasson, 2006, for an overview). In general, compared to a typically developing group, individuals with autism show different patterns of neuronal activation (Critchley et al., 2000; Hubl et al., 2003), and different neural correlates when processing familiar versus unfamiliar faces (Pierce, Haist, Sedaghat, & Courchesne, 2004). More specifically, different patterns of brain activation have been demonstrated during the perception of fearful faces among adults with high-functioning autism or Asperger's Syndrome (HFA/AS), as compared to control participants in a fMRI study (Ashwin, Baron-Cohen, Wheelwright, O'Riordan, & Bullmore, 2007). Adults with HFA/AS showed greater activation in the anterior cingulate gyrus and superior temporal cortex, whereas typically developing adults showed greater activation in the left amygdala and left orbito-frontal cortex. In addition to different patterns of neural activation, individuals with autistic disorders have a distinct visual scanpath for processing facial stimuli. Compared to controls, adults with Asperger's Syndrome are slower processing faces and face parts, such as the eyes or the mouth (O'Connor, Hamm, & Kirk, 2007), and fixate less on the eye region (Corden, Chilvers, & Skuse, 2008). Corroborating evidence suggests that adults with HFA also tend to rely more heavily on the mouth region for information cues (Spezio, Adolphs, Hurley, & Piven, 2007). Despite the accumulation of evidence for impaired facial processing abilities among individuals with AD, few studies examined how these impairments relate to the recognition of emotional affect from faces.

Similar to the facial processing literature, the inability to identify socially relevant information from faces among individuals with autism is often explained as a consequence of innate abnormality in neural systems (Adolphs, Sears, & Piven, 2001), including deficits in the amygdale-fusiform system (cf. Schultz, 2005, for a review). For example, while activations in the amygdale varied as a response to varying intensities of fearful expression among a control group, adults with HFA/AS did not respond differently to varying intensities of fearful faces (Ashwin et al., 2007). Additionally, hypoactivation of the fusiform gyrus during face processing has been consistently found in the neuroscience of autism. Results suggest that the fusiform and extrastriate cortices, areas responsible for the perception of faces, are less responsive in adults with AS than controls when viewing four facial expressions (fear, disgust, happiness, and sadness) at varying intensities (Deeley et al., 2007). Even after the completion of a computerized facial affect recognition training program, fusiform gyrus activation in adults with HFA did not significantly increase as compared to pre-training (Bölte et al., 2006).

Behavioral evidence further demonstrates facial affect recognition deficits among individuals with AD. Specific deficits have been consistently found in the recognition of fear among adults with autism (Howard et al., 2000; Humphreys, Minshew, Leonard, & Behremann, 2007; Pelphrey et al., 2002). Corden et al. (2008) examined the possibility that the avoidance of emotionally arousing stimuli, such as eyes, contributed to social-perceptual impairment in adults with Asperger's Syndrome. Their findings based on eye-tracking technology demonstrated that adults with AS have impaired recognition of fearful and sad expressions relative to controls (Corden et al., 2008). Specifically, the severity of fearful expression recognition impairment was predicted by the failure to fixate on the eyes. In addition, impaired recognition of fearful stimuli and decreased fixation on the eye regions were separately associated with higher levels of social anxiety among adults with AS (Corden et al., 2008).

However, the literature on facial recognition among children with AD is inconsistent with the results found among adults. Specifically, group differences found among adult populations are not always replicated among children with the same disorders. Recognition of still, dynamic, or strobe facial expressions did not differ between French children with autism spectrum disorders and controls (Gepner, Deruelle, & Grynfeltt, 2001). Similarly Japanese children with Asperger's Disorder performed as well as controls on response latency and accuracy identifying happy and disgusted expressions, regardless of whether the expressions were static versus moving or real versus cartoon faces (Miyahara, Bray, Tsujii, Fugita, & Sugiyama, 2007). It is unclear why differences found among adults were not replicated in these samples of children but it may relate to developmental age (Rump, Giovannelli, Minshew, & Strauss, 2009) or any number of differences in procedural factors associated with these two studies as discussed below.

Despite the relatively equivocal findings, additional research on facial affect recognition abilities among children with AD is warranted for several reasons. First, contrary evidence suggests that facial processing impairments are present in children with lower functioning autism (Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Speer, Cook, McMahon, Clark, 2007). Indeed, differential brain reactivity to emotional stimuli may be identified in autistic children as young as 3 years of age (Dawson, Webb, Carver, Panagiotides, & McPartland, 2004), and children with autism show a similar pattern of impaired facial processing abilities relative to adults with autism (cf. Dawson, Webb, & McPartland, 2005, for a review). Children with autism, like adults, show abnormalities for face processing, including fragmentary strategies during encoding, decreased reliance on the eyes for information, reduced processing speed, and atypical cortical specialization (Dawson et al., 2005; Wang, Dapretto, Hariri, Sigman, & Bookheimer, 2004). Additionally, a replication study extended the investigation by Gepner et al. (2001), and suggests that emotion recognition abilities are significantly worse in children with autism than normal controls, but that their abilities may be significantly enhanced when dynamic presentations of facial expressions are slowed to allow for their slow processing speed (Tardif, Lainé, Rodriguez, & Gepner, 2007). Second, because the emotion recognition task used in previous child studies that produced negative results (e.g., Gepner et al., 2001; Miyahara et al., 2007) presented only a narrow range of facial affect, it is possible that the measure may have had inadequate sensitivity to detect group differences. Other research has shown that youth with autism have specific impairments in recognizing certain emotions such as anger (Teunisse & de Gelder, 2001) or surprise (Baron-Cohen, Spitz, & Cross, 1993) which were not included in the Gepner et al. (2001) investigation. Third, it is not clear whether the ability to recognize facial affect is related to the social skill deficits or social awkwardness characterized among children with AD. Finally, no study has yet examined whether impairments in facial emotion recognition are unique to AD or are present among other children with social skill deficits.

Social Phobia

Similar to people with AD, people with social phobia also experience difficulties in social interactions, but their social behaviors are clinically different. Social phobia is defined by a marked and persistent fear of one or more social or performance situations in which the person is exposed to unfamiliar people or possible scrutiny (APA, 2000). Their primary concern is that they will say something embarrassing or humiliating in front of others, or that they will behave incompetently, leading others to judge them as anxious or weak. While the average age of onset for social phobia is middle to late adolescence, the disorder can appear in children as young as age eight (Beidel, Turner, & Morris, 1999). At an early age, children with social phobia may shy away from others and be less socially effective in social interactions. Indeed, children with social phobia are more anxious, less interpersonally skilled on a global rating of effective social performance, and display significantly longer speech latencies than typically developing children in behavioral role-play tasks (Beidel et al., 1999).

Differences in affect processing have been found consistently among people with social phobia. Individuals with social phobia show different patterns of neuronal activation while processing emotion relative to controls (Killgore & Yurgelun-Todd, 2005). Specifically, during the perception of fearful faces, amygdala activity was greater in adults with social phobia than in controls, and the degree of activity was correlated with social dimensions of anxiety, such as peer rejection (Killgore & Yurgelun-Todd, 2005). Similarly, amygdala activity in response to harsh faces (angry, disgusted, and fear) was significantly greater than the activity in response to happy faces among adults with social phobia (Phan, Fitzgerald, Nathan, & Tancer, 2006). In another study, adults with social phobia rated the emotional valence of disgust faces more quickly than neutral faces, rated neutral faces more negatively, and had elevated brain activation in the anterior cingulate cortex (area involved in processing emotional information) when attending to disgust faces only (Amir et al., 2005). To date, however, research on the neuropsychology of facial affect processing has yet to be integrated with behavioral research on facial affect recognition among individuals with social phobia.

Although the exact mechanism is unknown, effective social behavior is influenced by accurate recognition of nonverbal communication. One theory is that misinterpretation of facial expression during social exchanges may impair social effectiveness by contributing to a perpetual cycle that maintains the individual's anxiety in social situations (e.g., Yoon & Zinbarg, 2007). Corroborating evidence suggests that adults with social phobia are biased to interpret facial emotions as negative (Feinberg, Rifkin, Schaffer, & Walker, 1986; Foa, Gilboa-Schechtman, Amir, & Freshman, 2000), and that women with this disorder may be particularly sensitive to threat-related and approval-related social cues (Arrais et al., 2009). Additional findings consistent with core fears of negative evaluation suggest that adults with social phobia have a memory bias for threatening stimuli (Mogg, Philippot, & Bradley, 2004; Pishyar, Harris, & Menzies, 2004). For example, people with social phobia correctly recognized a greater number of threatening faces than non-threatening faces, and rated recognized faces as more threatening than unrecognized faces relative to controls (Coles & Heimberg, 2005; Lundh & Öst, 1996). An alternative theory is that adults with social phobia may be less effective in social interactions because they avoid looking at external social cues that maintain social anxiety. For example, adults with social phobia focused their attention more quickly to objects rather than facial stimuli (Chen, Ehlers, Clark, & Mansell, 2002). This preference to direct their attention away from faces may explain why adults with generalized social phobia were significantly less sensitive in detecting negative facial expressions of anger and disgust relative to controls (Montagne et al., 2006). These collective findings suggest that individuals with social phobia have impaired facial affect recognition capabilities.

Finally, in the only study to assess facial affect detection capabilities among children with social phobia, relative to controls, children with social phobia were less accurate identifying facial affect and reported greater levels of subjective anxiety after completing the facial affect recognition task (Simonian, Beidel, Turner, Berkes, & Long, 2001). In particular, facial affect recognition errors were particularly pronounced for happy, sad, and disgust expressions. Similar findings were found in an exploratory study examining a community sample of Italian children. Children identified with high social anxiety were less accurate in identifying facial emotions than same-aged peers (Battaglia et al., 2004). Furthermore, anger was often misidentified as disgust when the target expression was displayed by a boy, and neutral was often misclassified as sadness when the target expression was displayed by a girl. Overall, the facial affect recognition research literature on children with social phobia, similar to research on children with AD, is limited because findings are inconsistent, restricted types of emotions are included, measures of speed detection speed are often excluded, and the relationship between facial affect recognition and social functioning remains unclear.

The Present Study

The existing literature indicates that facial affect recognition differences exist between people with no psychiatric diagnoses and those affected by AD or social phobia. Of the studies that examined facial recognition abilities in children with AD, the comparison groups used were children diagnosed with other developmental disabilities (e.g., Celani, Battacchi, & Arcidiacono, 1999; Gross, 2004), whereas the comparison groups for children with social phobia were typically developing children (Battaglia et al., 2004; Simonian et al., 2001). Few studies, however, examine facial affect recognition differences across groups with different clinical diagnoses. Identifying common or unique patterns of facial affect recognition is crucial for the development of psychosocial interventions that address the remediation of these deficits.

This controlled, empirical investigation was designed to determine if facial affect recognition deficits exist in children with either AD or SP, and if so, whether these deficits are similar or unique across these disorders. A group of typically developing children is included as a comparison group. While many previous studies on facial affect recognition only examined accuracy, this study also included a measure of detection speed. The facial stimuli displayed in this study include a broad array of affect, with two levels of intensity, to examine whether any group differences in emotion recognition vary by intensity of the expression. Since previous research indicates that emotion recognition deficits in adult clinical populations (e.g., chronic schizophrenia) are related to deficits in overall social competence (Mueser et al., 1996), this study further examines whether facial affect recognition abilities are correlated with behavioral observation ratings of overall anxiety and social skills in analogue situations.

Hypotheses

First, the main hypothesis is that the two clinical groups will show a unique pattern of emotion identification, relative to each other and to TD children. Given that recognition of fearful and sad expressions is impaired in adults with AD (Corden et al., 2008), and recognition of anger is impaired in youth with HFA (Teunisse & de Gelder, 2001), it is predicted that children with AD are slower and less accurate in identifying expressions displaying anger, fear, and sadness relative to TD children. In addition, based on previous research (Simonian et al., 2001), it is predicted that children with SP are less accurate in identifying happy, sad, and disgust expressions relative to TD children. Children with SP may also be slower at identifying happy, sad, and disgust, relative to TD children. Second, while facial expressions provide critical information about a person's emotional state, not all emotions are expressed with the same intensity. For children with social skill deficits, more subtle forms of emotions may be harder to detect; thus it is predicted that intensity of the expression (mild versus extreme) influences emotion recognition performance among the two clinical groups. Third, it is predicted that children in the clinical groups will differ from TD children in their ability to discriminate a target emotion from non-target emotions. For example, based on prior studies, it is expected that children with SP interpret ambiguous neutral faces as threatening or angry more often than other children (Feinberg et al., 1986; Yoon & Zinbarg, 2007), or misidentify anger as disgust and neutral as sadness (Battaglia et al., 2004). Fourth, it is expected that children with SP are more anxious, and that children in either clinical group are less socially effective than TD children in a behavioral assessment of social skills task. Finally, behavioral ratings of anxiety and social skill effectiveness are expected to correlate significantly with facial affect recognition abilities.

CHAPTER THREE: METHODOLOGY

Participants

Participants consisted of 57 children (35 males and 22 females) between ages 7 and 13 (*M* = 10.37, *SD* = 1.90). Thirty-seven identified as Caucasian (64.9%), and 15 identified as non-white Hispanic (26.3%), all other children reported being Asian (*n* = 1), bi-racial (*n* = 3), or multi-racial (*n* = 1).

Three groups of children were included in the study. Children in group 1 (*n* = 19) had a primary diagnosis of Asperger's Disorder. Among children with AD, 42.1% also had a secondary Axis I diagnosis; ADHD (*n* = 6), social phobia (*n* = 1), and ADHD and social phobia (*n* = 1). Eight children in group 1 were taking medications at the time of assessment and medications included fluoxetine, Concerta, Vivance, or Risperadal with a psychostimulant (e.g., Metadate or Daytrana Patch). Children in group 2 (*n* = 17) had a primary diagnosis of Social Phobia. Among children with SP, 58.8% also met criteria for secondary anxiety disorders; generalized anxiety disorder (*n* = 5), separation anxiety (*n* = 1), and selective mutism (*n* = 4). Children in group 3 (*n* = 21) did not meet criteria for any lifetime Axis I diagnosis (TD group). All participants had at least average IQ (FSIQ ≥ 80) as determined using the Kaufman Brief Intelligence Test (K-BIT; Kaufman & Kaufman, 1990). No children in the SP or TD group had language delays or were on medications at the time of assessment.

Exclusion criteria

Children suffering from depression (as assessed by the parent/child diagnostic interview and a Children's Depression Inventory score > 14), psychosis, a primary thought disorder, conduct disorder, or low functioning autism were excluded from the study.

Measures and Procedure

Recruitment

The project was approved by the University of Central Florida (UCF) IRB. Participants were recruited from flyers, website advertisements, local news announcements, recruitment letters, the Anxiety Disorders Clinic at UCF, and the Center for Autism and Related Disorders. Prior to any assessment, clinicians reviewed consent/assent forms with parents and children. Participation was voluntary and did not influence their eligibility for treatment services offered at the UCF Anxiety Disorders Clinic.

Assessment

Parents and children participated in an assessment battery consisting of clinical, self-report, and behavioral assessment measures.

All participants were administered the Anxiety Disorders Interview Schedule – Children (ADIS-C/P; Silverman & Albano, 1996) by an advanced doctoral student in clinical psychology. The ADIS-C/P is a semistructured diagnostic interview that assesses anxiety disorders and other DSM-IV diagnoses. Diagnoses were based on information gathered from both the parent and the child. All cases were reviewed by a senior clinician to determine the final diagnosis.
Children in the AD group were referred from the Center for Autism and Related Disorders, where they had been diagnosed with AD. An advanced doctoral student in clinical psychology verified diagnostic information and all diagnoses were confirmed by a senior clinician. The Gilliam Asperger's Disorder Scale (GADS; Gilliam, 2001) was administered to further determine the presence/absence of AD. The GADS is a norm-referenced behavioral rating scale for people ages 3 through 22 years old. The 32-items divide into four subscales including social

interactive behaviors, restricted patterns of behaviors, cognitive patterns, and pragmatic skills. For this study, the Asperger's Disorder Quotient was used to differentiate between a child with a high probability (≥ 80), borderline probability (70-79), or low probability (≤ 69) of meeting criteria for Asperger's Disorder. The GADS has internal consistency and reliability of the subscales above .70 (Gilliam, 2001).

Behavioral assessments of social skills (BAT)

Each child participated in a structured role-play interaction with a same-age typically developing peer. The structured role-play interaction consists of five scenes (e.g., carrying a conversation, giving or receiving a compliment, offering to help a peer, responding to a bully). Children were asked to imagine the situations described by the researcher/clinician and respond as if it were really happening. Peer-confederates were trained to maintain appropriate levels of friendliness, eye contact, and allow approximately ten seconds for the participant to respond to a remark before speaking. Before and after the structured role-play interaction, children rated their anxiety using a pictorially adapted version of the Self-Assessment Manikin (SAM; Bradley & Lang, 1994). On the SAM, five pictures illustrate various levels of distress that represent a 5-point Likert scale: 1 = *little or no anxiety* to 5 = *extreme anxiety*.

Each BAT was videotaped and coded by trained observers blind to group status and research hypotheses. Fourteen percent of the BAT tapes were rated by a second rater to calculate inter-rater reliability, which in each case was greater than r = .85. Each role-play was rated for overall effectiveness and observable anxiety. In cases where the first and second coders disagree, a senior researcher determined the final rating. Overall effectiveness was rated according to a 4-point Likert scale: 1 = *not effective* to 4 = *very effective*. Raters considered elements of social behavior such as appropriate voice tone, voice volume, and verbal content. Anxiety was rated according to a 4-point Likert scale: 1 = *not anxious* to 4 = *highly anxious*. The average rating for both social skills effectiveness and anxiety across the five role-play scenarios were used as the final overall anxiety and effectiveness scores. In addition, timed response latency (in seconds) was generated.

Child Behavior Checklist (CBCL Parent Version; Achenbach, 1991)

The CBCL assesses both internalizing and externalizing behaviors. The standardized 102-item questionnaire asks parents to report children's problem behaviors over the preceding six months. The items are rated according to a 3-point scale: 0 = *if the problem is not true of the child*, 1 = *if the item is somewhat or sometimes true*, 2 = *if the item is very true of often true*. Scores are summed and converted to T-scores (*M* = 50, *SD* =10) on seven different syndrome scales and five different DSM-oriented scales. A T-score ≥ 70 is considered clinically significant. Although the scores combine to yield Internalizing Problems, Externalizing Problems, and Total Problems scores, only the Total Problems composite score was used in this study. The CBCL parent report has a test-retest (kappa) of .80 – .94 and internal consistency at .63 – .97 (Achenbach, 1991).

Children's Depression Inventory (CDI; Kovacs, 1980/1981)

The CDI is a 27-item self-report measure derived from the Beck Depression Inventory for adults. The child endorses one of three descriptions that best applies during the last two weeks (e.g., "I feel like crying every day," "I feel like crying many days," "I feel like crying once in a while"). Responses are scored on a range from 0 = *symptom absent* to 2 = *severe symptom present*. One-week test-retest reliability estimates for the CDI are .87 and .38, and internal consistency alpha coefficients of .80 and .94, were found for psychiatric populations and normal controls, respectively (Saylor, Finch, Spirito, & Bennett, 1984).

Kaufman Brief Intelligence Test (K-BIT2; Kaufman & Kaufman, 2004)

The K-BIT2 is a measure of intelligence that yields Verbal, Nonverbal, and composite IQ estimates. The K-BIT2 consists of two subtests that assess vocabulary and naming and provide an estimate of verbal IQ, and a third subtest designed to provide an estimate of nonverbal IQ by assessing visuospatial reasoning through the use of nonverbal analogies. The original K-BIT is a valid screening measure of verbal, nonverbal, and general intellectual ability that yields IQ estimates that are similar to those of the Wechsler Adult Intelligence Scale—Revised (Naugle, Chelune, & Tucker, 1993) – the correlations between verbal, nonverbal, and composite scales of the two measures were .83, .77, and .88, respectively. The K-BIT2 was used in this study to screen for mental retardation and low-functioning individuals with autism spectrum disorders as determined by a FSIQ ≤ 80.

Social Phobia and Anxiety Inventory for Children (SPAI-C; Beidel et al., 1995)

The SPAI-C is a 26 item self-report questionnaire that measures childhood social anxiety and fear by assessing the severity of social phobia symptoms. Each item is rated according to a 3-point Likert scale: 0 = *never or hardly ever*, 1 = *sometimes*, 2 = *almost always or always*. Higher scores on the SPAI-C indicate greater levels of social anxiety. The SPAI-C has an excellent two-week test-retest reliability coefficient of .86, and internal consistency with Cronbach's alpha coefficient of .95 (Beidel et al., 1995). Although the SPAI-C was not used as a diagnostic tool, a cutoff score of 18 on the SPAI-C may differentiate between socially anxious (SPAI-C ≥ 18) and non-socially anxious children (SPAI-C ≤ 18).

Facial Emotion Recognition Task

All children completed a facial emotion recognition task to assess facial recognition ability. Faces were taken from the standardized Penn Emotion Recognition set developed by Gur and colleagues (Gur, Sara, et al., 2002). These stimuli have been used in various clinical populations including obsessive compulsive disorder (Husted, Shapira, & Goodman, 2006), schizophrenia (Gur, McGrath, et al., 2002; Schneider et al., 2006) and social phobia (Phan et al., 2006). Before and after the task, participants also rated their perceived anxiety using the Self Assessment Manikin [SAM] rating on a 4-point Likert scale: 0 = *no anxiety* to 4 = *extreme anxiety*.

Equipment

The facial emotion recognition task was programmed using E-prime Version 2.0 developed by Psychology Software Tools, Incorporated. Stimuli was presented on a Dell computer with a 19", 60-Hz LCD monitor, 280 x 1024 pixels screen resolution, and 32 bit color quality. The visual stimuli consisted of photographs of 48 Caucasian faces (50% male and 50% female), displaying each of the six different emotional expressions: anger, disgust, fear, happy, neutral, and sad. For each emotion, with the exception of neutral, four images represented a mild version of the facial expression and four images represented an extreme version of the emotion. All of the faces were approximately 11" x 9" in dimension, presented randomly, and centered on a black background. A white 2" x 2" fixation cross was presented during the 1000 milliseconds inter-trial stimuli. Children identified the facial emotion by pressing a corresponding button on the computer keyboard (A- Anger, D- Disgust, F- Fear, H- Happy, N- Neutral, and S-Sad). Children were asked to choose and use one finger, from one hand, to press the keys throughout the entire computer program. Correct responses and reaction times (in milliseconds) were recorded for each recognition decision.

Two additional tasks were included to control for simple reaction time and choice reaction time. The simple reaction time task required children to press a keyboard button (N) as quickly and accurately as possible when presented with a visual stimulus to control for physical motor speed. The choice reaction time task presented the face of a male or female and required children to press a key as quickly and accurately as possible to correctly identify the sex of the model (V- female and M- male) and to control for decision making speed. Correct responses and reaction times (in milliseconds) were recorded but only simple and choice reaction times were used in this study. The order of the three tasks – emotion recognition, simple reaction, or choice reaction – were counterbalanced and randomly assigned to participants.

CHAPTER FOUR: DATA

Power Analysis

GPower software version 3.0.10 (Faul, Erdfelder, Lang, & Buchner, 2007) was used to determine needed sample size. The sample size estimate was calculated by using an effect size of .45, which was based on the average number of errors as reported by Simonian et al. (2001). Power was set to .80 as recommended by Cohen (1992). For an effect size of .45, $\alpha = .05$, power $(1- \beta) = .80$, and three groups, fifty-four total participants were needed for an omnibus, one-way, fixed effects ANOVA. Fifty-seven subjects were recruited and assessed in order to allow for missing data or equipment failure problems.

Data Screening

Intraindividual reaction times to each image were screened for outliers ± 3.5 SDs from the individual's mean reaction time to each of the corresponding emotion categories (Tabachnick & Fidell, 2007). This procedure resulted in zero outliers.

CHAPTER FIVE: RESULTS

Demographic and Clinical Characteristics

Means and standard deviations for all demographic and clinical data are presented in Table 1. There were no significant differences in age, race/ethnicity, CDI, or FSIQ by group membership. There was a significant group difference for sex (χ^2 (2) = 15.35, $p < .001$), with significantly more males in the AD (84.2%) and TD groups (71.4%) than SP (23.5%).

There was a significant group difference for the presence of comorbid diagnoses, a greater number of children with SP (58.8%) and children with AD (42.1%) had a secondary Axis I diagnosis than TD children (0%; χ^2 (2) = 16.51, $p < .001$). A greater number of children with AD (14%) were taking medication than SP (0%) or TD (0%; χ^2 (2) = 18.61, $p < .001$).

With respect to parental and self-report data, there were significant group differences on the CBCL total scores (F (54, 2) = 20.25, $p < .001$; TD < SP < AD) and on the SPAI-C total scores (F (54, 2) = 15.46, $p < .001$; AD = TD < SP). There were no significant group differences in any of the control variables, including subjective ratings of pre- or post- anxiety to the facial affect recognition task, simple reaction time, or choice reaction time.

Preliminary Analyses

Preliminary analyses revealed that demographic and clinical characteristics variables in which the groups differed (i.e., gender, comorbid diagnoses, or medication use) were not significantly related to facial affect recognition speed or accuracy (all *p*s > .05). Correlational analyses examined whether age was associated with facial affect performance. Only mean reaction time to neutral faces was negatively correlated with age (r = -.29, $p < .05$). No additional correlations were significant for age and facial affect recognition speed or accuracy.

Main Analyses

The primary hypothesis was that the two clinical groups would show a unique pattern of emotion recognition relative to each other and to TD children. Results are analyzed separately for reaction time and accuracy.

Reaction Time

A 3 (Group: AD, SP, TD) x 6 (Emotion: Anger, Disgust, Fear, Happy, Neutral, Sad) repeated measures within-subjects ANOVA, with Bonferonni correction, examined group and emotion type differences on facial affect reaction time (RT). Means and standard deviations are presented in Table 2. Results revealed a significant main effect for emotion (F (5, 270) = 32.14, p = .001, η_p^2 = .37) but no significant main effect for group (F (2, 54) = 1.64, p > .05, η_p^2 = .06), and no significant group x emotion interaction (F (10, 270) = 1.48, p > .05, η_p^2 = .05).

For the main effect of emotion, post hoc analyses using the Bonferonni correction (see Figure 1) revealed that reaction time to happy images (M = 2241.71, SE = 100.08) were significantly faster than all other categories (ps < .001). Reaction times to disgust (M = 2945.29, SE = 120.94) and sad images (M = 3322.87, SE = 166.00) were significantly faster than reaction time to angry (M = 4019.51, SE = 186.00) and fear images (M = 4690.72, SE = 282.97; all ps <.001). Reaction times to neutral images (M = 3395.83, SE = 204.92) was only significantly faster than to fearful images (i.e., Happy < Disgust = Neutral = Sad < Angry = Fear; Neutral = Angry). Results suggest that children across all groups respond to certain emotions more quickly than other emotions.

Accuracy

A 3 (Group: AD, SP, TD) x 6 (Emotion: Anger, Disgust, Fear, Happy, Neutral, Sad) repeated measures within-subjects ANOVA, with Bonferonni correction, examined the effect of recognition accuracy (see Table 2 for means and standard deviations). Results revealed a significant main effect of emotion (F (5, 270) = 38.04, p = .001, η_p^2 = .41). However, there was no main effect for group (F (2, 54) = .92, p > .05, η_p^2 = .03). Furthermore, there was no significant group x emotion interaction (F (10, 270) = .43, p > .05, η_p^2 = .02).

For the main effect of emotion, post hoc analyses with Bonferonni correction (see Figure 2) revealed that mean percent accuracy for happy faces (94.5%) was significantly higher than to all other emotions (*p*s < .001). Additionally, accuracy for identifying fearful (64.7%) and sad faces (64.9%) was significantly higher (*p*s < .001) than for angry (48.9%) and disgust faces (37.9%). Accuracy for neutral faces (65.2%) was significantly higher only for disgust images (p < .001). Results suggest that children across all groups identify certain emotions more accurately than other emotions.

Intensity Analyses

Previous investigations have not examined the role of intensity on detection of facial affect. However, not all emotions are expressed with the same intensity in every day situations and subtle forms of emotions may be harder to detect. Thus, intensity of the expression (mild and extreme) could influence group differences in emotion recognition performance.

Reaction Time.

To test whether intensity (mild vs extreme) influenced reaction time, five 3 (Group) x 2 (Intensity) repeated ANOVAS were utilized separately for each of the emotion categories

(Angry, Disgust, Fear, Happy, Sad). Reaction times to neutral faces were excluded from analysis because the stimulus set does not contain neutral faces at different levels of intensity. Bonferonni corrections were used for all tests to control for experimentwise error.

For happy faces, significant main effects were found for both Group (F (2, 54) = 4.30, p < .05, η_p^2 = .137) and Intensity (F (1, 54) = 24.13, p < .001, η_p^2 = .31). The Group x Intensity interaction was not significant. With respect to group, children with SP (M = 2474.97, SE = 182.57) were significantly slower (p <.05) identifying happy images than TD children (M = 1838.15, SE = 164.27), with a trend for children with AD (M = 2412.00, SE = 172.70) also responding more slowly than TD children (p = .06). Also, children across all groups identified extreme happy faces (M = 1889.54, SE = 77.75) significantly more quickly (p < .001) than subtle happy faces (M = 2593.87, SE = 155.78). These results suggest that overall extremely happy faces are easier to detect, and there are significant group differences in reaction time regardless of intensity.

For fearful faces, there was a significant Group x Intensity interaction (F (2, 54) = 4.90, p = .01, η_p^2 = .15). Follow-up post hoc one-way ANOVA analyses (F (2, 54) = 3.91, p < .05; see Figure 3) revealed significant group differences in RT to fear images at mild intensity only. Children with SP were significantly slower (M = 6841.72, SD = 4810.04) than TD children (M = 4121.90, SD = 1403.45) at identifying subtle expressions of fear. Scores for the AD group (M = 5808.14, SD = 2233.74) fell between the other two groups and were not significantly different from either group (p > .05). These results suggest that SP children are slower to detect subtle expressions of fear relative to the control group.

For angry and sad faces, significant main effects were found for intensity on RTs (all ps < .001). Children in all groups responded faster to extreme expressions than to subtle expressions for anger (*M* = 3463.70, *SD* = 1404.14 vs. *M* = 4550.10, *SD* = 1912.42, $p < .001$), and sadness (*M* = 2595.49, *SD* = 1086.24 vs. *M* = 4046.85, *SD* = 1856.18, $p < .001$). There were no group or group x interaction effects for these two categories. There were no significant main or interaction effects for disgust (extreme *M* = 2929.52, *SD* = 1059.05 vs. subtle *M* = 2956.16, *SD* = 1073.35, $p > .05$).

Accuracy

To test whether intensity (mild and extreme) influenced group differences in accuracy, five 3 (Group) x 2 (Intensity) repeated ANOVAS examined each of the emotion categories (Angry, Disgust, Fear, Happy, Sad). Bonferonni correction was used for all tests. Means and standard deviations are presented in Table 3.

For angry faces, there was a significant Group x Intensity interaction (F (2, 54) = 4.54, $p < .05$, $\eta_p^2 = .14$). Follow-up post hoc one-way ANOVA analyses (F (2, 54) = 4.63, $p < .05$; see Figure 4) revealed that children with AD were significantly less accurate (15.8%) than TD children (35.7%) at recognizing subtle angry faces. Detection accuracy to subtle angry faces for the SP group fell between the other two groups (32.4%) and was not significantly different from either group. There were no group differences for detection accuracy of extreme anger expressions.

For fear, happy, and sad faces, there were significant main effects for intensity (all *p*s < .001). Across all groups, children were more accurate identifying extreme vs subtle expressions of fear (76.8% vs. 52.2%), happiness (100.0% vs. 89.0%), and sadness (80.3% vs. 49.6%). No additional group or interaction effects were found for these categories.

There were no significant main or interaction effects for Disgust on accuracy (38.2% vs. 37.1%), which was characterized by low detection rates.

Sensitivity Analyses

A more detailed analysis of accurate facial affect detection used the sensitivity (d′) index from signal detection theory (SDT) (see Durand et al., 2007) to determine whether children with SP interpret ambiguous (neutral) faces as threatening (angry) more often than other children, or misidentify anger as disgust and neutral as sadness. The calculation of d′ measures the participant's ability to discriminate the target emotion from non-target emotions. Hit rate is defined as the proportion of target stimuli correctly identified as the target emotion (i.e., the number of happy faces correctly identified as happy, divided by the 8 happy faces presented). False alarm rate is defined as the number of nontarget stimuli incorrectly identified as the target emotion (i.e., the number of non-happy stimuli – angry, fear, disgust, neutral, or sad – identified as happy, divided by a total of 40 non-happy stimuli). The sensitivity index, estimated by d′ = Z-score (false alarm rate) – Z-score (hit rate), represents the difference between the means of the signal and the noise distributions. Higher d′ indicates that an individual has greater sensitivity and ability to readily detect the signal (Grier, 1971).

As such, a mixed model ANOVA was conducted with diagnostic group as the between-subjects factor, emotion category as the within-subjects factor, and hit rate as the dependent variable, to examine whether the target stimuli from a particular emotion category was correctly identified more often (as measured by hit rates) than other emotion categories. The results revealed a significant main effect for emotion category (F (5, 270) = 38.04, $p < .001$; see Table 4). There was no significant main effect for group and no significant interaction effect ($p > .05$). Follow up post hoc analyses with Bonferonni correction revealed that happy faces (M = .95, SD = .07) had significantly higher hit rates than all other emotions. Neutral (M = .65, SD = .38), fear (M = .65, SD = .22), and sad (M = .65, SD = .20) had significantly higher hit rates than angry (M = .49, SD = .17) and disgust (M = .38, SD = .26) faces. Lastly, angry faces had higher hit rates than disgust. When focusing primarily on the results for neutral faces, findings do not support the hypothesis that children with SP interpret ambiguous neutral faces as negative (i.e., threatening or sad) more often relative to other children, and anger was not misidentified as disgust. Means and standard deviations on the SDT indices (sensitivity, hit rates, and false alarm rates) across the three groups are displayed in Table 5.

Behavioral Assessment Analyses

A series of ANOVAs compared response latency, overall effectiveness, and overall anxiety across the three groups. Means and standard deviations are depicted in Table 6. There were significant group differences on all BAT variables (all ps < .001). On the measure of overall effectiveness, children with SP (M = 1.98, SD = .78) were rated as significantly less socially effective than children with AD (M = 2.56, SD = .59) and TD children (M = 2.87, SD = .63). With respect to response latency, children with SP (M = 5.32, SD = 3.18) had longer latencies than children with AD (M = 2.16, SD = 1.40) and TD children (M = 1.98, SD 1.40). With respect to observer ratings of anxiety, children with SP (M = 3.28, SD = .45) also were rated as more anxious than children with AD (M = 2.68, SD = .59) or TD children (M = 2.37, SD = .64). Additionally, children with SP (M = 2.41, SD = 1.06) reported significantly higher subjective anxiety after the BAT performance (p < .001) than children with AD (M = 1.26, SD = .45) and TD children (M = 1.60, SD = .82).

Previous investigations examining facial affect recognition ability have hypothesized that these deficits are related to social functioning. To study this relationship, correlation analyses examined whether recognition abilities were negatively associated with behavioral ratings of overall anxiety, and positively associated with behavioral ratings of social skills effectiveness. BAT response latency was correlated with reaction time to angry faces (r = .32, p < .05).

However, there were no other significant correlations between BAT variables and facial affect recognition performance. The correlation matrix of behavioral assessment variables and facial affect recognition abilities is displayed in Table 7.

CHAPTER SIX: DISCUSSION

This was the first study to examine facial affect recognition abilities in two groups with hypothesized social skills deficits and impaired social functioning – Social Phobia and Asperger's Disorder – relative to typically developing children. To extend findings from previous studies that have assessed accuracy, this study included a measure of detection speed and further examined whether the intensity of the displayed emotion affected speed or accuracy. This study also examined whether children in either clinical group differed from typically developing children in their ability to discriminate a target emotion from non-target emotions. Finally, the relationship between facial affect recognition abilities and behavioral ratings of social anxiety and social functioning was examined.

Data from this investigation indicate that children detect certain emotions more easily than other emotions. Specifically, regardless of group, all children identified happy faces more quickly (2.2 seconds) and more accurately (94.5%) than all other emotions. Also, all children identified disgust least accurately (37.9%). In fact, angry and disgust emotions were detected correctly less than 50% of the time, suggesting that preadolescent children, regardless of the presence of a psychological diagnosis, have difficulty detecting these complex negative emotions. These findings are consistent with the previous literature indicating that young children can identify simple emotions (e.g., happiness) better than those that are more complicated (e.g., disgust) (e.g., Durand et al., 2007; Herba et al., 2006; Montirosso, Peverelli, Frigerio, Crespi, & Borgatti, 2010; Widen & Russell, 2008).

With respect to potential group differences in detection accuracy, another important finding is that children with AD detected facial emotion as accurately as TD children. There was no overall difference on facial affect recognition performance between children with AD and TD children, even when a broader set of emotions is examined at varying intensities. Results are consistent with previous research indicating that these groups perform equally in the recognition of happy and disgusted expressions (Miyahara, 2007).

Similarly there were no differences in the overall ability to accurately detect facial emotion between children with SP and TD children. The absence of impairments between children with SP and their TD peers in this study stands in contrast to the results of a previous investigation (Simonian et al., 2001) that found impaired detection accuracy for happy, sad, and disgust faces in children with SP. One possible explanation for this inconsistency may be the use of different stimuli sets and administration procedures. That is, the Penn Emotion Recognition set (Gur, Sara, et al., 2002) used in this study were constructed based on digital imaging technology that yield three dimensional, high-quality facial images in color. The faces used in this study were approximately 11" x 9" and presented on a 19" computer screen. In contrast, Simonian and colleagues (2001) used a classic set of black and white slides from the Pictures of Facial Affect set (Ekman & Friesen, 1976) displayed on a 50" x 50" screen. As such, the accuracy rates in that study may have been an artifact of less sophisticated images presented on a large screen. Another possible explanation is that children in the Simonian et al. (2001) study viewed the facial image for 8 pre-recorded seconds. In contrast, children in this study were allowed as much time as needed to identify the emotion “as quickly as possible without making mistakes.” Although five children (9 %) in this sample had mean reaction times greater than or equal to 8 seconds for any of the faces, most children in this investigation responded quickly. While it is unclear whether group differences in accuracy may have been found if children in this study studied the images for 8 seconds, it is possible that variations in the presentation duration of facial stimuli yield different detection accuracy rates. Because the outcomes of these two studies indicated different results, it remains unclear whether children with SP are deficient in their ability to determine emotions based on facial affect.

Group differences in facial affect detection speed emerged, however, when results were examined based on the intensity of the displayed emotion. Children with SP were significantly slower to identify happy expressions and mildly fearful expressions than TD children. These reaction time latencies potentially explain why children with SP have longer response latencies in social interaction tasks as found in this study and in previous investigations (Beidel et al., 1999, Beidel et al., 2007). Although there may be a number of factors that contribute to longer speech latency, one hypothesis is that children with SP require more time to decode and determine certain facial expressions (happiness, fear) than TD peers. That is, it takes longer for children with SP to "read" faces, thereby, contributing to a delayed verbal response in social situations. Further investigation using more sophisticated assessment strategies are necessary to either confirm this relationship or explore alternative hypotheses. For example, paradigms that require children to identify affect, and then immediately respond to a peer, may help clarify factors responsible for speech latencies.

Overall, faces displaying extreme affective expressions were generally easier to identify than the corresponding mild versions. Regarding detection speed, all children responded more quickly to extremely angry, happy, and sad faces than to the corresponding subtle expressions. Regarding detection accuracy, all children identified extremely fearful, happy, and sad faces more accurately than corresponding subtle expressions. These findings indicate that children generally identify extreme displays of basic emotion more easily than subtle expressions, and correspond to the well documented developmental maturity effects that occur in facial affect detection abilities in children (Montirosso et al., 2010).

Group differences in facial affect detection accuracy similarly emerged when results were examined based on the intensity of the displayed emotions. Children with AD were significantly less accurate than TD children at recognizing mild angry faces. Although a previous study did not find group differences on detection of angry faces (Miyahara et al, 2007), the absence of group differences in that study may be a consequence of the lack of attention to stimulus intensity. The finding that children with AD are less adept at detecting mild anger cues is consistent with the clinical description of children with AD. These children are often described as inappropriately fixated on conversation topics and unable to read non-verbal cues from the conversational partner. In interactions with disinterested and often frustrated partners, children with AD are frequently unaware of the other person's negative feedback cues. They may report that they "did not know" the other person was disinterested. Thus, the identified deficit in the recognition of mild angry faces among children with AD provides a plausible explanation for their clinical presentation.

Collectively, the results of this investigation indicate that differences in facial affect detection ability may be overlooked when intensity of the emotional expression is ignored. Considering the intensity of emotions is important because expressions of facial affect are not always extreme in everyday experience. In fact, subtle expressions are common, such as a quick smile when greeting a friend rather than grinning broadly. Whether studies used prototypical faces displaying extreme affective expressions, ambiguous faces displaying mild affective expressions, or an amalgamation of faces with undifferentiated affective intensity, likely yield equivocal results (Montirosso et al., 2010). As such, inattention to expression intensity may be one explanation for the discrepant outcomes in the literature.

Sensitivity analyses were used in this study to extend previous research on children's ability to identify the target emotion from non-target emotions. Consistent with detection accuracy findings, sensitivity analyses indicate that happy faces had the highest hit rates (95%), while disgust had the lowest hit rates (38%). The absence of differences in signal detection rates between groups, however, indicates that children with SP or AD discriminated different emotions as well as TD children. Significant methodological differences may explain the discrepancy between these findings and findings in previous literature (Battaglia et al. 2004). Specifically, this investigation used adult faces in the stimuli set rather than children's faces (Battaglia et al., 2004). Developmental differences exist in the human ability to physically form emotional expressions, and the facial muscles involved in mimicking adult facial expressions are less developed in children (Houstis & Kiliaridis, 2009; Lewis, Sullivan, Vasen, 1987). As such, the facial affect modeled by same-aged peers in the Battaglia and colleagues study (2004) may have been more easily misidentified than the standardized adult expressions used in this study.

Data from the behavioral assessment of social skills indicate that children with SP demonstrated expected impairments on measures of anxiety and skill in an analogue situation relative to TD peers. Children with SP were slower to verbally respond during the role-play scenes, and were rated as more anxious by blinded observers, than children with AD or TD children. In addition, children with SP reported significantly greater levels of subjective anxiety after the behavioral analogue situation than children in the other two groups. Children with SP were also rated as significantly less socially effective than children in the other two groups. Collectively, these results are highly consistent with past investigations among children with social phobia (i.e., Beidel et al., 1999) and emphasize the utility of behavioral observations in the clinical assessment of social functioning.

However, contrary to expectations, children with AD in this study were rated as effective as TD children by blinded observers. This may reflect the influence of several potential methodological factors. Other investigations in our clinic also indicate that brief structured role-plays, or the global coding schemes, may be minimally sensitive in assessing the awkward behaviors (i.e., pragmatic behavior, speech and prosodic behavior, and paralinguistic conversational behaviors) seen in children with AD during unstructured and unguided social situations (Scharfstein, 2009). These findings suggest the need for extended, unstructured role-play scenarios that may be more likely to capture the nuanced social impairments unique to AD.

Finally, facial affect recognition abilities and behavioral observation ratings of anxiety and social skills effectiveness were uncorrelated in this study. While the ability to recognize facial affect accurately is necessary for effective social interaction, this ability alone is not sufficient to guarantee effective social functioning.

Although the findings from this investigation contribute to our overall knowledge of facial affect recognition abilities between two clinical populations with social skills deficits, this study is not without its limitations. To start, it is arguable that the use of static facial images may be distinct from real dynamic facial expressions in everyday situations. However, no significant differences in recognition abilities between still versus moving faces were found in previous research (Gepner et al., 2001; Miyahara et al., 2007). Furthermore, the images in this study were selected from the Penn Emotion Recognition set because of its documented realistic qualities (Gur, Sara, et al., 2002). Next, although prior research indicates that the recognition of subtle facial expressions becomes more accurate with age in typically developing individuals versus individuals with autism (Rump et al., 2009; Thomas, De Bellis, Graham, LaBar, 2007), developmental differences between the three groups in this study could not be detected due to the restricted age range used in this study. Also, demographic and clinical characteristics were not hypothesized as primary predictor variables in this study and thus, were not planned in the design. Thus, this study cannot identify variables that may be potential mediators or moderators in facial affect recognition performance.

Future Directions

As facial affect detection abilities become increasing considered in clinically relevant procedures, this study reinforces the importance of assessing a broad range of emotions at varying levels of intensity in future studies. Furthermore, as sophisticated technology is increasingly used to assess visual scan paths in adults, the adaptation of these innovations (e.g., eye tracking devices) to assess facial affect processing in children may be the next logical step for future research. Similarly, as facial affect recognition paradigms become increasingly considered in clinically relevant treatment components (e.g., Bölte et al., 2006; LaCava, Golan, Baron-Cohen, & Myles, 2007; Miyahara, Ruffman, Fujita, & Tsujii, 2010; Silver & Oakes, 2001), training children with AD or SP to recognize more subtle, mild expressions of affect may be as critical as teaching them to identify prototypically extreme expressions. Lastly, as the search for biological mechanisms responsible for facial affect recognition continues, integrating behavioral evidence with neuropsychological findings from brain imaging studies remains a promising future direction.

Conclusions

This was the first study to examine facial affect detection speed and accuracy, at two intensity valences, between groups with clinically impairing social skills deficits, relative to typically developing children. Measures of simple and choice reaction time were included for greater methodological control. Collectively, the findings in this study delineate both facial affect recognition abilities common to all children, as well as distinct facial affect recognition deficits in the clinical groups relative to controls. First, all children performed similarly in their ability to detect certain emotions. Specifically, happy faces were the easiest emotion to identify relative to other emotions (anger, disgust, fear, neutral, and sad). Except for disgust, all children identified extreme expressions more quickly and accurately than mild expressions. Children generally identified disgust most slowly and with the least amount of accuracy. Furthermore, all children performed similarly in their ability to discriminate a target emotion from non-target emotions. In line with detection accuracy findings, happy faces were the easiest to discriminate from non-target faces while disgust was the hardest. Second, distinct facial affect recognition deficits in the clinical groups emerge when the intensity of the emotion displayed is considered. Specifically, children with SP were significantly slower to identify happy expressions and mildly fearful expressions than TD children, and children with AD were significantly less accurate than TD children at recognizing mild angry faces. Results indicate that intensity of the displayed emotions plays a critical role in revealing the facial affect deficits unique to the two clinical groups. Finally, simply recognizing facial affect appropriately does not assure effective social functioning for children with either AD or SP. Behavioral assessments remain a critical tool in delineating the relationship between facial affect recognition abilities and social functioning in clinical populations.

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APPENDIX A: IRB APPROVAL

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Full Board Review and Approval of a New Study with Informed Consent Documentation

From : UCF Institutional Review Board
FWA00000351, Exp. 10/8/11, IRB00001138

To : Nina Wong & Deborah Beidel

Date : January 14, 2009

IRB Number: SBE-08-05842

Study Title: Children's Emotion Study

Dear Researcher:

Your research protocol noted above was reviewed by the University of Central Florida Institutional Review Board (IRB) at convened meetings on November 26 and December 10, 2008. Having received the revisions, clarifications and acknowledgement of stipulations requested by the Board, you may now proceed with your research and begin enrolling participants and collecting data and/or specimens. **The expiration date is December 10, 2009.** The IRB determined this study to be minimal risk for human subjects .The IRB has determined that the federally mandated criteria at 45 CFR 46, 45 CFR 164, and/or 21 CFR 50 & 56 for IRB approval of research have been met. This study will need to be renewed by full board review.

All data, including all signed consent form documents, must be retained in a locked file cabinet for a minimum of three years past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs.

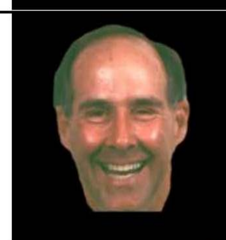
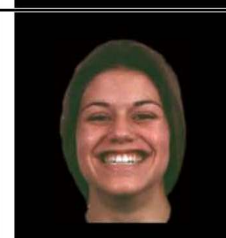
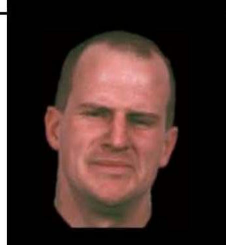
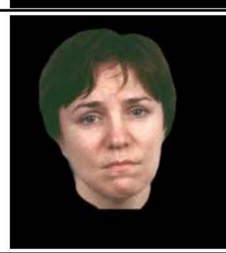
Unanticipated problems or serious adverse events must be reported within 5 working days by submitting either the Unanticipated Problem and Notable Event Report Form or the Serious Adverse Event Form. Do not make changes to the protocol methodology, consent form or other study documents before obtaining IRB approval. Minor changes to this research may be approved by expedited review and should be submitted using the online Addendum/Modification Request Form. To continue this research beyond the expiration date, a Continuing Review Application Form must be submitted 4 weeks prior to the expiration date. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All submission forms may be found in the iRIS system **Failure to submit a Continuing Review Application Form could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies.** The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

Sincerely,

Signature applied by Janice Turchin on 01/14/2009 11:37:48 AM EST

Janice M Turchin

APPENDIX B: STIMULI PRESENTED IN THE FACIAL AFFECT RECOGNITION TASK

Emotion	Mild		Extreme	
	Male	Female	Male	Female
Anger				
Disgust				
Fear				
Happy				
Sad				
Neutral				

APPENDIX C: TABLES

Table 1. Sample, demographic, and control variables

	AD (*n* = 19)		SP (*n* = 17)		TD (*n* = 21)		
Categorical	*n*	%	*n*	%	*n*	%	χ^2
Gender							
Males	16	84.2	4	23.5	15	71.4	
Females	3	15.8	13	76.5	6	28.6	15.35***
Race/ Ethnicity							
Caucasian	14	73.7	8	47.1	15	71.4	
Hispanic	3	15.8	8	47.1	4	19.0	
Other	2	10.5	1	5.9	2	9.6	14.98
Comorbid Diagnosis							
Present	8	42.1	10	58.8	0	0	16.51***
Absent	11	57.9	7	41.2	100	100	
On Medication	8	42.1	0	0	0	0	18.61***
Continuous	$\bar{X}$	*SD*	$\bar{X}$	*SD*	$\bar{X}$	*SD*	*F*
Age	11.26[a]	1.48	9.53[b]	2.07	10.24[a]	1.81	4.28*
FSIQ	118.21	14.93	108.31	10.92	113.43	11.21	2.72†
CBCL Total Problem	61.00[a]	5.21	53.88[b]	9.71	45.81[c]	7.35	20.25***
CDI	44.42	5.65	44.06	6.16	41.86	5.84	1.12
GADS	93.89[a]	15.32	55.24[b]	15.18	45.71[c]	7.16	76.41***
SPAI-C	8.16[a]	5.71	19.94[b]	8.27	9.48[a]	6.74	15.46***
Control Variables	$\bar{X}$	*SD*	$\bar{X}$	*SD*	$\bar{X}$	*SD*	*F*
Pre-Anxiety	.11	.32	.24	.44	.05	.22	1.58
Post-Anxiety	.37	.68	.29	.59	.10	.30	1.37
Simple RT	566.42	433.01	715.00	20.87	645.93	371.84	.51
Choice RT	1327.5 6	439.79	1457.74	386.66	1244.64	435.62	1.20

Note: Values with different superscripts are different at the $p \leq .05$ level.
AD = Asperger's Disorder; SP = Social Phobia; TD = Typically Developing; FSIQ = Kaufman Brief Intelligence Test Full Scale Intelligence Quotient; CBCL = Child Behavior Checklist Total Problem *T*-score; CDI = Child Depression Inventory total score; SPAI-C = Social Phobia Anxiety Inventory for Children total score; Pre/Post-anxiety ratings measured from 0-4; RT = reaction time in milliseconds; †$p = .07$, * $p \leq .05$, *** $p \leq .001$

Table 2. Computer task performance (Reaction time and accuracy) by group

Variable/ Emotion Category	AD (*n* = 19)		SP (*n* = 17)		TD (*n* = 21)	
	$\overline{X}$	*SD*	$\overline{X}$	*SD*	$\overline{X}$	*SD*
Reaction Time (milliseconds)						
Anger	3950.30	1074.28	4233.81	1339.50	3874.42	1676.60
Disgust	2911.06	983.12	2997.29	694.11	2927.51	989.37
Fear	4535.67	1334.85	5563.04	3203.61	3973.46	1554.77
Happy	2412.00	979.21	2474.97	780.01	1838.15	424.61
Neutral	3617.08	1305.56	3625.18	1814.91	2945.25	1498.50
Sad	3202.44	989.42	3407.29	1054.50	3358.87	1561.62
Accuracy (%)						
Anger	44.1	14.1	50.7	16.8	51.8	19.9
Disgust	29.6	22.5	41.9	31.2	42.3	23.9
Fear	63.2	18.9	69.1	16.6	61.9	27.8
Happy	94.1	6.4	94.1	7.8	95.2	6.2
Neutral	67.1	38.5	65.4	36.3	63.1	41.2
Sad	61.8	21.0	66.2	15.8	66.7	22.5

Note: AD = Asperger's Disorder; SP = Social Phobia; TD = Typically Developing; RT = reaction time in milliseconds; Accuracy measured by averaging the percent of correctly identified images.

Table 3. Group by Intensity Mean Percent Accuracy for Each Emotion

Emotion Category		Mild *M*	Mild *SD*	Extreme *M*	Extreme *SD*	Intensity F value	Group F value	Interaction F value
Anger		28.1	23.18	69.7	21.5	137.49***	1.14	4.54*
Post-hoc	AD	15.8	20.8	72.4	16.4	--	--	--
	SP	32.4	17.1	69.1	24.3	--	--	--
	TD	35.7	25.7	67.9	23.9	--	--	--
Disgust		37.1	32.1	38.2	26.3	.004	1.49	2.37
Fear		52.2	24.7	76.8	26.2	49.48***	.55	.23
Happy		89.0	13.4	100	0	37.44***	.19	.19
Sad		49.6	26.9	80.3	22.5	60.76***	.33	.40

Note: $^*p < .05$ *** $p < .001$

Table 4. Hit Rates across different emotions

Effect/Variable	$\overline{X}$	*SD*	*F*	*p*
F (54, 2) Group			.92	.40
F (270, 5) Emotion			38.04	. 001
F (270, 10) Group x Emotion			.43	.93
Anger	.49	.17		
Disgust	.38	.26		
Fear	.65	.22		
Happy	.95	.07		
Neutral	.65	.38		
Sad	.65	.20		
Contrasts	H > N = F = S > A > D			

Note: A = Anger, D = Disgust, F = Fear, H = Happy, N = Neutral, S = Sad

Table 5. SDT indices (Sensitivity, Hit rates, and False Alarm rates) by group

Category/ Variable	AD (*n* = 19)		SP (*n* = 17)		TD (*n* = 21)		
	$\overline{X}$	*SD*	$\overline{X}$	*SD*	$\overline{X}$	*SD*	*F*
Anger							
Hit rate	.44	.14	.51	.17	.52	.20	1.14
False Alarm	.03	.03	.05	.06	.03	.03	1.36
d′ prime	1.87	.71	2.09	.89	2.20	.82	.84
Disgust							
Hit rate	.30	.26	.42	.31	.42	.24	1.48
False Alarm	.11	.10	.10	.07	.12	.08	.35
d′ prime	.62	1.26	.89	1.59	1.10	1.20	.62
Fear							
Hit rate	.63	.19	.69	.17	.62	.28	.55
False Alarm	.03	.02	.04	.03	.05	.05	1.06
d′ prime	2.33	.75	2.41	.70	2.30	1.50	.04
Happy							
Hit rate	.94	.06	.94	.08	.95	.06	.19
False Alarm	.05	.07	.04	.03	.04	.04	.11
d′ prime	4.21	1.05	4.23	1.16	4.32	1.13	.06
Neutral							
Hit rate	.67	.38	.65	.36	.63	.41	.05
False Alarm	.10	.07	.06	.05	.06	.07	2.20
d′ prime	2.07	1.91	2.38	1.56	2.36	1.80	.18
Sad							
Hit rate	.62	.21	.66	.16	.67	.22	.33
False Alarm	.15	.06	.13	.06	.13	.08	.36
d′ prime	1.58	.80	1.71	.70	1.83	.76	.53

Note: AD = Asperger's Disorder; SP = Social Phobia; TD = Typically Developing; Hit and False Alarm rates all indicate proportions; d′ = Z-score (false alarm rate) – Z-score (hit rate).

Table 6. Behavioral assessment of social skills

Variable	AD (n = 19)		SP (n = 16)†		TD (n = 20)		
	$\overline{X}$	*SD*	$\overline{X}$	*SD*	$\overline{X}$	*SD*	*F*
Pre-SAM	1.42	.692	1.94	.966	1.50	.761	2.13
Post-SAM	1.26 [a]	.452	2.41[b]	1.06	1.60[a]	.821	9.48***
Response Latency	2.16[a]	1.40	5.32[b]	3.18	1.98[a]	1.40	14.14***
Anxiety	2.68[a]	0.59	3.28[b]	0.45	2.37[a]	0.64	11.96***
Social Skill Effectiveness	2.56[a]	0.59	1.98[b]	0.78	2.87[a]	0.63	8.39***

Note: Values with different superscripts are different at the $p \leq .05$ level.
AD = Asperger's Disorder; SP = Social Phobia; TD = Typically Developing; SAM = Self Assessment Manikan Anxiety Rating (1-5); Response Latency is measured in seconds; Anxiety (ranged from 1= not anxious to 4 = highly anxious) and Social Skill Effectiveness (ranged from 1= not effective to 4 = very effective) were rated by blinded coders.
† One child in the Social Phobia group did not complete the BAT.
*** $p \leq .001$

Table 7. Correlation matrix of behavioral assessment variables and facial affect recognition abilities

MEASURES	**BEHAVIORAL ASSESSMENT (*n* = 56)**			**FACIAL AFFECT RECOGNITION ABILITIES (*n* = 57)**											
	RESPONSE LATENCY	ANXIETY	SOCIAL SKILL EFFECTIVENESS	ANGER RT	DISGUST RT	FEAR RT	HAPPY RT	NEUTRAL RT	SAD RT	ANGER %	DISGUST %	FEAR %	HAPPY %	NEUTRAL %	SAD %
RESPONSE LATENCY	1	.55***	-.77***							-.03	-.05	-.17	.03	-.08	-.04
ANXIETY	.54***	1	-.61***							.06	-.08	.07	.03	-.08	-.04
SOCIAL SKILL EFFECTIVENESS	-.77***	- .61***	1							.04	.06	.11	.10	.09	-.02
ANGER RT	.32*	-.01	-.17	1						-.03	.07	-.27*	.07	.12	-.21
DISGUST RT	.04	.05	.04	.47***	1					.05	.05	-.19	.19	.11	-.37**
FEAR RT	.17	.10	-.16	.49***	.46***	1				.04	-.12	-.07	.20	-.09	-0.15
HAPPY RT	.11	.23	-.21	.29*	.56***	.33*	1			-.10	.02	.06	-.18	.20	-.30*
NEUTRAL RT	.08	.13	-.15	.22	.34*	.57***	.24	1		-.11	-.23	-.36**	.17	-.45***	-.05
SAD RT	.12	.09	-.02	.50***	.52***	.42***	.39**	.25	1	.13	.14	-.09	.09	.23	-.53***
ANGER %										1	.11	-.01	.17	.10	-.13
DISGUST %											1	.19	-.05	.26*	-.16
FEAR %												1	-.04	.20	-.02
HAPPY %													1	-.07	-.05
NEUTRAL %														1	-.12
SAD %															1

Note: RT = reaction time; % = percent accuracy; Response Latency is measured in seconds; Anxiety (ranged from 1= not anxious to 4 = highly anxious) and Social Skill Effectiveness (ranged from 1= not effective to 4 = very effective) were rated by blinded coders.
* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

APPENDIX D: FIGURES

Figure 1. Mean reaction time as a function of emotion category and group

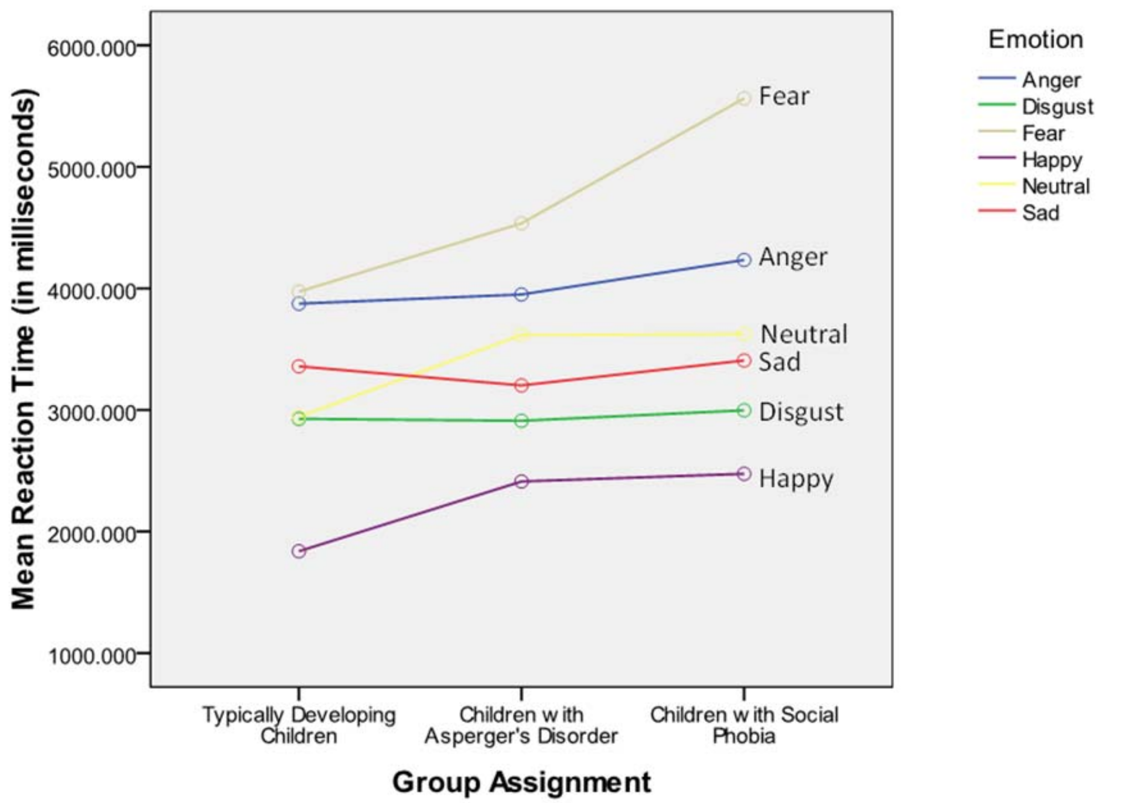
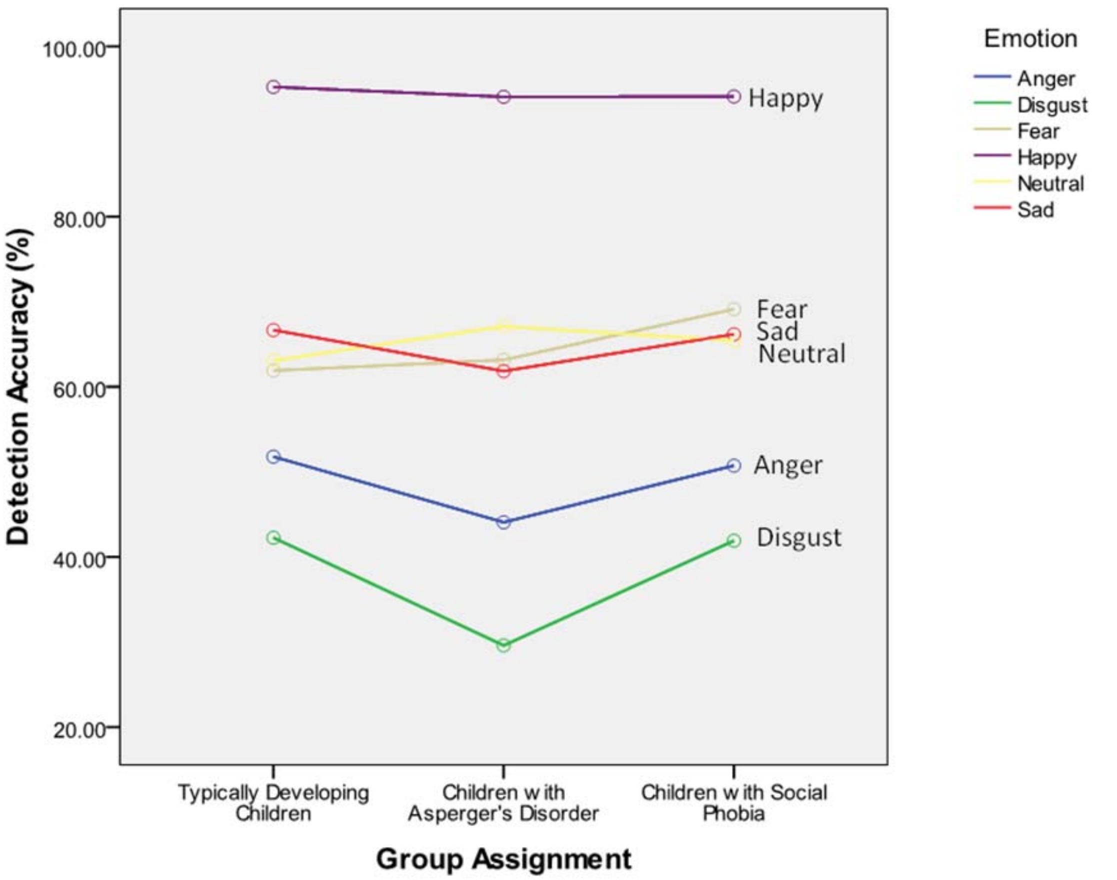


Figure 2. Detection accuracy as a function of emotion category and group



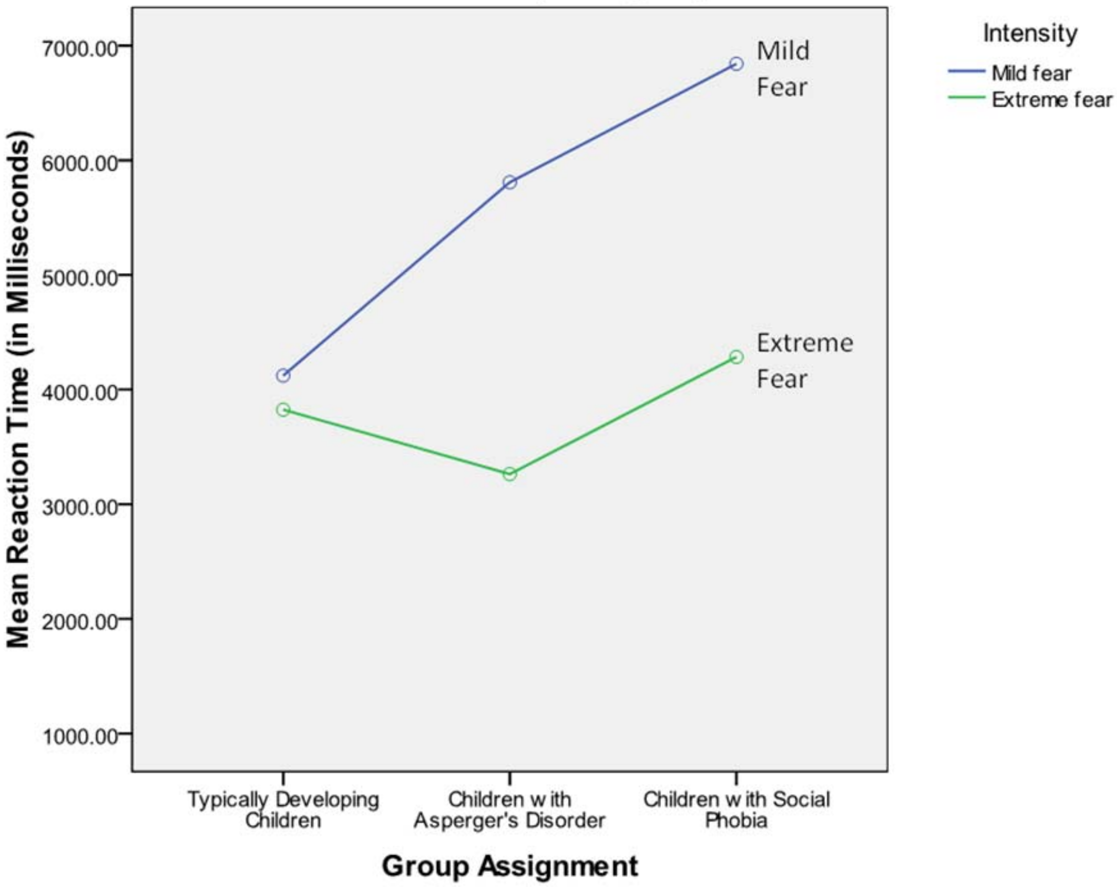


Figure 3. Mean reaction time to facial images depicting fear as a function of intensity and group

Figure 4. Percent accurate for facial images depicting anger as a function of intensity and group