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Emotional Acuity in Children With and Without Autism Spectrum Disorder

by

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## Abstract

## Emotional Acuity in Children With and Without Autism Spectrum Disorder

by

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Doctor of Philosophy in Education

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The present study investigated the ability of young children with and without Autism Spectrum Disorder (ASD) to identify emotion in photographs as well as their response to a distress event. Since communication is a core aspect of the disability, alternate methods of assessment were employed in order to investigate emotion understanding and emotion response in children with and without ASD. Thirty-one children with ASD (mean age 48 months) and forty typically developing children (mean age 53 months) participated. A sorting procedure was used to determine participants' ability to identify happy, sad and angry emotions in photographs with and without contextual information. Results suggest that context had no effect on either group. Children with ASD were significantly less likely to correctly sort emotional faces. When witnessing the experimenter in distress, children with ASD showed similar levels of affect matching and a similar pattern in heart rate. Significant differences were found in the eye gaze pattern of the two groups; the typically developing children were more likely to look at the face of the experimenter during the distress event. By reducing the language component required for the emotion identification task and including behavioral and physiological outcome measures to the response to distress paradigm, this study seeks to investigate the unique characteristics of children with ASD without the impediment of their communicative difficulties. These results provide insight into the emotional lives of children with ASD and may shed light on why these children respond differently to emotion than their typically developing peers.

## Dedication

To my mother, my inspiration  
Your belief in me was contagious. Thank you for giving all of you to make me who I am.

To my husband, my motivation  
Your confidence in my ability and conviction that I will do good things gives me the strength to  
carry on.

To my daughter, my hope  
You are a beautiful light in a sometimes shadowy world.  
Let your smile illuminate the darkness and brighten the hardened hearts.

My loves, all that I do is an attempt to make the world a better place for you.

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### Emotional Acuity in Children With and Without Autism Spectrum Disorder

Nearly every social interaction is shrouded in emotion. When we have the ability to understand the feelings of another, we are provided a window of understanding into the private realm of their emotional state. If our understanding of this emotion leads to an appropriate response, it allows us to connect and relate to the other, thereby strengthening the relationship.

Typically developing children begin to form an understanding of their own and others' emotions early in life. Emotion is usually experienced within a rich context that includes facial expressions, verbal and non-verbal language and environmental cues. Children begin to form templates for understanding emotions as they experience and hear labels for these feelings. Exposure to emotion concepts begins in the early months of life and overtime allows for a sophisticated understanding of complex emotions. A common experience of a young child in a childcare setting is to witness the distress of a peer when his or her parent leaves. As the parent says goodbye the child observes the peer become upset, followed by a teacher labeling the peer's feelings and comforting the peer. From these types of experiences young children begin to form ideas about what elicits specific emotions. Through repeated and varied interactions with emotion, typically developing children begin to form a complex understanding of their own and others' emotions.

Children with Autism Spectrum Disorder, or ASD, may respond to emotion differently than their typically developing peers. Currently it is believed that 1 out of every 88 children will be diagnosed with ASD by the age of three (Center for Disease Control and Prevention, 2012). ASD is a spectrum disorder, meaning children with an ASD diagnosis may have symptoms characteristic of the disorder that range from very severe symptoms to more mild symptoms. While there are many theories regarding the increase in the incidence of ASD, one of the most plausible has to do with our understanding of ASD as a spectrum. Additionally, our willingness to diagnose children on the high end of the spectrum as having the disorder likely contributes to an increase in the rate of diagnosis (Croen, Grether, Hoogstrate, & Selvin, 2002). Even though children characterized as having ASD may be very different from one another, there are similarities which they all share. According to the current *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000), children with ASD all show differences from their neurotypical peers in the areas of communication, socialization and repetitive or stereotyped behaviors. Frith (2003) discusses behaviors that are characteristic of children on the severe and mild ends of the autism spectrum. She says children who exhibit more severe symptoms of the disorder may not speak at all. They may spend most of their time alone and will often engage in self stimulatory behaviors such as hand flapping or head banging. On the mild end of the spectrum, children with high functioning autism, or Asperger's syndrome, may have a large expressive vocabulary but only use it to talk about things that are of interest to them. Without the pragmatic understanding of social communication they may dominate conversations and not pick up on cues that their communicative partners are no longer interested in what they are saying. They may display repetitive behaviors such as perseverating on one topic or twisting of the hands and fingers (Frith, 2003). While differences in communication, socialization and repetitive or stereotyped behaviors define the disorder, other differences in these children are starting to be identified particularly in the area of emotion understanding and response.

Children with ASD may experience emotion differently than typically developing children (Capps, Yirmiya, & Sigman, 1992; Da Fonseca et al., 2009; Dawson, 2004). One of the

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

core manifestations of the disorder is a lack of social awareness and/ or engagement. These social differences may lead children with ASD to observe fewer emotional events. While children with ASD are less likely to attend to others' emotions, they often display strong emotions themselves. The difficulty they experience regulating their own emotions may make it even more difficult for them to learn what leads to specific emotional experiences. Typically developing children respond to others' emotions with insight gleaned from numerous and varied emotional experiences. Children with ASD however, may have more difficulty responding to others' emotions in a socially acceptable way due to their lack of history with emotion concepts.

Typically developing children and adults are likely to show compassion for others experiencing negative emotions. Children with ASD, however, often appear to ignore social stimuli including emotional events. Researchers across disciplines have found that the majority of children with ASD behave differently when witnessing a person in distress (Bacon, Fein, Waterhouse & Allen, 1998; Dawson, 2004; Iacoboni, 2008; McDonald, & Messinger, 2012; Rogers, Dziobek, Hassenstab, Sigman & Kasari, 1992; Wolf, & Convit, 2007). The reasons behind these differences are less clear. Are these behavioral differences simply a manifestation of the disorder? Or, is there some internal response to emotion that differs between typically developing children and children with ASD? Where does the breakdown occur, and what leads to this different pattern of behavior? Do children with ASD "feel" the same things internally when witnessing someone in distress but respond in a behaviorally different way? Does the behavior pattern of children with ASD match that of younger typically developing children, or is it different altogether?

Children's behavioral responses to emotional events may shape the way that they are viewed by their peers. While typically developing children generally provide some sort of support when seeing another in distress, children with ASD often seem to ignore emotional situations (Dawson et al., 2004). A common occurrence among young children is to witness a peer in distress after a minor injury, such as a fall while running. If a child with ASD witnesses a peer displaying such emotions and does not respond, the peer may feel he or she is being rejected or that the child with ASD is being cold and unfriendly. Responding to others' emotions is an important factor for successful social interaction and developing friendships. Without the behavioral responses that show care and concern for another's feelings, peers may feel that the child with ASD does not care or is even intentionally hurting them. This kind of distrust can lead to further exclusion from the peer group and increased isolation of a child who may already have difficulty entering and engaging in peer play.

Emotion understanding and culturally appropriate emotional response are key aspects in both daily life and relationship building. In the present study I explored differences in emotion processing between children with and without ASD. The goals of this research were accomplished through two studies. First, I looked at children's ability to identify emotion in faces. The emotion identification task utilized a sorting procedure which required children to sort photographs of faces depicting three distinct emotions: happy, sad and angry. While researchers have used emotional photographs to test children's emotion recognition, typically a verbal response is required (e.g. Wright et al., 2008). In order to overcome potential expressive language difficulties in the children with ASD the task was modified so that no verbal response was required. Next, I examined children's responses to an unfamiliar adult's distress. The emotion response task incorporated observable behavioral measures, including eye gaze and affect matching, as well as heart rate, which served as a measure of children's internal physiological response. The response to distress task has been used in several studies to measure

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

how children with ASD respond to another's distress (Bacon et al. 1998; Dawson, 2004; Scrambler et al. 2007). However, this will be the first time that this procedure has included the physiological measure heart rate (henceforth HR). Examining HR will provide valuable information about children's internal physiological responses to witnessing a distress event. This is of particular importance for young children and children with ASD, both of whom are less able to verbally express their emotional experiences. Through these experimental tasks, I will attempt to disentangle these constructs to better understand how children with and without ASD understand the emotions of others.

To explore differences in emotion identification and response in children with and without ASD the following research questions were addressed:

1. Does ASD status, receptive language level or chronological age predict number correct when sorting emotional faces?
2. Does providing visual contextual information predict higher success in typically developing children than children with ASD when sorting emotional faces?
3. Does ASD status predict percent affect matching during a distress situation?
  - 3.1. Is ASD status, receptive language level or chronological age correlated with affect matching during the distress task?
4. Does a display of distress differentially affect the looking patterns of children with and without ASD?
  - 4.1. Do children with ASD look less at the face of the person in distress than typically developing children?
5. Does ASD status predict a higher HR during a distress situation when controlling for chronological age?
  - 5.1. Is chronological age correlated with HR for typically developing children?
  - 5.2. Does HR change for a typically developing child as a result of witnessing a person in distress when controlling for chronological age?
  - 5.3. Is HR correlated with eye gaze during the distress event?

### **Literature Review**

How we learn to understand and respond to emotion is the subject of research in several fields, including child development, social cognition, and neuroscience. Our ability to identify and respond to others' emotions is achieved through attention to emotional facial expressions, as well as words or vocalizations, and the context that surrounds an event. In this review I will discuss many of the aspects of emotion that may lead to or impair a socially appropriate response.

The behaviors of children with ASD in response to emotional events are different than the behaviors of their typically developing peers. This review will explore several of the theories behind these differences as well as provide a framework for the current study. I will begin by summarizing the literature describing how typically developing children learn to identify emotions, and contrast this typical trajectory with the development of children with ASD. Next, I will discuss how we respond to others' emotions through the process of emotional contagion and how this may lead to different specific physiological and behavioral responses in typically developing children as compared to children with ASD. Lastly, I will discuss how the current study adds to the literature and will provide insight into why children with ASD respond differently to others' emotions.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

### **Autism Spectrum Disorder (ASD)**

Individuals with autism spectrum disorder (ASD) show a wide range of symptoms that may impact their capacities to empathize. This categorical diagnosis includes: classic autism, high functioning autism, Asperger's syndrome, and pervasive developmental disorder not otherwise specified. While there is a significant range in ability for these children, there are some commonalities within the diagnostic criteria (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000). Children who meet the qualifying criteria for ASD all have some impairment in reciprocal social interaction and repetitive stereotyped behaviors. Children who qualify specifically for autism must also have communication impairment and must show signs of abnormal functioning before the age of three. For the purposes of this paper, I will be looking at the differences in emotion understanding between children with ASD (as defined above) compared to their typically developing peers.

### **Emotion Identification**

Developmentally, one of the earliest appearances of emotion identification is evident in the social referencing of infants. Social referencing is a process that typically developing infants and toddlers use in order to make sense of a confusing situation or new object by looking at a caregiver's face for cues on how to respond (Carpenter, 1998). This early use of emotional facial expression is important because it provides children practice reading emotions in terms of a didactic good feeling/ bad feeling response. This basic understanding of positive and negative emotion lays the foundation for more sophisticated understanding of a broad range of emotions later in life. By the time they are four years old, children are not only able to read simple emotions in others' faces but they are also able to understand more complex emotions such as fear and surprise (Widen & Russell, 2010). Preschool age children also begin to become more adept at understanding both how they can use emotion to influence the behavior of others and how their behavior can influence others' emotions. Cole and colleagues (2008) found that by the age of three children were reliably capable of generating strategies to change the affective state of sadness. By age four they could generate strategies to change feelings of anger. Cole also found that a child's ability to come up with strategies to change the emotions of others were predictive of the child's ability to self-regulate frustration. The type of strategy that is used in an attempt to change another's emotional state is at least in part a factor of development. McCoy and Masters (1985) found that in children 5, 8 and 12 years old, the younger children were more likely to select "material" change strategies where older children tended to use "verbal" strategies. Younger children focused on how to change the situation (provide a toy, give a hug) whereas older children tried to help the person in distress change his or her cognitive process (things like "tell him it is not worth thinking about").

The way that children respond to emotion is an important component in how accepted they are by their peer group. Children who have higher emotion knowledge and show more prosocial behavior are generally viewed as more likeable by their peers (Denham, 1990). This has important implications for children who have difficulty understanding and responding appropriately to others' emotions. A lack of emotional competence may have significant ramifications over time. Denham and colleagues (2003) found that preschool children who had higher levels of emotional competence (consisting of emotional expressiveness, emotion knowledge and emotion regulation) were rated as having higher social competence in both preschool and kindergarten. Several studies show short term stability in emotion understanding throughout the preschool years and up to the elementary age level (Denham et al., 2003; Pons & Harris, 2005). However, the long term implications for children who do not develop these skills

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

early are yet unknown. It is likely that children would continue to experience some difficulty in the realm of social interaction as a result of a lack of emotion understanding. In an attempt to understand the differences in emotion understanding for children with ASD, several theories have been posited about how social and contextual environments lead to understanding and how children learn to understand emotions through facial expressions.

**A lack of experiential learning.** How these differences in emotion understanding come to occur in children with ASD is still a source of debate. A developmental approach to understanding the nature of ASD would argue that a significant portion of these differences are due to early impairments in social attention (Carpenter & Tomasello, 2000). The different nature of social experiences for children with ASD may lead to reduced participatory experience in emotional situations.

While differences in the verbal identification of emotion and empathetic response may not be visible until later, early differences are also present. While typically developing children use social referencing in infancy to determine how to respond to unusual stimuli, children with ASD are significantly less likely to reference the emotional expression of adults (Capps, Yirmiya, & Sigman, 1992; Carpenter & Tomasello, 2000; Dawson, Hill, Spencer, Galpert, & Watson, 1990).

Children with ASD also attend less to child directed speech (Paul, Chawarska, Fowler, Cicchetti, & Volkmar, 2007; Watson, Roberts, Baranek, Mandulak & Dalton, 2012). Typically developing children are highly motivated to use language to interact and engage socially with others (Markova & Legerstee, 2006). For children with ASD, language may be less socially driven and they may be less attentive to language in general (Carpenter & Tomasello, 2000; Dawson et al., 2004). The result may be that while typically developing children attend to labels provided for emotions, children with ASD may be less inclined to attend to the language that surrounds emotional events.

**Weak central coherence.** Children with ASD may be at a further disadvantage in deciphering emotional events due to a weak central coherence. Frith (2003) discusses how typically developing children are able to use many aspects of their environment to make sense of a specific situation. Individuals with ASD however, may have a processing bias for “featural information”; they may fail to appreciate important contextual information. For children with ASD, simply focusing on a different aspect of the environment irrelevant to the emotional valence of an event may cause them to miss key information that would allow for understanding. Emotional expressions are often fleeting; therefore, a brief period of inattention to the face may be all that it would take for children with ASD to lose vital information necessary for processing the event. By not attending to crucial elements of the context such as the person’s facial expression or the events that led to the emotional event, children with ASD are less likely to effectively build a broad based understanding of emotion concepts.

**Inability to identify emotional facial expressions.** Even when individuals with ASD are attending to the face of another, they may not be processing their emotional expression. Clark, Winkielman and McIntosh (2008) found that adults with ASD were uniquely impaired in identifying emotion in briefly presented faces. When instructed, individuals with ASD attended to the stimuli (picture cards of faces) and were found to be as accurate as controls at identifying the gender of a face. However, they were significantly less likely to be able to quickly name the simple emotions “happy” and “angry”. Wright and colleagues (2008) found a similar effect for elementary age children with ASD in the happy and angry conditions. Interestingly, Wright reports a higher degree of variability in the scores of the children with ASD for the happy stimuli

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

and lower overall scores for the angry stimuli. Winden and Russell (2010) suggest that typically developing children acquire emotion labels in a systematic order beginning with happy, then moving to sad, then angry and finally surprise and fear. This suggests that children with ASD may follow a similar developmental pattern but show a developmental delay. There may also be a subset of children with ASD who have more difficulty processing emotion than others.

### **Emotion Response**

**Developmental trajectory of emotion response.** A developmental approach to understanding empathy responding in children posits that emotion response processes initially stem from reflexive actions and move along a continuum to more purposeful empathetic actions (Zahn-Waxler, 2002). Reflexive empathy can be seen in newborn babies through contagious crying (Hoffman, 1975). Hoffman contends reflexive crying in response to hearing another infant's cry is a primitive act of empathetic arousal. These initial empathetic responses develop into an effortful understanding and ability to empathize with others. Primitive personal distress responses such as contagious crying are most often seen within the first year. By the second year of life empathy responses appear to become more prosocial as the child begins responding to others in distress through care and concern (Zahn-Waxler, 2002). These responses are a product of cultural conventions and are often physical in nature, such as offering a hug or pat on the back. Responses of care and concern may serve a dual purpose of comforting both the victim and the observer. In the second or third year of life a child's response to distress becomes more focused on perceived need. Svetlova, Nicholos and Brownell (2010) found that at age two children are competent in instrumental helping, engaging in actions that are motivated by interest in the persons, actions or objects involved, such as, handing something to a parent that was dropped on the floor. By age three there appears to be a transition from instrumental helping to empathetic helping which is based on an "other-oriented" response. Children engaging in empathetic helping show more advanced methods of consoling others by offering differentiated assistance more appropriate to the cause of the victim's distress (Zahn-Waxler, 2002).

From a developmental perspective the response of care and concern is not specifically reinforced or prompted and emerges from within the child in response to her environment. These interactions initially take place within the context of the family, often the mother-child dyad. Through natural development as well as continued experience and exposure to distress and altruistic responses within their environment, children learn to generalize their ability to respond appropriately to others in distress. The development of empathy is seen as a part of a continuum; therefore, in typical development a reduction of the self distress response is believed to come before the ability to effectively care for and comfort others (Zahn-Waxler, 2002).

**Emotional contagion in young children.** When witnessing a person experiencing an emotional event typically developing individuals may find themselves imitating the emotion on the others' face. This is believed to occur because of a process called the mirror neuron system (henceforth MNS). The MNS is a process in the brain that allows us access into the feelings of others through emotional contagion or what developmental theorists might call "reflexive empathy." The MNS causes neuronal imitation of another's emotions which allows individuals to feel what another is feeling (Gallese, 2006; Shamay-Tsoory, Aharon-Peretz & Perry, 2009).

The MNS was first observed in motor actions in non-human primate research. Researchers found that when a monkey observed an action (such as picking up a banana) the monkey's brain showed activity similar to having engaged in that particular action. Researchers concluded that when a primate (human or non-human) saw a conspecific performing an action,

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

the primate's brain activity showed neuronal firing similar to the pattern that would be seen while actually performing that specific action (Rizzolatti & Craighero, 2004).

Many proponents of the MNS believe that there is a connection between this system and empathetic response. Studies have shown that human brains act similarly when that individual sees a person experiencing a specific emotion as to when the individual is experiencing that emotion personally (Dapretto et al., 2006). Some researchers believe that the mimicking process induced by the MNS precedes emotion recognition and is what allows us to perceive and express emotions (Iacoboni, 2008). Proponents of the MNS theory suggest that this system results in emotional contagion, or feeling what another is feeling, which allows individuals to understand and empathize with others.

Researchers have attempted to identify why children with ASD respond to emotion differently than typically developing children. Theories about the causes of differences in emotion response are grounded in several disciplines. First, I will discuss how developmental theorists account for differences in emotion response of children with ASD. Then I will look at how neuroscientists have attempted to locate specific areas of, and processes in, the brain that may be at the root of these children's atypical responses.

**Developmental differences.** Developmental researchers hypothesize that empathetic actions begin as reflexive responses and gradually become more purposeful pro-social actions over time. A lack of experiential learning will disrupt the development of social processes in the brain leading to differences in behavioral outcomes. Developmental theorists believe that this places children with ASD at a further disadvantage in the development of these skills throughout the lifespan (Mundy & Neal, 2001). This may mean that children with ASD show a developmental delay in emotion processing leading them to respond to distress with the most rudimentary forms of emotional contagion rather than developing pro-social responses. If this were the case, we might see children with ASD respond to others' distress with personal distress. Support for this behavior has been documented by several researchers (e.g. Dziobek et al., 2008; Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). Alternatively, over time a lack of attention to social stimuli, specifically emotionally valenced stimuli, may lead children with ASD to have less drive to attend to emotional events leading to increased social difficulties (Iacoboni, 2008; Sigman & Kasari, 1992).

**Processes that lead to understanding others' emotions.** There is evidence suggesting that there are two ways that one may come to understand another's emotions: emotional contagion and cognitive empathy. Emotional contagion is believed to be driven by reflexive emotion whereas cognitive empathy derives from how we think about emotion. Neuroscientists consider the MNS, the process leading to emotional contagion and cognitive empathy to be directly linked to specific areas of the brain (Dziobek et al., 2008). Shamay-Tsoory, Aharon-Peretz & Perry (2009) conducted research that mapped specific brain structures to empathy processes. They examined participants with brain lesions in either the inferior frontal gyrus or the ventromedial prefrontal lobe. Their results suggest a double disassociation between emotional and cognitive empathy. This means that an individual can be impaired in one empathy process and show normal functioning in the other. They found that emotional contagion stemming from the MNS can be mapped onto the inferior frontal gyrus. Participants with lesions to this area of the brain were specifically impaired in emotional empathy response. Cognitive empathy is a separate system believed to be located in the ventromedial prefrontal lobe. Shamay-Tsoory and colleagues (2009) research indicated that patients with lesions to the ventromedial lobe showed impairments in cognitive empathy but not emotional empathy.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

It is likely that reflexive emotional empathy or emotional contagion is the most direct way to access another's affective state. However, there may be times when this process is interrupted in some way, due to a dysfunction of the system or a lack of ability to witness the emotion. As a repair strategy cognitive empathy may be used to develop an understanding of the emotion. By three years of age children begin to be able to think about another's emotional state and use that information to drive their response (Baron-Cohen & Frith, 1985). Once they have determined another's affective state, children as young as three begin to be able to develop strategies to change others' feelings. Research findings suggest that individuals with ASD are uniquely impaired in their ability to use cognitive empathy to understand the emotions of others (Dziobek et al. 2008; Rogers et al. 2007). This may mean that if emotional contagion does not occur they are less able to use cognitive skills to decipher the underlying emotion.

Yirmiya and colleagues (1992) found a positive association between cognitive ability and emotion understanding for children with ASD that was not present for typically developing children. This may indicate a discrepancy in the incidence of reflexive empathy as it occurs for children who are typically developing and children with ASD. Children with ASD may need to use cognitive empathy to understand emotion that typically developing children would reflexively comprehend. However, as mentioned earlier children with ASD are less likely to be able to cognitively process emotion and use cognitive empathy to understand affective states (Dziobek et al. 2007; Rogers et al. 2007). Since cognitive empathy is, as Gallese (2006) states, "the only compensating strategy available in absence of direct experiential take on the world" children with ASD may be at a severe disadvantage when attempting to understand others' emotions.

**Mirror neuron dysfunction.** Reflexive empathy or emotional contagion allows quick access to another's emotional state. Since children with ASD are specifically impaired in using cognitive empathy this reflexive process becomes even more important for emotion understanding. Neuroscientists have begun to disentangle deficits in emotional contagion and cognitive empathy for individuals with ASD. Research by Dziobek and colleagues in 2009 suggests that adults with ASD are specifically impaired in cognitive empathy but not emotional empathy. However, the employed methodology used reported levels of arousal and concern as measures of emotional empathy rather than less subjective measures more likely to capture a true emotional contagion response. Dapretto and colleagues (2006) used functional magnetic resonance imaging (fMRI) to examine brain activity in typically developing children and children with ASD upon witnessing and imitating emotional faces. They found that when children with ASD witnessed and imitated emotional faces their brain scans showed different activity than the typically developing children. (Dapretto et al., 2006). Typically developing children engaged the IFG region of the brain which has been shown to be associated with the MNS, whereas children with ASD showed a higher than normal use of visual and motor areas of the brain but showed no activity in the IFG. These researchers conclude that individuals with ASD are impaired in reflexive emotional contagion.

Further support for the MNS dysfunction theory is evidenced in a study by Minio-Paluello and colleagues (2009) on the embodiment of pain. When observing a video of a painful stimulus (a hand being pierced by a needle) individuals with ASD showed less sensorimotor contagion than the typically developing adults. These studies provide support for the theory that individuals with ASD do not implicitly experience emotions as a result of the embodiment of another's feelings in the same way that typically developing individuals do.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

While it remains somewhat unclear what factors are responsible for the variance in the way that children with ASD respond to distress, we do see distinct differences from this population as compared to typically developing children. Several studies have documented that children with ASD are less likely to show concern for a person in distress (e.g. Bacon et al. 1998; Dawson, 2004; Scrambler et al. 2007). While these studies all use contrived events where the child must respond to an artificial display of distress, there are distinct differences in the responses of children with and without ASD. Specifically children with ASD attend less to the person in distress and show little change in facial expression in response to seeing another in distress.

**Assessing emotion identification and response.** Previous research on emotion identification has focused on children on the high end of the autism spectrum. Working with elementary age children with higher language capabilities has allowed researchers to require verbal responses to emotion tasks. For example Capps and colleagues (1992) asked children with high functioning autism to provide examples of times that they had experienced a specific emotion. Other research has required less sophisticated verbal response but still requires some degree of expressive language. For instance, Wright and colleagues (2008) asked children with high functioning autism to label emotions in photographs. While a list of possible emotions was included, language was still a key component of the task.

In the current study I sought to simplify the language component as much as possible in order to test younger children with ASD as well as those with more severe symptoms of the disorder. In order to accomplish this, a sorting procedure was used. Because I did not require a verbal response I was able to test children who have less expressive language than those previously studied.

The emotion response task used in the current study has been previously completed with children both on the high and low end of the autism spectrum. In order to elicit a measureable response to distress, the experimenter hits her finger while playing with a wooden hammer/ peg toy. Previous studies have used this task to provide a measure of directed eye gaze toward a person in distress and examine potential changes in facial expression when witnessing a distress event (e.g. Bacon et al. 1998; Dawson, 2004; Scrambler et al. 2007).

I analyzed both affect and eye gaze for my experimental group. However, unlike previous research, when coding facial expression I considered affective display in terms of a relative matching effect. A matching effect is conceptualized as the amount of similarity between the child and the experimenter's emotional expression. This was different from previous research which focused on affective display as a change in the child's facial expression from before to during the distress event. Research using the hammer/ peg task has focused on the behavioral outcomes for a child with ASD witnessing a distress event, in addition to these measures I also examined the child's heart rate for insight into their physiological response to the distress event (for more details see section Study 2: Emotion response- Hammer/ peg task, below). Next I will discuss how I conceptualized each of these tasks in order to answer my research questions and explore differences in emotion understanding for children with and without ASD.

**Study 1: Emotion identification- Sorting emotional faces.** Typically developing children can verbally identify simple emotion in faces by the age of three (Winden & Russell, 2010). However, language, particularly expressive language, is one of the core deficits characterizing children with ASD. Therefore, testing emotion identification through a verbal task might prohibit the children with ASD from successfully completing the task. The emotion identification sorting task was designed to be familiar to children. Young children often practice

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

sorting objects based on specific attributes (Denham, 1990; McConnell & Odom 1999). At the time of this paper, there is no research that has used sorting as a response measure for emotion identification in young children with ASD. Instead researchers examining children's ability to identify emotion in photographs have relied upon the child's ability to verbally identify the emotion (e.g. Wright et. al., 2008). The author developed the following procedure in an attempt to reduce the cognitive load required of a verbal response while still effectively measuring emotion identification ability.

The emotion identification stimuli consisted of black and white photographs of a person's face and torso on a white background. The photographs came from a standard set of emotion photographs called the "Language builder picture cards: Emotions" and were developed by Stages Learning Materials. The photos were copied and presented in black and white so as to reduce potentially distracting contextual information (like the color of the person's shirt). The sorting baskets were color coded to help children remember which basket represented each category (yellow for happy, blue for sad and red for angry). Additionally, emotion labels (happy, sad and angry) were attached to the front of the baskets for readers (see Appendix A: Study 1- Emotion Identification Set Up). Emotions were first sorted without contextual information and then were presented with contextual information. Responses were recorded during the test session (see Appendix B. for data sheet).

Da Fonseca and colleagues (2009) examined the ability of children with ASD to recognize emotions and objects through the use of contextual information. Stimuli consisted of photographs in which a component of the scene was masked with a white circle (covering either a person's face or an object). The children were asked to identify the emotion of the person in scene or the object that was missing. They found that children with ASD were uniquely impaired in their ability to determine emotion from the relevant contextual stimuli. These findings coupled with the weak central coherence theory (Frith, 2003), described earlier in this review, were used to ground the hypothesis that children with ASD would be differentially affected by the inclusion of contextual information in the emotion identification task.

**Study 1: Hypotheses.** Several hypotheses were tested in the emotion identification task. First, I hypothesized that in the typically developing group, older children and children with higher language would score higher on the task than younger children and children with lower language. Second, I hypothesized that when controlling for age and language, typically developing children would score higher on the emotion identification task than children with ASD. Lastly, I hypothesized that typically developing children would benefit from contextual information and would score better on the task with context than without, whereas children with ASD would perform worse on the task when given contextual information.

**Study 2: Emotion response- Hammer/ peg task.** The emotion response task used in this study was developed by Sigman and colleagues (1992). Several researchers have validated the use of this task to measure behavioral responses of distress in children with ASD (e.g. Dawson et al. 2004, Scrambler et al. 2007). The task involves an examiner interacting with the child with a wooden hammer/peg toy. After a few minutes of play the adult pretends to hit her hand with the hammer and makes an obvious display of distress. Outcome measures from previous studies included where the child was looking and how much concern they show for the person in distress.

**Affect Matching.** Previous research using the hammer/ peg task substantiates claims that children with ASD are less likely to be rated as showing concern for the person in distress (Dawson, 2004; Scrambler et al., 2007). In this study I will look at the child's affect in relation to

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

the experimenter's affect in an attempt to capture an affect matching response. Affect matching would result from emotional contagion, suggesting neuronal imitation of the witnessed emotion, or the mirror neuron response.

**Eye Gaze.** Findings from studies using the response to distress hammer/ peg paradigm show differences in the responses of children with and without ASD. Children with ASD tend to look less at the person in distress both in terms of frequency and duration (Dawson, 2004; Sigman et al., 1992). While these studies clearly demonstrate a difference in the attention of children with ASD to a person in distress, it is unclear how much the attention of both groups shifts as a response to the distress event. The current study expands these findings by examining the change in the rate of looking by both children with and without ASD between the time periods before, during and after the distress event.

**Heart Rate.** Several studies have documented behavioral differences for children with ASD when witnessing distress (Dawson et al., 2004; Scambler, Hepburn, Rutherford, Wehner, & Rogers, 2007; Sigman, & Kasari, 1992). However, the causes of these differences are difficult to determine, since children with ASD are less likely to be able to verbalize their own feelings or their thoughts about another's feelings. Therefore one way to understand their response to emotion is by examining their physiological state. Several outcome measures have been used in an attempt to document physiological responses to emotion including heart rate (HR), respiratory sinus arrhythmia (RSA), electrodermal arousal (EDA), skin temperature and muscle tension (Eckman, 1983; Porges, 2007; Vos, 2012; Watson et al., 2012). This study examined the visceral response heart rate.

One of the primary systems involved in physiological arousal is the autonomic nervous system (henceforth ANS). The ANS is divided into two opposing systems: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). During times of stress or activity the SNS becomes dominant, resulting in a fight or flight response. When a person feels at ease or is at rest the PNS becomes dominant, resulting in a slowing of the body's systems (Appelhans & Luecken, 2006). One measure of ANS is heart rate, the number of heart beats that occur per minute.

Building on animal research, a model proposed by Bradley, Codispoti, Cuthbert & Lang in 2001 suggests that when a person experiences mild to moderately unpleasant stimuli their heart rate will slow. This is similar to an animal's response when they see a predator in the distance. Aware of the potential danger, their attention is focused. When unpleasant stimuli are strong, heart rate will increase, just as an animal prepares for fight or flight when a predator is within striking distance. Vos et al. (2012) found, as with typically developing individuals, heart rate can provide information about the emotions of individuals with severe and profound intellectual disabilities.

Heart rate appears to be mediated more by the PNS than the SNS during different attention phases (Richards & Casey, 1991). Researchers have found that typically developing infants and children show a slowing of heart rate that is associated with a behavior of attentive looking (Richards & Cronise, 2000). At the time of this study attention of children with ASD has been measured through looking patterns in the response to distress paradigm but not through a physiological measure, such as heart rate.

Findings suggest that heart rate is influenced by age, with younger children having a faster heart rate than older children (Porges, Doussard-Roosevelt, Portales, & Suess, 1994). It is believed that this is primarily due to body size, with smaller bodies having faster heart rates. Since I will be examining children who range in age from 2 to 6 years, it will be important to

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

determine if in fact this finding is present in the current study and to covary age with heart rate in my interpretation of the results. Several studies have concluded that children with ASD behave differently due to a lack of attention to the emotional event. The current study will examine one of the physiological correlates of attention (heart rate) as a parameter of level of arousal and resulting attention to the distress event.

**Study 2: Hypotheses.** Hypotheses were developed for each of the three outcome measures: affect matching, eye gaze and heart rate. Based on the research presented above I hypothesized that children with ASD would display less affect matching during the distress episode than their typically developing peers. Additionally, I hypothesized that children with ASD would have a different pattern of looking during the distress situation; specifically they would use less eye gaze toward the experimenter than the typically developing children. When examining the heart rate measure, I hypothesized that younger children from both groups would have a faster heart rate than older children. I also hypothesized that children with ASD would have an increase in their heart rate as a result of witnessing the distress event whereas the typically developing children would have a decrease in heart rate during the distress episode. Lastly, I hypothesized that there would be a positive correlation between eye gaze and heart rate for both the ASD and TD groups.

The current body of research on emotion processing provides a foundation for understanding how children with and without ASD identify and respond to emotion in others. This study adds to the research base by providing a unique response method for children to demonstrate their ability to identify emotion in faces. Additionally, this study builds on previous research which explores differences in emotion response in children with ASD. The current study investigates not only observable behavioral responses to distress but also internal physiological response to a distress event. These new ways of examining emotion processing will add depth to our understanding of the emotional lives of children with ASD.

## Method

### Study 1 & 2

**Sample and participant selection.** In order to gain access to a large number of children with and without ASD, I recruited children from classrooms that were self-nominated by teachers. Teachers were recruited through university-level early childhood and special education classes in an urban area of northern California and through personal contacts. I spoke to five university level classes (approximately 125 students) most of whom were teachers. Interested teachers provided information for administrators who were then contacted by me and given information about the study. Ten administrators from childcare centers were contacted, four declined to participate, three did not respond, three agreed to participate. Seven administrators for sites specifically serving children with ASD were contacted, three declined to participate, one did not respond and three agreed to participate.

In order to help the children feel as comfortable as possible during the experimental sessions all of the testing occurred where the children spent their day (childcare center or early childhood special education classroom). Administrators were asked to identify a quiet space away from other children for the testing session (empty classroom, library, speech therapy room, etc.). Experimental set up consisted of a preschool-size table and two child-size chairs, one for the child and one for the experimenter. Study materials were presented to the child on the table one at a time. Video cameras were set up to capture the torso of both the child and the experimenter and the heart rate data which was streaming onto a computer screen. Parents of

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

participating children were told that their child would receive a small toy worth \$2-3 after the experiment. The experimental procedures were submitted and approved by a university institutional review board. All ethical standards for working with individuals from a vulnerable population were met.

Due to the nature of the experimental tasks it was necessary for children to sit for several minutes at a time. Therefore, teachers were asked to selectively send information about the study to parents. Only children who were able to sit for periods of five minutes or longer and did not have severe challenging behaviors that would interfere with their participation were invited to participate in the study. Children who were not able to sit or had severe challenging behaviors were excluded from the study.

**Typically developing children.** Teachers self-nominated their classrooms and provided contact information for their administrators. The three schools that participated were privately run and served children age 2 to 6. Teachers were asked to send home a flyer about the study to all parents of typically developing children (henceforth TD) in their classrooms ages 2 to 6 who did not have an identified disability, significant challenging behaviors, and could sit for a period of five minutes or longer. Parents who were interested in participating spoke to their child's teacher when dropping off or picking up their child from school, or emailed me, indicating their desire to participate. For parents that indicated interest, permission forms including permission to videotape were sent home. Permission forms were received for 40 typically developing children.

**Children with ASD.** Teachers of children with ASD self-nominated their classrooms and provided contact information for their administrators. Two of the participating schools were run by local school districts. The third school was privately run and designed to provide educational therapy for children with special needs. Teachers were asked to send home a flyer about the study to all of the parents of children in their classrooms diagnosed with ASD ages 3 to 7 who did not have significant challenging behaviors and could sit for a period of five minutes or longer. Parents interested in having their child participate in the study spoke to their child's teacher when dropping off or picking up their child from school, or emailed their child's teacher or me indicating their desire to participate. Interested parents were sent permission forms, including a permission to videotape form, in their child's backpack. Permission forms were received for thirty-one children with ASD. One student with ASD was enrolled in a general education classroom where typically developing children were recruited. This student's parent saw the flyer that was sent home with his typically developing sibling and asked if her child with ASD could also participate.

The typically developing children ranged in age from 30 to 70 months; the average age across typically developing participants was 48 months. Participants with ASD were between 38 and 71 months with an average age of 53 months. The age difference between the ASD and TD groups was intentional to allow children to be matched on both language level and chronological age.

**Sample size, power and precision.** The intended sample size was 30 children with ASD and 40 typically developing children. The desired sample allowed for more children who were typically developing in order to match the groups on both chronological age and language level.

The achieved sample for the typically developing children appears representative of the target population in terms of the primary characteristics included in this study. There were an equal number of boys and girls. Additionally, all of the typically developing children tested within the "normal range" on receptive language ability. The achieved sample of children with ASD differed from the target population in the number of boys and girls who participated.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

According to the CDC (Center for Disease Control and Prevention, 2012) there are approximately 5 boys diagnosed with ASD for every 1 girl with the disorder. In my ASD sample there were about 7 boys for every girl. As with the target population the majority of the children with ASD in this sample tested below their age equivalence in terms of their receptive language.

The sample for the current study was designed to be similar in size to the seminal research done by Sigman and Kasari in 1992. Sigman and Kasari's 1992 study documents the first time that the hammer/peg response to distress task was used. They examined 3 groups of subjects: children with Autism, children with intellectual disability and "normal" children. Each group included 30 participants. In the current study I did not include participants with intellectual disability. However, I used a larger group of typically developing children that included younger children so that a clear understanding of the typical trajectory of the development of these skills could be explored and potential differences or developmental delays in the ASD group could be identified.

**Research Design.** This study included both between subject and within subject components. Between subject analyses were conducted to determine differences between children with ASD and TD children in the emotion identification, sorting of emotional faces task (Study 1). Study 2, the response to distress situation, included both between and within subject analyses. Between subject analyses compared the two groups on their responses to witnessing distress including both behavioral responses (affect and eye gaze) and physiological response (heart rate). Within subject analysis examined the effect of witnessing a distress event on affect, eye gaze, and heart rate; data from these measures was compared before, during and after the distress event separately for each group.

**Preliminary Assessment: Receptive Language Measure.** The Peabody Picture Vocabulary Test- Third Edition (PPVT-III) was administered to all children prior to beginning Study 1 in an effort to determine the receptive language of all participants. The PPVT-III uses a simple pointing protocol and black and white pictures to measure receptive language. Standard PPVT-III protocol was followed (Dunn & Dunn, 1997). Due to a lack of variability in the scores of the children with ASD, the raw score was used in analyses rather than an age equivalent or standard score.

**Testing procedure set up and setting.** All testing procedures were videotaped. Two video cameras were used. One was placed so that both the child's and my (researcher's) face and torso were captured. A second video camera documented the HR data that was streaming onto a computer. This allowed me to place a time stamp within the HR data denoting the start of the distress episode after the testing session. To do this, I listened for the distress signal ("ouch!") while watching the HR data and inputted a time marker. Prior to beginning the assessments a heart rate monitor band was placed around the child's chest. Parents identified who they would like to place the HR band on the child, me or the child's teacher. The child was told "This is a bear hug band that you get to wear while you play here. If you leave it on the whole time you are here you get to pick a prize." Three typically developing children and four children with ASD refused to wear the device. Additionally, the device malfunctioned and did not record HR data for two typically developing children and two children with ASD. Therefore HR data was not available for these subjects. The remaining data set included HR data for 26 children from the ASD group and 35 children from the TD group.

All participants were tested at their school or childcare center away from other children. Participants were introduced to me by their teacher and told that they would go play for a little while and then come back to their classroom. The child and I sat on child-size chairs at the

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

corner of a child-size table. This allowed both the child and my face to be captured by the video camera. I completed the language measure with the child and then ran both studies sequentially. The total time of the testing session was approximately 10 to 15 minutes. After the testing session children were offered a small toy as a thank you for their participation. All children were allowed to pick out a toy regardless of whether or not they wore the heart rate band.

### Study 1: Emotion Identification

**Participants.** Thirty-one participants with ASD (mean age = 53 months, SD = 9) and forty TD children (mean age = 48 months, SD = 14) participated in this study. The receptive language level as measured by the PPVT raw score for the ASD group was  $M = 17$ ,  $SD = 18$  and for the TD group was  $M = 49$ ,  $SD = 26$ .

**Stimuli.** Two sets of emotional photos were used. Each set consisted of nine photos of emotional faces, three of each of the following emotions: happy, sad and angry. The photo cards were 3 ½ by 5 inches and were black and white. The laminated cards were portrait style photographs of a person from the shoulders up. The sets were counterbalanced across participants so that half of the children from each group (TD and ASD) received set A with context and half of the children received set B with context. “Context” was a 4” x 6” black and white photograph centered in the lower half of a laminated 8 ½” x 11” white paper. Typed below the picture was a two sentence “story” which was read aloud to the child. For example: *“Madison’s mommy just left, how does Madison feel”* (shown with a girl looking out a window waving, with a sad expression on her face).

**Procedure.** During the emotion recognition task one set of nine photos of emotional faces (three of each emotion: happy, sad and angry) were sorted by the child, an additional three photos served as examples and were sorted by the experimenter to model the procedure. Each participant was shown three small baskets (yellow, blue and red with emotion labels on the front). The child was told: “This basket (pointing to the yellow basket with the “happy” label) is for people who feel happy.” A photo card displaying a person with a happy face was shown to the child and I modeled putting the photo in the yellow basket. Next, the child was told “This basket (pointing to the blue basket with the “sad” label) is for people who feel sad” a photo representing a sad person was shown to the child and placed in the blue basket. Last, the child was told “This basket (pointing to the red basket with the “angry” label) is for people who feel angry” the experimenter modeled putting a photo of an angry person into the red basket. Each participant was then shown each of the nine emotional faces and asked to “put this person where he/she belongs”.

In the case that the child did not respond I repeated the prompt. If the child still did not respond I said “put in” and gestured towards the baskets. All children from both groups placed the pictures in the baskets with two or fewer prompts per picture. After the child placed each photo in a basket I provided non-specific praise by saying “thank you” or “great” before moving on to the next photo. Once the first set of nine photos was sorted the alternate set of nine photos of emotional faces was presented with contextual information. Data were collected regarding correct and incorrect sorting during the task. See Appendix D for the coding sheet. The contextual information provided matched the emotional expression and was visually displayed on an 8 ½ by 11” piece of paper in a plastic sheet protector in a three ring binder. The visual context was a black and white photograph with a two sentence “story” beneath it. For example: *“Today is Taylor’s Birthday Party. How does Taylor feel?”* (shown with a picture of smiling child at a birthday party). The child was asked to sort nine photos, three of each emotion, presented with contextual information into the three color-coded baskets. After placing the card

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

in the basket I provided non-specific praise. A diagram of the set up with corresponding photos (matched from set A and set B); along with the accompanying context can be found in Appendix A.

**Analyses.** Differences between groups (TD/ ASD) on their success in the sorting task were examined through a t-test. Additional analyses were performed to determine if correlations existed between sorting total, ASD status, receptive language level and chronological age. The predictor variables: group status, language level and age were then used to develop a regression model for the outcome measure sorting total.

### Study 2: Emotion Response

**Participants.** Thirty-one participants with ASD (mean age = 53 months, SD = 9) and 40 TD children (mean age = 48 months, SD = 14) participated in this study. The receptive language level of these children as measured by the PPVT raw score for the ASD group was  $M = 17$ ,  $SD = 18$ ; for the TD group  $M = 49$ ,  $SD = 26$ . Due to a video camera malfunction during the testing of one child from the ASD group, affect matching data and eye gaze data was collected on thirty participants with ASD (mean age = 53  $SD = 7$ ; mean PPVT = 17  $SD = 17.991$ ). Affect matching and eye gaze data were collected on all forty children from the TD group. Three typically developing children and four children with ASD refused to wear the heart rate device. Additionally the device malfunctioned and did not record HR data for two typically developing children and two children with ASD. The remaining data set included HR data for 26 children from the ASD group (mean age 53 =  $SD = 9.327$ ; mean PPVT = 20  $SD = 18.379$ ) and 35 children from the TD group (mean age 48 =  $SD = 13.106$ ; mean PPVT = 49  $SD = 24.322$ ). The flow of participants through the study can be found in Figure 1.

**Instruments and materials: Heart rate monitor.** The Polar brand heart rate monitor is embedded in a rubber and elastic chest band and has a sticker of a teddy bear on the front. The HR monitor uses a Polar 91033460 WINDLink to transfer data from the chest strap to a computer in real time. A video camera was aimed at the computer recording the HR data. After the test session I used the video recording to listen for the “distress signal” (“ouch!”). This allowed me to time stamp the beginning of the distress episode within the HR data.

The response to distress task used a hammer/ peg toy. The hammer/ peg toy is commercially available and developmentally appropriate for young children. Additionally, it has been validated for use in measuring response to distress for children with ASD by other researchers (Dawson et al., 2004; Sigman & Kasari, 1992). The toy is made of wood with brightly colored pegs that fit into a wooden board and can be hammered down; the toy can then be flipped over so that they can be hammered again.

**Procedure.** I introduced the child to the hammer toy and asked; “Have you ever seen this toy before?” Then I said “Let me show you how it works” and modeled using the hammer to hit the pegs. Next I handed the hammer to the child and said “your turn”. After the child hammered a few pegs down I said, “May I have a turn?” and took the hammer from the child. After hammering one peg down I placed my finger on top of another peg and “accidentally” hit my finger with the hammer. I made an obvious display of distress saying “ouch, that hurt! I hit my finger.” I looked at my finger with concern and shook my hand while making a clear facial expression of distress for about 10 seconds. Then I said, “It’s okay, it’s all better now” and continued playing with the toy. After a few minutes I told the child that he/ she was all done and could pick a toy before going back to his/ her classroom.

**Coding Behavioral Data.** Behavioral data on affect matching and eye gaze was coded by two trained coders. Coders attended a training session with the principal investigator. The two

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

coders and the PI did practice coding on video that was not a part of the data set (using sections of video that were not used for the analysis) until initial reliability was reached for both measures (80% agreement). Coders were kept blind to ASD status. All videos were randomly assigned a video ID that was in no way related to group status. Next, I will discuss the specific procedures used to code affect and eye gaze as well as the obtained inter-rater agreement for these measures.

**Affect matching.** Coders rated both the experimenter and child on their affect. Coding occurred each second for three 10-second time periods: 10 seconds before the distress signal (when the experimenter hits her finger with the hammer and says “ouch”), 10 seconds during the distress episode (after the distress signal) and 10 seconds following the end of distress signal (“it’s okay I’m all better”). For the remainder of this paper these time segments will be referred to as “before”, “during” and “after”. Facial expression was rated on both the experimenter and the child using the mutually exclusive categories: positive, negative, neutral and uncodable. Once both the experimenter and the child’s affect had been rated the percent of affect “matching” was calculated. See Appendix D for coding sheet for behavioral data (affect and eye gaze). Affect matching was the degree to which both the experimenter and the child displayed the same affect from the three mutually exclusive categories (if either of the participants affect was “uncodable” it was not counted in the total percent correct or incorrect). See Appendix C for coding manual for study two: emotion response (affect matching and eye gaze). The two coders obtained interrater reliability with 80% agreement on affect matching for 31% of the data (22 video segments).

**Eye gaze.** Attention to the distress episode through eye gaze was also measured according to mutually exclusive categories each second for 30 seconds (beginning 10 seconds before the initial distress signal). The categories included: looking at the adult’s face, adult’s hand, child’s own hand, toy, away or uncodable. See Appendix C for eye gaze coding manual. The two coders obtained interrater reliability with 95% agreement on affect matching for 31% of the data (22 video segments).

**Coding Physiological Data: Heart Rate.** The heart rate device provided continuous data throughout the distress situation. Each heart beat was measured and recorded as a factor of the total beats per minute. A video camera captured the HR data as well as the audio of the experimental testing session. After the testing session I used the audio from the video to place a time stamp marker within the heart rate data after hearing the distress signal “ouch, that hurt!”. To analyze the data the distress event was broken into three 10-second intervals: 0-10s “before” the distress event, 10-20s “during” the display of distress and 20-30s “after” the distress event. HR was averaged for the 10 seconds in each of these intervals.

**Analyses.** Preliminary analyses examined how heart rate is covaried with chronological age. Next, differences between groups were analyzed in terms of affect matching and eye gaze. Between group analyses (Pearson’s correlation, t-test, regression analysis and ANOVA) examined chronological age, receptive language and the interaction between group status and receptive language ability on affect matching and eye gaze. Within group analyses explored how children from each group responded in terms of eye gaze and heart rate before, during and after the distress situation.

## Results

### Study 1 & 2

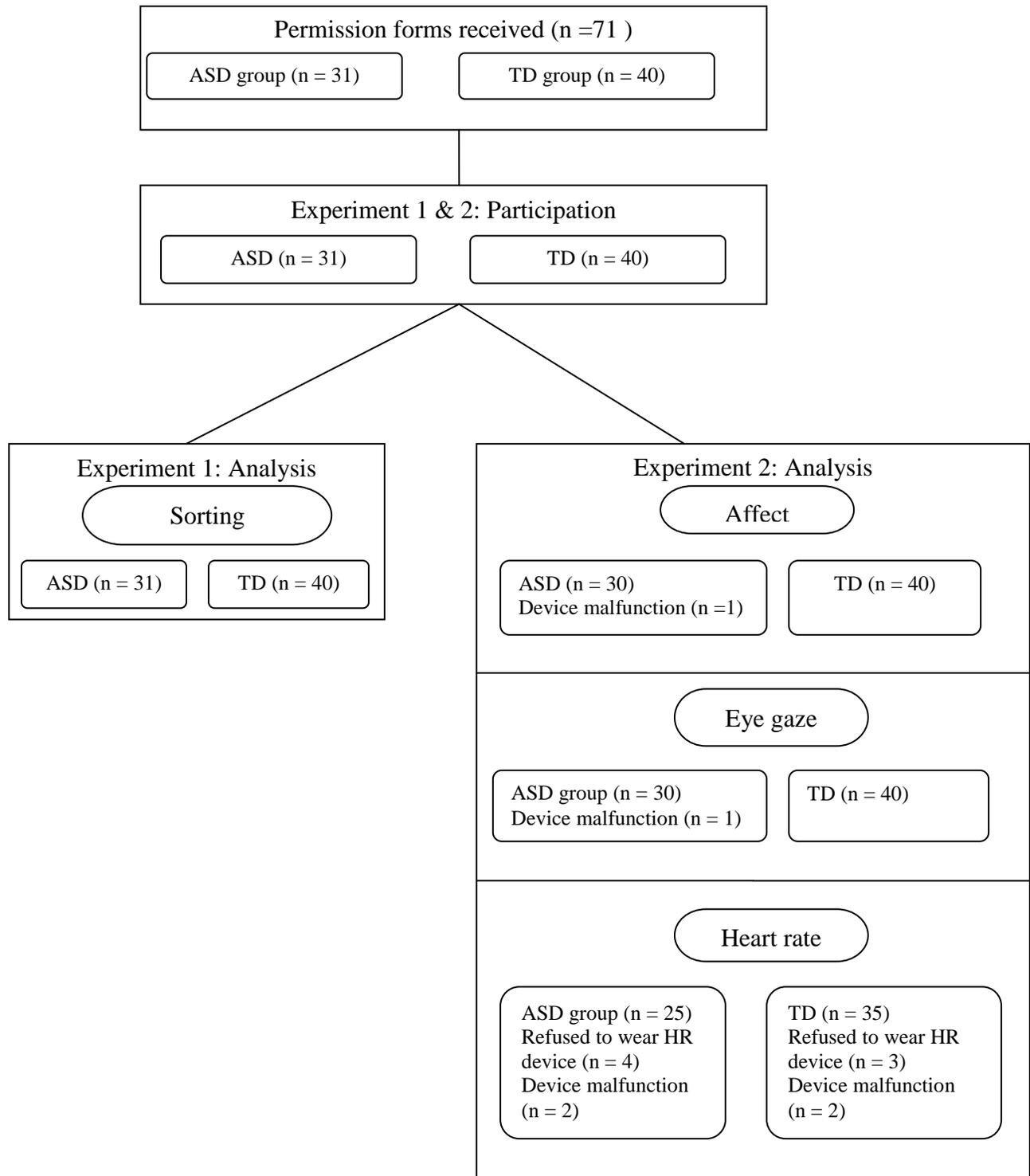
**Recruitment.** Primary sources for potential subjects came from early childhood teachers. Teachers sent home recruitment flyers to all students in their class, with the exception of those

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

who did not meet the behavioral criteria mentioned above. Recruitment occurred October 2011 through June 2012. Twenty-nine participants with ASD were recruited from public school settings and two came from private schools. Of the typically developing children all of the 41 children who participated were recruited from private school settings. This difference occurred because children with ASD are offered early childhood education programs through their local school district, whereas this option is not available to typically developing children. Figure 1 shows the participant flow through each stage of the study.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

Figure 1  
Flow of Participants through study 1 & 2



**Missing data.** The participant flow chart provides a visual display of how participants moved through the study and includes information about missing data resulting from participant non-compliance with the experimental procedures and device malfunctions. No data were lost in Study 1. In Study 2 data for affect matching and eye gaze were lost for one participant due to video device malfunction. These data are missing completely at random. Additionally, two children from the typical group and two children from the ASD group had device malfunction for the heart rate monitor; these data are also missing completely at random.

Three children from the typical group and four children with ASD are missing heart rate data due to their refusal to wear the device. It is likely that these missing data are not completely random but rather result from unique participant characteristics. For the ASD group missing data may be an effect of the severity of ASD, discomfort with the testing session, the experimenter or some other factors. The typical developing children who refused to wear the heart rate monitor may also have felt uncomfortable with the testing session, the experimenter or some other factors. We cannot assume that the children who did participate are completely representative of the initial subject group that was recruited. It is possible that the remaining sample included children with less severe cases of ASD, and/ or typical children and children with ASD who were more comfortable with unusual situations and unfamiliar adults.

**Sex differences by group.** The ASD group included 27 male and 4 female participants. The TD group was composed of 20 males and 21 females. Independent t-tests were carried out on the TD group to determine if there were differences between males and females in scores on the PPVT, sorting total, affect matching, eye gaze, or heart rate that might influence the findings. The test revealed that there was no statistically significant difference between males and females for sorting total  $t(38) = -.5, p > .05$ , affect matching  $t(38) = .408, p > .05$ , eye gaze  $t(38) = .386, p > .05$  or heart rate.  $t(38) = .623, p > .05$  However, the test revealed that there was a statistically significant difference between males and females  $t(38) = -2.138, p < .05$  in receptive language scores as measured by the PPVT. The mean PPVT of males ( $M = 41.05, SD = 20.626$ ) was lower than the mean PPVT of females ( $M = 57.75, SD = 28.185$ ). The effect size,  $d$ , was computed to be 0.68, which is a medium effect size.

### **Study 1: Emotion Identification**

**Preliminary Analysis.** To determine if context influenced total correct in the sorting task an Independent samples t-test was carried out between the ASD and TD groups on number correct when sorting with context, minus the number correct when sorting without context. The test revealed that there was no statistically significant difference between the ASD and TD group  $t(71) = .0288, p > .05$ . Therefore the remaining analyses for the sorting task use a collapsed variable called sorting total. Sorting total is the number of emotional faces that were correctly sorted both with and without context.

**Statistics and Data Analyses.** Pearson's correlations were computed for ASD status, receptive language level, chronological age and emotion identification (sorting task). The tests revealed that there was a highly statistically significant correlation between sorting total and group status  $r(71) = .566, p < .001$ . Results also indicated a statistically significant correlation between sorting total and age  $r(71) = .23, p < .05$ . The correlation between sorting total and language  $r(71) = .75, p < .001$  was also highly statistically significant. Lastly, there was a highly statistically significant correlation between sorting total and group x language  $r(71) = .511, p < .001$  (see Table 1).

Table 1 Correlations between emotion identification and independent variables.

	Sorting Total	Group	Age (months)
Group	.566 **		
Age (months)	.230 *		
Language (PPVT raw score- centered)	.750 **	.581 **	.477 **
Interaction (Group*Language)	.511 **		

\*Significant at the .05 level

\*\* Significant at the .001 level

To further investigate group differences an independent samples t-test was carried out between the ASD and TD groups on the emotion identification sorting task. The test revealed that there was a highly statistically significant difference between the ASD and TD groups  $t(71) = 5.2131, p < .001$ . The mean emotion identification score of ASD ( $M = 9.32, SD = 4.25$ ) was lower than the mean emotion identification score of TD ( $M = 14.50, SD = 4.01$ ). The effect size,  $d$ , was computed to be 1.25, which is a large effect size.

A multiple regression was conducted to determine what factors influenced success with the sorting task. The regression included the following predictor variables: ASD status (group), age, language, and group x language, with sorting total as the outcome variable. The model produced an R square of .637, which was statistically significant,  $[F(4,0) = 28.930, p = 0.001]$ . Group, age, language, and the interaction between group and language can account for 63.7% of the variance in total score of the sorting task. While group ( $B = 1.357, t = 1.085, p = .282$ ) and age ( $B = -.030, t = -.629, p = .532$ ) were not statistically significant they were left in the model due to their influence on the remaining variables. Language was positively related to sorting total ( $B = .184, t = 5.760, p = .001$ ) with higher language leading to increased success in the task. Group x language was negatively related to sorting total, with the children with ASD being group 0 and the typically developing children being group 1 ( $B = -.115, t = -2.906, p = .005$ ). This means that the children with ASD with lower language did worse on the task than typically developing children with lower language.

### Study 2: Emotion Response

**Affect Matching.** An independent t-test was carried out between ASD and TD on the degree of affect matching during the distress situation. The test revealed that there was no statistically significant difference between ASD and TD  $t(68) = .9933, p > .05$ .

Pearson's correlations were computed for ASD status, receptive language level, chronological age and affect matching. The test revealed that there was no significant correlation between any of the independent variables and affect matching. Group status  $r(70) = .120, p = .324$ ; age  $r(70) = .101, p = .407$  and language  $r(70) = .181, p = .133$ .

A multiple regression was conducted to determine what may influence affect matching. The regression included the following predictor variables: Group, Language, Age, and Group times Language Interaction, with Affect matching as the outcome variable. The model produced an R square of .035, which was not statistically significant,  $[F(4,0) = .588, p > .05]$ .

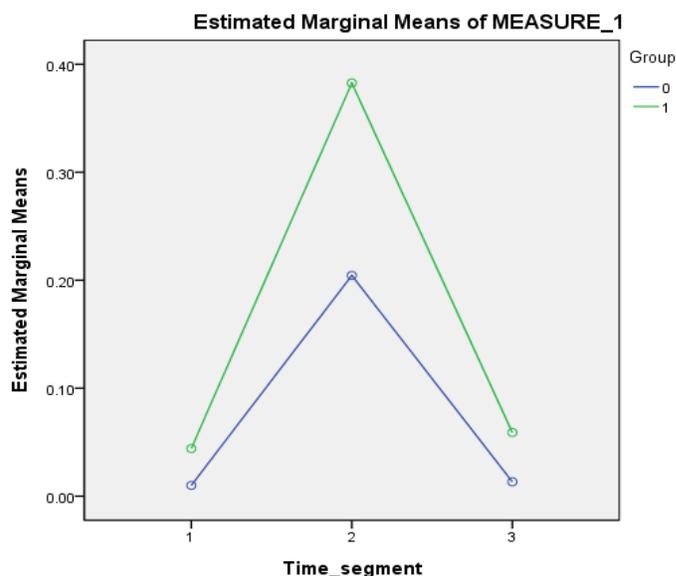
**Eye Gaze.** An independent sample t-test showed that the difference in percent of time looking at the face of the person in distress in the ASD group ( $N = 31 M = .20444, SD = .19273$ ) and TD group ( $N = 40 M = .37409, SD = .20774$ ) was statistically significant,  $t(68) = 3.4864, p = 0.0009$ . In order to more fully understand this phenomenon an additional t-test was done to determine if a difference existed in the pattern of looking "before" the distress and "during" the distress in both groups. The t-test showed that the difference in eye gaze (during-before) in the ASD

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

group ( $N = 31$ ,  $M = .1944$ ,  $SD = .19120$ ) and the TD group ( $N = 40$ ,  $M = .3350$ ,  $SD = .21528$ ) was statistically significant,  $t(68) = -2.834$ ,  $p = .006$ .

To examine differences between the TD group and the ASD group a factorial analysis of variance (ANOVA) was run on time segment (before, during and after witnessing the distress). Mauchly's test statistic was significant  $p < .05$ , therefore sphericity cannot be assumed. The epsilon value was .77 so the Huynh-Feldt correction was used. There was a statistically significant main effect of time segment  $F(1.554, 104.092) = 98.113$ ,  $p < .001$ . There was also a statistically significant interaction between time segment and group  $F(1.554, 104.092) = 6.867$ ,  $p < .005$  showing that children with ASD increased their amount of looking less than typically developing children during the distress situation. Between subjects analysis revealed that there was a statistically significant main effect of group for looking in the distress task,  $F(1, 67) = 14.226$ ,  $p < .001$ . Figure 2 shows the amount of looking before, during and after the distress for each group.

Figure 2. Time spent looking at the experimenter before, during and after distress for ASD and TD groups



**Heart Rate.** First, a correlation analysis was run to confirm the relationship between heart rate and chronological age. Age ( $M = 48$ ,  $SD = 14$ ) and HR ( $M = 97.31$ ,  $SD = 13.65$ ) were strongly and significantly correlated,  $r(70) = -.504$ ,  $p < .001$ . Additionally, between subjects analysis revealed that there was a statistically significant main effect of age during the distress task,  $F(1, 58) = 17.504$ ,  $p < .001$ . Therefore chronological age was covaried in the remaining analyses.

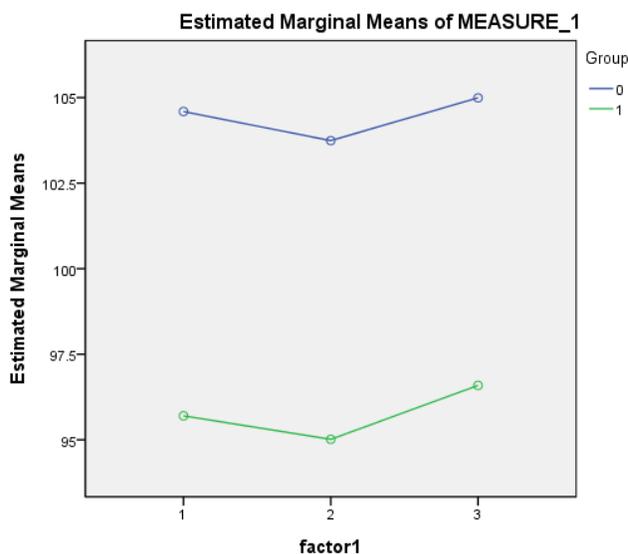
Next a repeated measures ANOVA procedure was used to determine if HR changed for a typically developing child as a result of witnessing an episode of distress. Mauchly's test was not significant ( $p > .05$ ) so we conclude that the assumption of sphericity has been met. A one-way repeated measures ANOVA was carried out to determine whether witnessing a distress situation had an effect on heart rate. Heart rate and chronological age were co-varied to control for age related effects. There was no statistically significant main effect of time segment,  $F(2,68) =$

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

.894,  $p > .05$ . The mean heart rate for TD children before the distress episode was 96.78 0-150 (SD = 13.649). The mean heart rate for TD children during the distress episode was 96.19 0-150 (SD = 15.037).

To examine differences between the TD group and the ASD group a factorial analysis of variance (ANOVA) was run on time segment (before, during and after witnessing the distress). Mauchly's test was not significant ( $p > .05$ ) so we conclude that the assumption of sphericity has been met. There was a statistically significant main effect of group,  $F(1, 58) = 7.348$ ,  $p < .01$ . There was not a statistically significant main effect of time segment (witnessing the distress),  $F(1, 58) = .038$ ,  $p > .05$ . There was no statistically significant interaction between time segment and group,  $F(1, 58) = .003$ ,  $p > .05$ . Figure 3 displays these results.

Figure 3. Heart rate before, during and after witnessing distress: ASD and TD groups



Covariates appearing in the model are evaluated at the following values: Age months = 50.16

**Interaction Between Heart Rate and Eye Gaze.** Pearson's correlations were carried out on heart rate and eye gaze for both groups. A Pearson correlation was carried out on heart rate and eye gaze for the typically developing children. The test revealed that there was a statistically significant correlation between heart rate and eye gaze  $r(36) = -.376$ ,  $p < .05$  for this group. Therefore, for typically developing children a lower heart rate is associated with increased eye gaze. In the ASD group the test revealed that there was no statistically significant correlation between heart rate and eye gaze  $r(24) = .206$ ,  $p > .05$ . Therefore, for children with ASD there does not appear to be an association between heart rate and eye gaze.

### Discussion

The emotional lives of young children with ASD are not well understood. Much of the previous research on how individuals with ASD discern emotion has focused on older individuals on the higher end of the autism spectrum. While research on children classified with Asperger's Syndrome or high functioning autism helps us begin to identify the difficulties that all children with ASD might share in emotion processing, it is unclear if these processes are similar for children who have less language. This study used alternate response mechanisms in order to assess young children with and without ASD who have less language. By examining behavioral and physiological responses there was no need for expressive language. This may lead to a better understanding of the sources of difficulty in emotion processing for young children with ASD.

The purpose of this study was to broaden our understanding of how young children with ASD identify and respond to the emotions of others. The goals of this research were twofold. First, I sought to explore underlying differences in children with and without ASD in terms of their ability to identify emotion in faces. Second, I investigated differences in how these two groups respond to an emotion of distress, through both behavioral and physiological responses. Here I will interpret the results of these experiments and discuss how these findings fit within the current research base. Then I will examine some of the potential bias and limitations of the current study. Lastly, I will consider the implications of these findings.

#### **Study 1: Emotion Identification - Sorting Task**

In Study 1 I sought to explore the differences in how children with and without ASD identify emotion in pictures. I hypothesized that the typically developing children would score higher on this task than the children with ASD. Secondly, I hypothesized that the addition of contextual information would lead to a higher score for the typically developing children and a lower score for the children with ASD.

The first hypothesis was confirmed. I found that there were differences between children with and without ASD in their ability to sort emotional faces. Children with ASD were significantly less likely to correctly sort the emotional faces than the typically developing children. This is consistent with previous reports that children with ASD have difficulty quickly identifying emotion in faces (Clark, Winkielman, & McIntosh, 2008).

The emotion identification task was designed as a sorting procedure to reduce the cognitive load and language skills necessary for success. However, the results demonstrate that the difference in success rate was largely influenced by receptive language ability. The emotion identification procedure used here required less language than previous studies, which asked participants to verbally identify emotions. However, the ability to receptively understand emotion labels was still necessary for success in the task. If possible it would be valuable to further reduce the need for language since a difficulty with language is fundamental to a diagnosis of ASD. By making the task non-linguistically mediated we could determine if in fact children with ASD are able to identify representations of emotion without the impediment of one of the core components of their disability. This would provide insight about whether the difference in emotion understanding for children with ASD is itself an underpinning of the disorder, or simply a byproduct of less sophisticated communication skills.

A new finding from the emotion identification task was a language by group interaction. This interaction effect suggests that language functions differently in this task for children with and without ASD. The results suggest that there was a negative relationship between language ability and success on the emotion sorting task for children with ASD but not for children who

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

were typically developing. This means that children from the ASD group with low language did worse than children from TD group with low language. This suggests that for children with ASD success on the task was dependent on language whereas for the TD group it was not.

This finding can be interpreted multiple ways. As mentioned earlier, typically developing children have a plethora of experience with emotion concepts, and begin to recognize simple emotions in others as early as infancy. Perhaps the typically developing children have enough experiential emotion knowledge that they can successfully complete the task without language. It is feasible that they have developed an understanding of emotion concepts that while initially mediated by language no longer requires language for understanding. Research suggests children with ASD often have fewer experiences with emotions, due to inattention to child directed speech as well as a lack of social orienting and joint attention (Dawson, 2004; Mundy & Neil, 2001; Paul et al., 2007; Watson et al., 2012). This lack of a foundational understanding of emotion concepts might make them more reliant on language for success in this task. Alternatively, it is possible that typically developing children have a prereflexive understanding of emotion giving them the ability to identify emotion entirely without the use of language. Children with ASD lack this prereflexive understanding (Gallese, 2006; Iacoboni, 2008) and perhaps need to rely on language in order to overcome this impairment. Further research would need to be done to determine if experience or an underlying non-verbal understanding leads to differences in emotion identification between children with and without ASD. A longitudinal study documenting the development of emotion concepts over time as well as the emotional experiences of typically developing young children might help to shed light on these concepts.

Secondary analysis was performed to determine the effect of context on children's rate of success in the sorting task. Based on previous findings that children with ASD are less able to extract emotion from context (Da Fonseca, et al., 2009) and on work done by Frith (2003) on weak central coherence, I hypothesized that context would aid the typically developing children and hinder the success of the children with ASD. Results showed no effect of context on success in the sorting task for either group. There are several factors that may have influenced this finding. It is possible that the type of context did not provide enough information or the right kind of information to affect children's ability to identify the emotions. It is equally possible that the brevity of the contextual information that was presented did not provide an adequate amount of information to help the typically developing children or provide enough competing information to hinder the children with ASD. Additionally, a ceiling effect may have contributed to the lack of variability in scores with and without context for the typically developing children. The majority of the typically developing children successfully sorted almost all of the emotional pictures both with and without context. A large portion of children with ASD were at or near chance levels for the task both with and without context. Therefore, a basal effect may have made it less likely for the context to influence the correct response in the children with ASD. Understanding of the influences of context on emotion identification could be further developed by research that addresses these issues. Perhaps providing more in depth contextual information, as well as including more emotions such as surprise or disgust would lend to greater variability in this measure.

The emotion identification task utilized a sorting technique that may have been more familiar to some children than others. While there is no reason to believe that one group would have more exposure to sorting tasks than the other, it is a possibility. Children who had practice using a sorting procedure may have been more capable of correctly sorting the emotions than those who were less familiar with this type of task.

**Study 2: Response to Distress- Hammer/ Peg**

In the second study I was interested in differences in how children with and without ASD responded to the distress of another. Several outcome measures were explored including affect matching, eye gaze and heart rate. I hypothesized that children with ASD would have less affect matching than their typically developing peers during the distress episode. I expected that the typically developing children would match the negative affect of the experimenter during the distress situation, whereas children with ASD would not. Similar to previous research I also hypothesized that children with ASD would direct less eye gaze to the experimenter while witnessing the distress. In terms of the physiological response I hypothesized that the typically developing children would have a decrease in their heart rate as a result of witnessing the distress, whereas the children with ASD would have an increase in heart rate during the distress episode. Additionally, I hypothesized that there would be a negative association between eye gaze and heart rate, with higher eye gaze leading to a lower heart rate for both the typically developing children and the children with ASD.

**Affect matching.** Counter to my hypothesis there were no significant differences in the amount of affect matching during the distress situation between the children with and without ASD. Secondary analysis revealed no differences in affect matching as a result of language or chronological age. One potential limitation for the interpretation of these findings is in the task itself. The familiarity of the toy may have led to differences between children's responses, with those less familiar with the toy attending more to it than the experimenter or responding differently when the experimenter appeared to get hurt by the object. This extraneous variable may have been more of a driver in affect matching than whether or not the child had an ASD diagnosis.

Of additional concern is the artificial nature of the response to the distress task. In order to reduce extraneous variables the task was conducted in a controlled manner for all participants. While this allowed for analysis between participants, it is likely that the situation appeared unusual to the children who were asked to leave their familiar classroom and accompany a stranger to a different area of the school. They then played strange games and watched as the stranger appeared to hurt herself. The very nature of the testing situation brings into question the ecological validity of the task and may have led children to respond to the perceived distress in different ways. Had they observed a familiar person hurt themselves in a more everyday situation it is likely that their response to the distress would be different. However, research has shown that even when responding to the distress of a familiar adult, such as a parent, children with ASD do show differences in their behavioral responses (Dawson et al. 1990; McDonald, & Messinger, 2012).

The inability to reject the null hypothesis that these two groups had the same degree of affect matching while witnessing a distress event is an interesting finding that can be rationalized in a few different ways. First, if in fact this measure effectively tested the construct "affect matching", the results find that there are no differences between children with and without ASD. Both groups showed a similar level of "affect matching" during the distress episode. This would suggest that children with ASD show no impairment in emotional contagion as evidenced by their taking on and expressing others' emotions to the same degree as children who are typically developing. This finding is in agreement with researchers who have not found evidence for a mirror neuron dysfunction in children with ASD (Dinstein, et al., 2010). Interpreted in this way, these results suggest that the two groups experience emotional contagion in similar ways.

Alternatively, it is possible that the measure of affect matching did not adequately measure the intended construct. In order to assess affect matching both the experimenter and the child's affect were rated in mutually exclusive categories: positive, negative and neutral; and then categorized as matching or not matching. Visual inspection of the data showed that most of the typically developing children did not display high affect matching during the distress situation. Therefore, this measure failed to replicate findings that typically developing children reliably mirror another's emotion. It is possible that the affect categories (positive, negative, neutral) did not capture the nuances of emotion to the extent that a true matching effect could be observed. Additional research could elucidate these issues through thorough microanalysis of facial expression using methodologies such as the Facial Action Coding System (FACS) developed by Ekman and Friesen in 1977 (for more information refer to Ekman, Friesen, & Hager, 2002). Utilizing a more fine tuned approach to rate the emotional facial expressions of the participant and the experimenter would allow a scale to be developed representing the degree of affect matching. This would allow for deeper interpretation than the dichotomous variable used in this study. If in fact there was still no difference between the two groups, it would appear that children with ASD experience emotional contagion to the same degree as children who are typically developing. If, on the other hand, a more fine tuned analysis revealed differences between the two groups it would lend behavioral support to the theory of mirror neuron dysfunction in children with ASD.

**Eye gaze.** Similar to other study findings (Dawson et al., 1990; Dawson et al. 2004; Scrambler et al. 2007; Sigman & Kasari, 1992), there were differences between groups in the total amount of eye gaze towards the experimenter during the distress situation. In the current study typically developing children looked at the face of the experimenter twice as much as children with ASD "during" the distress situation. This supports the contention that children with ASD may be at a further disadvantage in learning about emotion concepts due to a lack of attention to emotion as it occurs in their daily life. Additionally, there was an interaction between time segment and group. While both groups of children looked more "during" the distress situation, as compared to "before" and "after", the slope between time segments representing the degree of looking was significantly higher for the typically developing children than the children with ASD.

Both typically developing children and children with ASD paid little attention to the experimenter's face before the distress event. At the onset of the event both groups increased their attention to the experimenter's face. The typically developing children, however, maintained their interest in the experimenter's face, whereas the children with ASD looked briefly and then redirected their gaze, most often towards the toy or away. This difference in the pattern of looking response to distress may further justify behavioral differences of care and concern between the two groups. Further analysis might provide additional information about these differences. Future research would benefit from the use of hierarchical linear modeling to determine if there is a delay in the looking pattern for children with ASD or if their attention shifts to the person in distress at the same time as typically developing children. Additionally, this would provide information about eye gaze patterns for typically developing children. For example perhaps typically developing children look away for a short time and then look back, whereas the children with ASD look away and do not look back. One potential limitation in interpreting these findings is the preference in children with ASD for repetitive stereotypical movements, such as banging. Because of this feature of the disorder the toy may have been more appealing to the children with ASD than the typically developing children. This might have led

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

the children with ASD to continue focusing on the object rather than the experimenter even during the distress episode.

**Heart rate.** Similar to other research (Porges et al., 1994) I did find age related effects for heart rate for typically developing children, with younger children having a higher heart rate than older children. Therefore, age was covaried with heart rate for the remaining analyses. There were no statistically significant within subject differences in HR for either group as a factor of time. However, there were between group differences. The children with ASD had a significantly higher heart rate overall than the typically developing children.

Previous research suggests that the higher heart rate of typically developing younger children is generally accounted for by their smaller body size (Porges et al, 1994). While I did find an age related effect in my sample with younger children having higher heart rate, I also found that the children with ASD, when controlling for age, had higher heart rates than the typically developing children throughout the experimental session. This raises the possibility that there is a potential developmental delay that is associated with the physiological response of heart rate for children with ASD. Alternatively, and perhaps more likely, is the possibility that children with ASD have higher levels of arousal at all times as compared to their same age peers. Studies have shown that heart rate appears to be mediated more by the parasympathetic system than the sympathetic system (Richards & Casey, 1991). Perhaps there is some difference in the functioning of the parasympathetic system for children with ASD that influences their level of arousal as evidenced by their unusually high heart rate. These findings suggest that children with ASD appear to lack the ability to modulate their levels of arousal in the same way that typically developing children do. Further research should examine other physiological measures of arousal such as respiratory sinus arrhythmia (henceforth RSA) and electrodermal arousal (henceforth EDA). RSA reflects the influence of the vagus nerve in regulating heart rate. This measure would provide deeper insight into the functioning of the parasympathetic system when witnessing emotional events. EDA is also an important physiological measure to explore within this population. EDA provides a measure of the sympathetic response system by assessing skin conductance. Examining these two variables in concert could provide a more complete picture of the physiological functioning of children with ASD when witnessing an emotional event.

Previous research has found that for typically developing children heart rate should decrease with increased attention and focus on another (Richards & Cronise, 2000). While I did not find this to be the case in the current study there are some potential explanations for this discrepancy. Due to malfunction of the HR device as well as refusal to participate by a few children the sample size for both groups was reduced for this measure. It is possible that a larger sample would lead to more power to detect the differences in HR when witnessing the distress event. It is equally likely that the apparent distress exhibited by the experimenter did not appear severe enough or last long enough to change the physiological response of HR. Again, hierarchical linear modeling would provide a more complete picture of these results by allowing us to see the pattern in the responses of the two groups. Using hierarchical linear modeling I could determine if there were HR differences between groups at the onset of the distress event, if there was a difference or delay in HR across time segments as a result of age or group status, and if the HR returned to pre-distress level at the same rate for both groups.

**Interaction between Heart Rate and Eye Gaze.** Research shows that a lowered heart rate is correlated with increased attention (Watson et al., 2012). In the current study I found that heart rate was correlated with eye gaze for the typically developing children. An increase in eye gaze during the distress event was correlated with a lowered heart rate. However, for the children

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

with ASD heart rate and eye gaze were not correlated. These findings could be interpreted two ways. Since children with ASD with a lower heart rate were not found to have an increase in eye gaze it is possible that for these children heart rate is not a measure of attention. Alternatively, it is possible that eye gaze is not in fact a measure of attention for children with ASD. Perhaps these children are actually attending to the event, as suggested by their lowered heart rate but they do not have the behavioral correlate of eye gaze. Further research should examine other physiological markers of attention, like RSA and EDA, to determine if in fact children with ASD are attending to emotional stimuli without using eye gaze.

### **Limitations**

The sample of the current study limits the generalizability of my findings. Similar to other studies on special populations the small number of participants involved restricts the ability to generalize these findings. Additionally, the two groups of children came from different educational placements and, therefore, may have different characteristics. The typically developing children were drawn from private community childcare centers whereas the children with ASD were recruited from public schools. The difference in the educational settings for the two groups is a direct result of ASD status but as a consequence there may be other differences between the groups such as social economic status and maternal or paternal levels of education. Additionally, these different settings may focus on teaching emotion constructs to varying degrees and in different ways. It is possible that due to their educational placement in special day classes, the educational programs of the children with ASD focus more on academic skills; whereas the curriculum in the community childcare programs focus more on social emotional competence.

Complications of completing the studies within different school settings could also have influenced the results. While ideally the setup would have been exactly the same for each participant there were slight environmental differences in terms of where the study took place and the furniture that was provided. It is likely that some of the children were more familiar with the experimental testing room than others. For example, at one community childcare center the director placed me in the library to complete the testing procedures, in another childcare center I was directed to set up and complete the study in a conference room. It is likely that the children who were tested in the library were more familiar with the environment and therefore may have responded more naturally to the tasks than the children who were in the conference room for the first time. It is also possible that some of the children were more accustomed to being asked to go with unfamiliar adults to do unfamiliar things than others. Most of the children in the ASD group saw several different therapists throughout the day and were likely led to different areas of their school for speech services or adaptive physical education. On the other hand, most of the typically developing children stay with their primary teachers throughout the day and may have found it more unusual to be asked to leave with an unfamiliar adult. These differences in expectations may have led to different responses of the children.

### **Implications**

This study explored the issues of emotion understanding and response in young children with and without ASD. Current findings surrounding the difficulties in emotion identification for children with ASD supports previous research. Even when less language was required for emotion identification, children with ASD performed worse than their typical counterparts. Additionally, the present study expanded upon the current knowledge base by providing information about the behavioral measures of affect matching and eye gaze as well as the physiological response of heart rate as outcomes to a distress event. While there was no

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

significant difference in affect matching between the two groups, in terms of eye gaze, children with ASD did respond differently. While the typically developing children frequently looked at my face during the distress event, the children with ASD were more likely to look at the toy or away from the situation all together. Children with ASD also had a higher heart rate throughout the testing session, suggesting an increased level of arousal. Additionally, there was a correlation between eye gaze and change in heart rate during the distress situation for the typically developing children, but not the children with ASD.

This study sheds light on a few potential reasons for the differences in the behavioral response to emotion for children with ASD, including a difference in the ability to identify emotion in faces and reduced attention to the face of someone in distress. Equally important, however, are findings that commonalities in emotion processing for children with and without ASD exist. Children with ASD appear to show similar levels of affect matching as a result of witnessing distress. Additionally, children with and without ASD appear to have a similar pattern of HR response when observing a distress event. These findings help to elucidate where the breakdown is occurring for children with ASD. The results of this study suggest that there is not a disruption in the emotional contagion response and that at least in part the internal mechanisms that mediate emotional responding are similar to those for typically developing children.

One potentially important finding is that children with ASD had a higher heart rate throughout the testing session when compared to their typically developing peers. Further research is needed to determine if this quickened heart rate might be in part responsible for the increased levels of arousal often characteristic of children with ASD. If in fact these children are experiencing increased physiological stress it would follow that their behavioral responses to emotional events would likely be different than those of their typically developing peers.

As children with ASD often lack the language necessary to describe their internal states, future research should continue to connect behavioral and physiological measures of emotion response. Research focused on additional physiological measures such as EDA and RSA would provide much needed insight into the emotion processing of children with ASD. Additionally, it remains unclear if children with ASD can identify emotion in faces when the response mode is not language driven. Future research might concentrate on further reducing the need for language in an emotion identification task to determine if, without the impediment of a language response, children with ASD can in fact recognize basic emotions. The current study helps to clarify why children with ASD may respond differently to emotion than their typically developing peers. This line of research is critical, not only for understanding the nature of children with ASD, but also for providing an emotional bridge between children with ASD and their typically developing peers, and the acumen to create instructional activities that might entice them across.

## References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC.
- Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review Of General Psychology, 10*(3), 229-240. doi:10.1037/1089-2680.10.3.229
- Bacon, A., Fein, D., Morris, R., Waterhouse, L., & Allen, D. (1998). The Responses of Autistic Children to the Distress of Others. *Journal of Autism & Developmental Disorders, 28*(2), 129-142.
- Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a 'theory of mind'?. *Cognition, 21*(1), 37-46.
- Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1*(3), 276-298. doi:10.1037/1528-3542.1.3.276
- Capps, L., Yirmiya, N., & Sigman, M. (1992). Understanding of Simple and Complex Emotions in Non-retarded Children with Autism. *Journal Of Child Psychology & Psychiatry & Allied Disciplines, 33*(7), 1169-1182. doi:10.1111/1469-7610.ep11425387
- Carpenter, M., & Nagell, K. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs Of The Society For Research In Child Development, 63*(4), 1-143.
- Carpenter, M. & Tomasello, M. (2000). Joint attention, cultural learning, and language acquisition: Implications for autism. In A. Wetherby & B. Prizantz (Eds.), *Autistic Spectrum Disorders: A Transactional Developmental Perspective*. Brookes.
- Center for Disease Control and Prevention. (2012). Retrieved March 21, 2013, from <http://www.cdc.gov/ncbddd/autism/data.html>.
- Clark, T. F., Winkielman, P., & McIntosh, D. N. (2008). Autism and the extraction of emotion from briefly presented facial expressions: Stumbling at the first step of empathy. *Emotion, 8*(6), 803-809. doi:10.1037/a0014124
- Cole, P. M., Dennis, T. A., Smith-Simon, K. E., & Cohen, L. H. (2009). Preschoolers' Emotion Regulation Strategy Understanding: Relations with Emotion Socialization and Child Self-regulation. *Social Development, 18*(2), 324-352. doi:10.1111/j.1467-9507.2008.00503.x
- Croen, L. A., Grether, J. K., Hoogstrate, J., & Selvin, S. (2002). The changing prevalence of autism in California. *Journal Of Autism And Developmental Disorders, 32*(3), 207-215. doi:10.1023/A:1015453830880
- Da Fonseca, D., Santos, A., Bastard-Rosset, D., Rondan, C., Poinso, F., & Deruelle, C. (2009). Can Children with Autistic Spectrum Disorders Extract Emotions out of Contextual Cues?. *Research In Autism Spectrum Disorders, 3*(1), 50-56.
- Dapretto, L., Davies, M., Pfeifer, J., Scott, A., Sigman, M., Bookheimer, S. & Iacoboni, M. (2006). Understanding emotions in others: Mirror neuron dysfunction in children with autism spectrum disorders. *Nature Neuroscience, 9*, 28-30.
- Dawson, G., Hill, D., Spencer, A., Galpert, L., & Watson, L. (1990). Affective exchanges between young autistic children and their mothers. *Journal of Abnormal Child Psychology, 18*, 335-345.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

- Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early Social Attention Impairments in Autism: Social Orienting, Joint Attention, and Attention to Distress. *Developmental Psychology, 40*(2), 271-283. doi:10.1037/0012-1649.40.2.271
- Denham, S. A., & And, O. (1990). Emotional and Behavioral Predictors of Preschool Peer Ratings. *Child Development, 61*(4), 1145-52.
- Denham, S. A., Blair, K. A., DeMulder, E. E., Levitas, J. J., Sawyer, K. K., Auerbach-Major, S. S., & Queenan, P. P. (2003). Preschool Emotional Competence: Pathway to Social Competence?. *Child Development, 74*(1), 238-256.
- Dinstein, I., Thomas, C., Humphreys, K., Minshew, N., Behrmann, M., & Heeger, D. J. (2010). Normal Movement Selectivity in Autism. *Neuron, 66*(3), 461-469.
- Dunn, L. M. & Dunn L. M. (1997). Peabody Picture Vocabulary Test- Third Edition (PPVT-III). San Antonio, TX: Pearson.
- Dziobek, I., Rogers, K., Fleck, S., Bahnemann, M., Heekeren, H. R., Wolf, O. T., & Convit, A. (2008). Dissociation of Cognitive and Emotional Empathy in Adults with Asperger Syndrome Using the Multifaceted Empathy Test (MET). *Journal Of Autism And Developmental Disorders, 38*(3), 464-473.
- Ekman, P., Friesen, W. V., & Hager, J. C. (2002). Facial action coding system. *A Human Face*.
- Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic Nervous System Activity Distinguishes Among Emotions. *Science, 221*(4616), 1208-1210.
- Frith, U. (2003). *Autism: Explaining the Enigma*. (2<sup>nd</sup> Revised Edition) Oxford: Blackwell Publisher.
- Gallese, V. (2006). Intentional attunement: A neurophysiological perspective on social cognition and its disruption in autism. *Brain Research, 1079*(1), 15-24. doi:10.1016/j.brainres.2006.01.054
- Hoffman, M. L. (1975). Developmental synthesis of affect and cognition and its implications for altruistic motivation. *Developmental Psychology, 11*(5), 607-622. doi:10.1037/0012-1649.11.5.607
- Iacoboni, M. (2008). Mirroring people: The new science of how we connect with others. (pp: 106-129; 157-177). Farr, Straus & Giroux, New York.
- Markova, G., & Legerstee, M. (2006). Contingency, imitation, and affect sharing: Foundations of infants' social awareness. *Developmental Psychology, 42*(1), 132-141. doi:10.1037/0012-1649.42.1.132
- McConnell, S. R., & Odom, S. L. (1999). A Multimeasure Performance-Based Assessment of Social Competence in Young Children with Disabilities. *Topics In Early Childhood Special Education, 19*(2), 67.
- McCoy, C. L., & Masters, J. C. (1985). The Development of Children's Strategies for the Social Control of Emotion. *Child Development, 56*(5), 1214. doi:10.1111/1467-8624.ep7252301
- McDonald, N. M., & Messinger, D. S. (2012). Empathic Responding in Toddlers at Risk for an Autism Spectrum Disorder. *Journal of autism and developmental disorders, 1*-8.
- Minio-Paluello, I., Baron-Cohen, S., Avenanti, A., Walsh, V., & Aglioti, S. (2009). Absence of embodied empathy during pain observation in Asperger Syndrome. *Biological Psychiatry, 65*, 55-62.
- Mundy, P. & Neil, R. (2001). Neural placticity, joint attention and a transactional social orienting model of autism. In L. Glidden (Ed.) *International review of research in mental retardation: Vol 23. Autism* (pp 139-168). New York: Academic Press.

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

- Paul, R., Chawarska, K., Fowler, C., Cicchetti, D. & Volkmar, F. (2007). Listen to my children and you shall hear": Auditory preferences in Toddlers with autism spectrum disorders. *Journal of Speech, Language & Hearing Research*, 50, 1350-1364.
- Pons, F., & Harris, P. L. (2005). Longitudinal change and longitudinal stability of individual differences in children's emotion understanding. *Cognition & Emotion*, 19(8), 1158-1174. doi:10.1080/02699930500282108
- Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology*, 74(2), 116-143. doi:10.1016/j.biopsycho.2006.06.009
- Porges, S. W., Doussard-Roosevelt, J. A., Portales, L. A., & Suess, P. E. (1994). Cardiac vagal tone: Stability and relation to difficultness in infants and 3-year-olds. *Developmental Psychobiology*, 27(5), 289-300. doi:10.1002/dev.420270504
- Richards, J. E., & Casey, B. (1991). Heart Rate Variability During Attention Phases in Young Infants. *Psychophysiology*, 28(1), 43-53. doi:10.1111/1469-8986.ep11028328
- Richards, J. E., & Cronise, K. (2000). Extended Visual Fixation in the Early Preschool Years: Look Duration, Heart Rate Changes, and Attentional Inertia. *Child Development*, 71(3), 602.
- Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience*, 27(1), 169-164. doi: 10.1146/annurev.neuro.27.070203.144230
- Rogers, K., Dziobek, I., Hassenstab, J., Wolf, O. T., & Convit, A. (2007). Who Cares? Revisiting Empathy in Asperger Syndrome. *Journal Of Autism And Developmental Disorders*, 37(4), 709-715.
- Scambler, D. D., Hepburn, S. S., Rutherford, M. D., Wehner, E. A., & Rogers, S. J. (2007). Emotional Responsivity in Children with Autism, Children with Other Developmental Disabilities, and Children with Typical Development. *Journal Of Autism & Developmental Disorders*, 37(3), 553-563. doi:10.1007/s10803-006-0186-y
- Shamay-Tsoory, S., Aharon-Peretz, J. & Perry, D. (2009). Two systems for empathy: A double disassociation between emotional and cognitive empathy in inferior frontal gyrus vs. ventromedial prefrontal lesions. *Brain*, 132, 617-627.
- Sigman, M. D., & Kasari, C. (1992). Responses to the negative emotions of others by autistic, mentally retarded, and normal children. *Child Development*, 63(4), 796. doi:10.1111/1467-8624.ep9301120029
- Svetlova, M., Nichols, S. R., & Brownell, C. A. (2010). Toddlers' Prosocial Behavior: From Instrumental to Empathic to Altruistic Helping. *Child Development*, 81(6), 1814-1827. doi:10.1111/j.1467-8624.2010.01512.x
- Vos, P., De Cock, P., Munde, V., Petry, K., Van Den Noortgate, W., & Maes, B. (2012). The Tell-Tale: What Do Heart Rate; Skin Temperature and Skin Conductance Reveal about Emotions of People with Severe and Profound Intellectual Disabilities?. *Research In Developmental Disabilities: A Multidisciplinary Journal*, 33(4), 1117-1127.
- Watson, L. R., Roberts, J. E., Baranek, G. T., Mandulak, K. C., & Dalton, J. C. (2012). Behavioral and Physiological Responses to Child-Directed Speech of Children with Autism Spectrum Disorders or Typical Development. *Journal Of Autism And Developmental Disorders*, 42(8), 1616-1629.
- Widen, S. C., & Russell, J. A. (2010). Differentiation in preschooler's categories of emotion. *Emotion*, 10(5), 651-661. doi:10.1037/a0019005

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

- Wright, B., Clarke, N., Jordan, J., Young, A. W., Clarke, P., Miles, J., & ... Williams, C. (2008). Emotion Recognition in Faces and the Use of Visual Context in Young People with High-Functioning Autism Spectrum Disorders. *Autism: The International Journal Of Research And Practice*, 12(6), 607-626.
- Yirmiya, N., Sigman, M., Kasari, C. & Mundy, P (1992). Empathy and cognition in high-functioning children with autism. *Child Development*, 63(1), 150. doi:10.1111/1467-8624.ep9203091733
- Zahn-Waxler, C. (1991). The Case for Empathy: A Developmental Perspective. *Psychological Inquiry*, 2(2), 155.

Appendix A

Study 1- Emotion Identification Set Up



Set A

Set B



Jackie is dancing.

How does Jackie feel?

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

## Appendix B

## Study 1- Emotion Identification Data Sheet

Child ID \_\_\_\_\_

Date \_\_\_\_\_

## Emotion Recognition Test:

1.	<u>H</u>	S	A
2.	H	<u>S</u>	A
3.	H	<u>S</u>	A
4.	H	S	<u>A</u>
5.	<u>H</u>	S	A
6.	H	S	<u>A</u>
7.	H	<u>S</u>	A
8.	<u>H</u>	S	A
9.	H	S	<u>A</u>

# Correct: \_\_\_\_\_ % Correct: \_\_\_\_\_

## Emotion Recognition Test (w/context):

1.	<u>H</u>	S	A
2.	H	S	<u>A</u>
3.	H	<u>S</u>	A
4.	<u>H</u>	S	A
5.	H	<u>S</u>	A
6.	H	S	<u>A</u>
7.	H	S	<u>A</u>
8.	H	<u>S</u>	A
9.	<u>H</u>	S	A

# Correct: \_\_\_\_\_ % Correct: \_\_\_\_\_

Comments:

## Appendix C

## Study 2- Emotion Response Video Coding Manual

**Background:** This study examined the emotional responses of 71 children with and without ASD to a standardized distress procedure. The purpose of the study is to determine any differences in responses for children with and without ASD as well as understand a typical developmental trajectory of emotional response to distress.

**The Distress task:** The task begins with the adult showing the hammer/ peg toy to the child and asking, “Have you ever seen this toy before”. After the child responds, the adult continues “let me show you how it works”. The adult demonstrates how to hammer the pegs using the hammer and then hands the hammer to the child. After the child has hammered a few pegs the adult asks, “Can I have a turn”. On her turn she hammers one peg successfully and then on the second peg hits her finger with the hammer and exclaims, “Ouch!” She continues to show her discomfort by shaking her finger and commenting on how it hurts for at least 10 seconds, afterwards she smiles and says “It’s okay. It’s all better”, and goes back to engaging with the child.

**Coding intervals:** For the purpose of coding, the task is broken into three intervals “before” distress event, “during” distress event and “after” distress event.

- The time period of “Before” begins when the adult says, “*Have you ever seen this toy before*”. You will code “Before” for 10 consecutive seconds starting from the end of this cue.
- The time period of “During” begins when the adult exclaims, “*Ouch!*” after hitting her finger with the hammer. You will code “During” for 10 consecutive seconds after this cue.
- The time period “After” begins when the adult says, “*It’s okay. It’s all better*”. You will code “After” as 10 consecutive seconds after this cue.

Each time period may last beyond the 10 seconds that you will code. You do not need to code beyond 10 seconds for each interval. If you find that an interval lasts longer wait for the next cue to begin coding the next interval. For example if the “Before” time period lasts for 20 seconds, code the first 10 seconds, right after hearing the “Before” cue “Have you seen this toy before” then stop coding and wait for the next cue of “Ouch” to begin coding the “During” interval.

**The coding form:**

- You will fill out one coding sheet for each video that you are assigned. Begin by filling out the video number, your initials and the date that the video was coded on the top. Please leave “Child ID #” blank.
- There are two main sections to the coding form “Affect” and “Eye Gaze”. In the beginning you will likely need to watch each video 3—4 times in order to complete the different parts of the coding form.
- Make sure to include the starting time (in seconds) for each interval “Before”, “During” and “After” in both the affect and eye gaze sections.

**Affect**

Affect refers to the experience of feeling or emotion as distinguished from cognition, thought or action (Huitt, 2003). Affect also refers to affect display, which is a facial expression or gestural behavior that serves as a marker for a specific emotion (APA, 2006). Affect attempts

## EMOTIONAL ACUITY IN CHILDREN WITH ASD

to capture the emotional quality of a person's feelings. For the purpose of this study affect will be very simply categorized as positive, negative, neutral and uncodable. Positive affect is a "happy" emotion. Negative affect includes sad, angry and frustrated. Neutral affect refers to a lack of observable emotion from looking at the face. Use the code "uncodable" when you are unable to determine the affect of the participant. You will begin by coding individual affect scores for both the child and the adult. Then you will determine the amount of affect matching between the two individuals.

**Individual Affect Scores:** Affect, or emotional state, will be recorded for both the child and the adult for 10 seconds during each of the coding intervals, before, during and after the distress event. Affect will be coded into four distinct categories: positive, negative, neutral and uncodable. Code affect for each second (10 seconds for each interval, 30 seconds total) for the child, in the row labeled "child". Next, do the same thing for the "adult".

**Affect Codes**

Affect	Definition	Example	Code
Positive	Facial expression is indicative of a positive emotional state.	<ul style="list-style-type: none"> <li>• Mouth: Corners of lips turned up (smiling), mouth may be open, teeth may be showing</li> <li>• Eyes: slightly squinted with cheeks raised, or fully open</li> <li>• Brow: relaxed</li> <li>• Head lifted, body turned towards partner</li> </ul>	+
Negative	Facial expression is indicative of a negative emotional state.	<ul style="list-style-type: none"> <li>• Mouth: Corners of lips turned down (frowning) or pursed</li> <li>• Eyes: slightly closed, narrowed or looking down.</li> <li>• Brows: furrowed or raised in the middle.</li> <li>• Head down, body turned away from partner</li> </ul>	-
Neutral	No readable expression of positive or negative emotion is evident on face but face is visible	<ul style="list-style-type: none"> <li>• No smile or frown is present, Eyes and brow are relaxed.</li> </ul>	o
Uncodable	Face is not visible or emotion cannot be classified as positive negative or neutral (such as surprise)	<ul style="list-style-type: none"> <li>• Turned away, off screen etc.</li> <li>• Face appears "surprised", eyebrows raised, eyelids pulled up, mouth open</li> </ul>	x

**Affect Matching:** Once affect has been coded for both the child and the adult affect matching will be determined. Simply look at each one second interval for the child and the adult. If both have the same affect (+, -, o), write "Y" in the row labeled "match". If the affect of the two individuals does not match, write "N". If either the child or the adult's affect was uncodable, write "X". Next you will calculate the percentage of affect matching for each interval. Simply add the number of "Y's" in the match row and divide by the total number of codable seconds.

### Child's Eye Gaze

Child's eye gaze will be recorded for 10 seconds during each interval (Before, During & After). Eye gaze will be coded using the mutually exclusive categories: adult's face, adult's hand or finger, child's own hand or finger, toy, away and uncodable.

#### **Child's Eye Gaze Codes**

<b>Eye Gaze toward...</b>	<b>Definition</b>	<b>Code</b>
Adult's face	Eye gaze directed at the adult's face or eyes	F
Adult's hand	Eye gaze directed at the adult's hand or finger	H
Child's own hand	Eye gaze directed at the child's own hand or finger	C
Toy	Eye gaze directed at the peg toy or the hammer	T
Away	Eye gaze directed away from adult or toy	A
Uncodable	Child is turned away, off camera or eye gaze is not distinguishable	X

Next fill out the boxes indicating the % of eye gaze codes for each interval ("Before", "During" and "After"). Simply count the number of occurrences of each code and divide by the total number of codable seconds, record the percentage in the appropriate box.

#### References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC.
- Huitt, W. (2003). The affective system. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved 7/2/12 from: <http://www.edpsycinteractive.org/topics/affect/affsys.html>

