FACIAL EMOTION PROCESSING IN CHILDREN WITH FETAL ALCOHOL
SPECTRUM DISORDERS: A TEST OF THE EMOTION SPECIFICITY
HYPOTHESIS

by

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Facial Emotion Processing in Children with Fetal Alcohol Spectrum Disorders: A Test of the Emotion Specificity Hypothesis

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at George Mason University

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DEDICATION

This is dedicated to Meghan Cody, Amy, Patricia and Stephen Way, who supported me throughout this process.

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ADHD	Attention-Deficit/ Hyperactivity Disorder
ARBD	Alcohol Related Birth Defects
ARND	Alcohol Related Neurodevelopmental Disorder
BAC	Blood Alcohol Content
BPVS	British Picture Vocabluary Scales
BRFSS	Behavioral Risk Factor Surveillance System
CA	Chronological Age
CD	Conduct Disorder
CNS	Central Nervous System
DANVA	Diagnostic Analysis of Nonverbal Accuracy
DS	Down syndrome
FAS	Fetal Alcohol Syndrome
FASD	Fetal Alcohol Spectrum Disorder
FXS	Fragile X Syndrome
IOM	Institute of Medicine
MA	Mental Age
NCBDDD	National Center on Birth Defects and Developmental Disabilities
NIAAA	National Institute on Alcohol Abuse and Alcoholism
NOFAS	National Organization on Fetal Alcohol Syndrome
NSID	Nonspecific Intellectual Disability
ODD	Oppositional Defiant Disorder
OFC	Occipital-Frontal Circumference
PFAS	Partial Fetal Alcohol Syndrome
SIP	Social Information Processing
TD	typically developing
VABS	Vineland Adaptive Behavior Scales

ABSTRACT

FACIAL EMOTION PROCESSING IN CHILDREN WITH FETAL ALCOHOL
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George Mason University, 2010

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Prenatal alcohol exposure is the leading non-genetic, biological cause of birth

defects and other anomalies. Perhaps as many as 1 in 100 children born in the United

States each year have been exposed to alcohol during prenatal development and meet the

criteria for a Fetal Alcohol Spectrum Disorder (FASD) diagnosis (May & Gossage, 2001;

Schonfeld et al., 2006; Wattendorf & Muenke, 2005). There is abundant evidence of

deficits in social functioning as a result of prenatal alcohol exposure (Coggins et al.,

2003; Kodituwakku, May et al., 2001; McGee et al., 2009; Thomas et al., 1998). Many

other atypically developing populations with demonstrated social deficits also have

emotion-specific impairments in facial recognition that are more pronounced than would

be expected based on the overall cognitive functioning of these individuals (i.e. emotion

specificity hypothesis; Rojahn et al., 1995). The documented social impairment in

children with prenatal alcohol exposure indicates these individuals also have emotion-

specific facial recognition impairments. This study tested the emotion specificity

hypothesis in a group of children with FASD and compared the facial emotion processing

abilities of these children with reports of their adaptive social behavior.

Twenty-five children with a FASD diagnosis, 14 children with Down syndrome,

and 23 typically developing children matched on mental age participated in this study.

Four facial processing tasks (2 emotion processing and 2 control tasks) were administered

to all participants. Both labeling and matching formats were included in the emotion and

control tasks. Although not expected, the children with FASD had similar performance to

the typically developing children on all facial processing tasks, which failed to support

the emotion specificity hypothesis in this population. As predicted, the children with

Down syndrome showed poorer performance than the children with FASD and the

typically developing children across all facial processing tasks. These tasks failed to

reveal performance differences between children with FASD and typically developing

children; however, facial emotion processing deficits may still exist within the FASD

population. Future studies should consider modifying task demands to more accurately

reflect natural face processing situations and include children with a FASD diagnosis

from less enriched environments and with documented intellectual delays.

Chapter I. Fetal Alcohol Spectrum Disorders

Prenatal alcohol exposure is responsible for more birth defects, developmental

disabilities, and intellectual deficiencies than any other non-genetic, biological cause; yet

Fetal Alcohol Syndrome (FAS), first identified by Jones and colleagues in 1973, is

completely preventable (National Center on Birth Defects and Developmental

Disabilities National Task Force on Fetal Alcohol Effect [NCBDDD], 2004; National

Institute on Alcohol Abuse and Alcoholism [NIAAA], 2000; Caley, Kramer, &

Robinson, 2005; O'Leary, 2004; Streissguth, Aase, Clarren, Randels, LaDue & Smith,

1991). The costs associated with FAS makes the fact that it is completely preventable

even more significant. In 1992, the National Institute on Drug Abuse estimated the

lifetime cost of caring for an individual with FAS to be $1.5 million (Caley et al., 2005).

In 1998, the *10th Special Report to the U.S. Congress on Alcohol and Health* noted FAS

costs the United States $2.8 billion (Caley, et al., 2005).

The teratogenic effects of alcohol include interfering with the growth,

progression, and functioning of nerve cells during fetal development (Caley et al., 2005;

NCBDDD, 2004; O'Leary, 2004). Specifically, prenatal alcohol exposure causes

dysmorphia by hampering cell growth and survival, promoting the creation of free

radicals that damage the cells, changing the way chemical signals pass through cells, and

influencing gene expression (NCBDDD, 2004). There is also a direct link between the

amount and recurrence of prenatal alcohol exposure and the amount and type of brain

dysmorphia during two crucial periods of brain development: the initial eight to twelve

weeks and the final two months of pregnancy (O'Leary, 2004). A study of the embryonic

dysmorphia found in terminated pregnancies of chronic alcoholic mothers during the first

trimester revealed a variety of problems, with brain development (absence of one or both

cerebral hemispheres or reduced brain mass), skull formation, and neuronal migration

(O'Leary, 2004). O'Leary (2004) also points out that many of the adverse effects

including growth retardation, cognitive, and behavior difficulties found in individuals

after birth are associated with alcohol exposure in the last few weeks of pregnancy.

Diagnosis of Fetal Alcohol Syndrome

According to the guidelines produced by the Scientific Working Group formed to

research Fetal Alcohol Syndrome Diagnostic Criteria, there are four features required for

a diagnosis of FAS (Caley et al., 2005; NCBDDD, 2004; Warren & Foudin, 2001): (1)

specific malformed facial features, (2) evidence of pre- and/or post-natal growth

retardation, (3) evidence of anomalies within the Central Nervous System (CNS), and (4)

maternal alcohol exposure during pregnancy. Each of these features will be explored

below.

Facial Dysmorphia

Although there are numerous physical anomalies commonly found in individuals

with FAS (see Figure 1), the dysmorphic criteria for a diagnosis of FAS requires the

presence of a smooth philtrum (less pronounced or absent perpendicular indentation

between the nose and upper lip), a thin top lip with a thin vermillion border (less pronounced line distinguishing the lip from surrounding skin), and small palpebral fissures (openings between the upper and lower eyelids measured from outer corner to inner corner of each eye) (Astley & Clarren, 1997; 1999; 2000; 2001; Caley et al., 2005; NCBDDD, 2004).

These three facial features are part of the FAS diagnostic criteria because they are found to some degree in all individuals with FAS and the combination of these three features are unique to those individuals with prenatal alcohol exposure (Astley & Clarren, 1997; 1999; 2000; 2001; Caley et al., 2005; Streissguth et al., 1991). Unfortunately (from a clinical perspective), facial dysmorphia associated with FAS do not remain stable across development. As the individual ages, the face loses its distinctiveness (Astley & Clarren, 2000; 2001 NCBDDD, 2004; Streissguth et al., 1991). Therefore, a diagnosis of FAS in older individuals often relies on *photographs* of the individual as a young child (Astley & Clarren, 2001; O'Leary, 2004; Streissguth et al., 1991).

Growth Retardation

A second and easily recognized criterion for diagnosing FAS is evidence of impaired or delayed growth in one or more of the following three parameters: (1) body height, (2) body weight, or (3) head circumference. For each parameter, the severity of retardation must put the individual at or below the 10th percentile on growth charts (Caley et al., 2005; NCBDDD, 2004); which can be difficult to diagnose with the prevalence of pre- and post-natal treatments to remedy growth problems. To account for the availability of treatments, including feeding tubes and hormone therapies, the Scientific Working

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Group stipulated that a history of delayed growth or physical development in either pre- or post-natal growth meets the diagnostic criteria (NCBDDD, 2004).

CNS Anomalies

A third diagnostic criterion, is the presence of central nervous system (CNS) anomalies including the (1) confirmed presence of structural abnormalities (overall head circumference, also known as Occipital-Frontal Circumference (OFC) at or below the 10th percentile, small or abnormally shaped corpus callosum, cerebellum, basal ganglia, or frontal and/prefrontal cortex) (2) neurological abnormalities (seizures not caused by post-natal trauma, difficulties with coordination, visual motor problems, or nystagmus); or (3) functional deficiencies (decreased IQ or other evidence of a global cognitive deficit "or deficits in three or more specific functional domains" (Caley et al., 2005; NCBDDD, 2004, p. 14).

In many cases, individuals with FAS exhibit multiple structural, neurological, or functional deficiencies (NCBDDD, 2004). It is also important to note that although the CNS deficiencies are usually present throughout one's life, the FAS neurobehavioral presentation can change across the lifespan (NCBDDD, 2004).

Alcohol Exposure

A final diagnostic criterion is exposure or suspected exposure to alcohol during prenatal development. Hard evidence of prenatal alcohol exposure via maternal reports, reported observations of others, or medical records that document a positive blood alcohol content (BAC) is beneficial and strengthens the reliability of the diagnosis;

however, confirmed alcohol exposure is not necessary for a diagnosis of FAS if the other three criteria have been met (Caley et al., 2005; NCBDDD, 2004).

Despite the efforts of the Scientific Working Group to outline the FAS diagnostic criteria, diagnosis has been a somewhat unscientific (subjective) process. The absence of an objective tool for diagnosis has led to inconsistent classification because medical and other professionals arbitrarily rank the significance of the individual features when examining individuals (O'Leary, 2004). This "gestalt method" is based on general "qualitative definitions for FAS facial phenotype" and simply notes the presence or absence of a feature (Astley & Clarren, 2001, p.152).

The last decade, however, has seen the development of an unbiased, inclusive and complete, "case-defined" procedure for diagnosis of FAS and all other disorders that result from prenatal alcohol exposure, known as the "4-Digit Diagnostic Code" (Astley & Clarren, 1997; 1999; 2000; 2001). Each of the 4 digits corresponds to the degree of severity (measured on a 4-point Likert Scale) of the key diagnostic characteristics of FAS in the following order: (1) growth deficiency, (2) the FAS facial phenotype, (3) brain damage/ dysfunction, and (4) prenatal alcohol exposure (Astley & Clarren, 2001). One significant finding is that the 4-Digit rating of FAS facial dysmorphia is correlated with severity of brain structural and functional deficits, a linear relation that has not been reported in any other studies (Astley & Clarren, 2001).

Fetal Alcohol Spectrum Disorders, a term which encompasses all disorders caused by prenatal alcohol exposure, has been introduced into the literature; however, FASD is not meant to be used for the purpose of clinical diagnosis (Caley et al., 2005;

Jacobson & Jacobson, 2002; National Organization on Fetal Alcohol Syndrome [NOFAS], 2004; Weinberg, 1997). Similar to other diagnostic spectrums, such as the Autistic Spectrum, FASD provides a way of grouping conditions with the same etiology. Currently, FAS is the only disorder within FASD with recognized diagnostic criteria.

Diagnosis of Other Fetal Alcohol Spectrum Disorders

Although FAS is the most severe consequence of prenatal alcohol exposure, several other conditions exist that are marked by prenatal alcohol exposure and result in some of the diagnostic features of FAS (Caley, et al., 2005; Jacobson & Jacobson, 2002; NCBDDD, 2004; O'Leary, 2004; Streissguth, et al., 1991). Partial Fetal Alcohol Syndrome, Alcohol Related Neurodevelopmental Disorder, and Alcohol Related Birth Defects are all used for individuals who have been exposed to alcohol prenatally and exhibit some of the characteristics of FAS (Caley, et al., 2005; O'Leary, 2004; Stratton, Howe, & Battaglia, 1996; Warren & Foudin, 2001).

Partial Fetal Alcohol Syndrome (PFAS)

The definition of Partial Fetal Alcohol Syndrome (PFAS), which was formally called Fetal Alcohol Effects, is based on Stratton, Howe, and Bagttaglia's (1996) report to the Institute of Medicine (IOM). The diagnostic criteria outlined in the IOM report includes current or prior presentation of "some" of the discriminating dysmorphic facial features of FAS along with at least one of the following: current or prior presentation of growth retardation consistent with FAS, current or prior presentation of CNS anomalies consistent with FAS, or "evidence of a complex pattern of behavior or cognitive

abnormalities that are inconsistent with developmental level and cannot be explained by familial background or environment" (Stratton et al., 1996, p.76). A PFAS diagnosis has the more stringent requirement of confirmed prenatal exposure to alcohol (maternal report, observation, positive BAC, etc.) because the other diagnostic criteria can individually be found in other conditions (Stratton et al., 1996; Warren & Foudin, 2001).

Alcohol-Related Neurodevelopmental Disorder (ARND)

The confirmation of prenatal alcohol exposure is also required for diagnosis of alcohol-related neurodevelopmental disorder (ARND) used to identify individuals who exhibit functional or cognitive impairments as a result of exposure to alcohol during the prenatal period (Caley, et al., 2005; Jacobson & Jacobson, 2002; O'Leary, 2004). The IOM report identifies structural or functional CNS abnormalities including "microcephaly, partial or complete agenesis of the corpus callosum, cerebellar hypoplasia… impaired fine motor skills, neurosensory hearing loss, poor tandem gait, and poor eye-hand coordination" as likely areas of abnormality (Stratton et al., 1996, p 77; Warren & Foudin, 2001).

Alcohol-Related Birth Defects (ARBD)

Deformity in bone structures and major organ systems resulting from confirmed prenatal alcohol exposure defines alcohol-related birth defects (Caley, et al., 2005; Jacobson & Jacobson, 2002; O'Leary, 2004). The IOM report describes "congenital anomalies, including malformations and dysplasias" are possible in "cardiac, skeletal, renal, ocular, and auditory" systems (Stratton et al, 1996, p.77; Warren & Foudin, 2001).

Symptoms of both ARND and ARBD may be evident in some individuals. If the criteria of ARND and ARBD are met, both should be diagnosed (Stratton et al., 1996; Warren & Foudin, 2001). FASD diagnoses (with the exception of FAS) contain some ambiguity in diagnostic criteria and some symptom overlap between diagnoses. Although the precise diagnosis may not always be clear, the presence of significant abnormalities in behavior, physical, cognitive, and social abilities is impossible to ignore.

Prevalence

In addition to inconsistent classification, the prior lack of clear FAS diagnostic criteria and the lack of clear diagnostic criteria for other FASDs has resulted in discrepancies in frequencies of occurrence. The prevalence rate of FAS varies depending on the source. Caley et al. (2005) reports one to three out of every 1,000 births are affected by FAS. The *IOM Committee* formed to research Fetal Alcohol Syndrome Diagnostic Criteria cites the prevalence rate between 0.5 and 3.0 cases per 1,000 births, which means out of the 4 million annual births between 2,000 and 12,000 will meet the diagnosis of FAS (Stratton et al., 1996). The FAS prevalence rates within disadvantaged groups are even higher, with FAS estimates ranging between 3.0 and 5.0 cases per 1,000 (NCBDDD, 2004). Even more alarming, the estimated prevalence rate of alcohol-related neurodevelopmental disorder (ARND) is at least ten times higher than the prevalence rate of FAS (Caley et al., 2005). Some recent studies of FASD prevalence rates estimate one in 100 children born in the United States each year meet the criteria for a FASD diagnosis

(including FAS, PFAS, ARBD, and ARND) (May & Gossage, 2001; Schonfeld, Paley, & O'Connor, 2006; Wattendorf & Muenke, 2005).

The higher prevalence of FASDs among disadvantaged groups is attributed to socio-economic status, patterns of alcohol consumption, and other socio-cultural variables; however, racial characteristics are not thought to contribute to the discrepant rate (Caley et al., 2005). Other factors proposed to cause increased prevalence of FASDs in disadvantaged groups include: eating habits and nutritional patterns, environmental pollutants, maternal smoking or exposure to second-hand smoke, maternal psychological stress and physical abuse (Coggins, Timler, & Olswong, 2007; Koponen, Kallard, Autti-Rämö, 2009; O'Leary, 2004). A study of the effects of marital violence on women's psychological functioning found that women engaged in more episodes of heavy drinking following husband-to-wife aggression in an effort to cope with their pain (Testa & Leonard, 2001). Coggins et al. (2007) note a strong link between alcohol abuse and adverse, violent living environments. Mothers who experience high levels of psychological stress or who are exposed to physical abuse are likely fall into the same cycle of using alcohol to cope with the effects of abuse.

Medical professionals and health care workers usually tell their patients that no amount of alcohol is safe during pregnancy, a concept ratified by many advocacy and support groups associated with Fetal Alcohol Spectrum Disorders (Caley et al., 2005; NIAAA, 2000; NCBDDD, 2004; NOFAS, 2004). However, one has to wonder about the effectiveness of such a recommendation to abstain from alcohol during pregnancy. In a 1999 survey, over half of the "women of childbearing age" ingested alcohol within the

previous month (NCBDDD, 2004). Even more disturbing are the rates of moderate and

heavy drinking by women of childbearing age. According to NCBDDD, 15% were

classified as moderate or heavy drinkers and 13% as binge drinkers (consuming 5+ drinks

in a single occasion) (2004). In fact, an analysis of the reported drinking behaviors of

329,975 women between 18 and 44 years of age (collected between 2001 and 2005 as a

part of the Behavioral Risk Factor Surveillance System [BRFSS] surveys) revealed over

half of the women (52.8%) reported alcohol use and 12.1% engaged in binge drinking in

the month prior to being surveyed (CDC MMWR Weekly May 22, 2009 [CDC]).

Although 316,155 women did not report being pregnant at the time of the survey,

172,621 (54.6% of the 316,155) reported alcohol use (CDC, 2009). "Given that nearly

half of all U.S. pregnancies are unintended, and that millions of fertile women are

sexually active while not using adequate contraception, an estimated 2% of women could

be at risk for an alcohol-exposed pregnancy annually" (NCBDDD, 2004, p.2).

The potential risk associated with the rate of alcohol use in women of

childbearing age is significant, but the actual data on the 4.2% of the BRFSS sample that

reported being pregnant when surveyed is shocking. Between 2001 and 2005, 11.2%

(1,548) of the 13,820 women who reported being pregnant at the time of the survey had

consumed an alcoholic beverage and 1.8% (248) of these pregnant women had engaged

in binge drinking in the past 30 days (CDC, 2009); which would mean these women were

most likely drinking during at least some portion of their pregnancy. Surprisingly, 25.6%

(3,538) of the pregnant women who had at least attended some college reported alcohol

use in the prior month; however, only 8.5% (1,175) of the pregnant women who attained

a high school diploma or less reported using alcohol in the prior 30 days. Another surprising finding is that only 8.6% of the pregnant women between 18 and 24 years of age used alcohol in the prior month; however, 11.2% of the pregnant women between 25 and 34 years of age and 17.7% of the pregnant women between 35 and 44 years of age used alcohol in the prior month. These percentages support the NCBDDD (2004) claim that all women of childbearing age who choose to drink are at risk for a pregnancy negatively impacted by alcohol exposure.

The potential rate of alcohol use during pregnancy is alarming when one considers the lasting effects prenatal alcohol exposure can have on an individual's functioning. Some of these effects are present at birth or emerge in infancy. Other effects are not noticeable until the child is older, perhaps as late as entry into formal education, when the child stands in stark contrast to peers. The women who consume alcohol during pregnancy are likely unaware that their behavior could result in significant impairments in their children.

Associated Areas of Concern

Many other problems are associated with FASDs, but are not part of the diagnostic criteria because they are found inconsistently in individuals with prenatal alcohol exposure. Like the diagnostic criteria, these problems vary in range and level of severity. Although each is not present for every individual with prenatal alcohol exposure, these issues are prevalent and cause considerable dysfunction in children with FASDs.

Physical Problems

One area of potential impairment or delay is in motor systems. The diagnostic criteria for FAS does not include motor deficits and not all individuals with FASDs experience the same motor problems; however, motor delays and movement disorders are common in individuals with prenatal alcohol exposure (Jones & Smith., 1973; Kodituwakku, Handmaker, Cutler, Weathersby, & Handmaker, 1995; O'Leary, 2004). These motor delays may be visible as early as the child's first birthday and include both fine and gross motor difficulties (O'Leary, 2004). Specific deficits that have been reported include "abnormal walking and balance, and fine motor and prehensile coordination at 1 year of age" (O'Leary, 2004, p.5) Vision problems have also been reported and may contribute to the difficulties in motor coordination (Caley et al., 2005; Carter et al., 2005; Uecker & Nadel, 1996).

Cognitive Deficits

The last three decades of research on individuals with prenatal alcohol exposure have been dominated by studies identifying related cognitive deficits, including attention difficulties and deficits in executive control (Burden, Jacobson, & Jacobson, 2005; Burden, Jacobson, Sokol, & Jacobson, 2005; Kodituwakku, May, Clericuzio, & Weers, 2001; Mattson et al., 2006; NCBDDD, 2004). Although attention problems, such as attention deficit hyperactivity disorder (ADHD), are common among individuals with prenatal alcohol exposure, there is inconsistency among researchers about whether the severity of cognitive problems corresponds to FASD diagnosis and/ or amount of prenatal alcohol exposure (Howell, Lynch, Platzman, Smith, & Coles, 2006; Jacobson &

Jacobson, 2002; O'Leary, 2004; Streissguth et al., 1991; Streissguth, Bookstein, Barr, Press, & Sampson, 1998; Weinberg, 1997). In their review of studies, Jacobson and Jacobson reported individuals with a diagnosis of FAS or Partial FAS were more likely to be diagnosed with ADHD than individuals with other alcohol related conditions. Alcohol exposed individuals recruited from clinics also had higher rates of ADHD and other attention problems than alcohol exposed individuals recruited from records of mothers who reported drinking but had not been seen at a clinic (Jacobson & Jacobson, 2002).

Although Jacobson and Jacobson (2002) reported the severity of the attention problems varies as a function of specific diagnosis and recruitment source, Lee, Mattson, and Riley (2004) found no differences between "alcohol-exposed children with or without FAS" on several measures of attention. Several studies examining the impact of prenatal alcohol exposure on executive functioning have found no difference in performance based on FASD diagnosis or severity of alcohol exposure prior to birth (Kodituwakku, Kalberg, & May, 2001; Kodituwakku, May et al., 2001; Schonfeld et al., 2006).

The increased prevalence of attention problems in those individuals seen in clinics compared to those recruited from maternal records of alcohol consumption may indicate that a significant attention problem is a symptom that parents notice due to familial disruption (Jacobson & Jacobson, 2002). This disruption to family functioning may eventually create a selection bias because parents might be more likely to take a child for medical and behavioral help when the problems affect the whole family. As part of intervening with these children, they could be formally diagnosed, which would

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contribute to the link between diagnosis and deficits in functioning noted in studies of attention.

Intellectual disabilities have been found in many individuals with prenatal alcohol exposure, but the severity of cognitive deficits is not consistent across the diagnoses within the Fetal Alcohol Spectrum of Disorders (NCBDDD, 2004). Children with FAS generally score in the mild mental retardation range on measures of IQ (70-55) (Jacobson & Jacobson, 2002; Streissguth et al., 1991; Weinberg, 1997). Partial FAS (formerly known as FAE) individuals are usually in the borderline range of IQ measures (70 to 85) (Jacobson & Jacobson, 2002; Weinberg, 1997). However, due to the variability in the severity and type of intellectual deficits found in individuals with prenatal alcohol exposure, intellectual disabilities are not part of the diagnostic criteria for any of the FASDs.

Behavioral Issues

Comorbidity of psychiatric disorders is particularly relevant to research on individuals with prenatal alcohol exposure. In addition to intellectual disabilities, several other psychological disorders are also commonly found in individuals with a FASD. High rates of depression and severe behavioral problems are prevalent in individuals with prenatal alcohol exposure (O'Connor, Kogan, & Findlay, 2002; O'Connor & Paley, 2006; NCBDDD, 2004). Professionals who work with individuals with prenatal alcohol exposure frequently report significant behavioral problems (Howell et al., 2006; Jacobson & Jacobson, 2002; O'Leary, 2004; Streissguth et al., 1991; Streissguth et al., 1998; Weinberg, 1997). Some studies report that behavioral problems are significant enough for

a diagnosis of conduct disorder or oppositional defiant disorder (Ryan & Ferguson, 2006; Weinberg, 1997). Descriptions of people with FAS, such as having no fear of strangers, gullibility, choosing inappropriate friends, superficiality of social interactions, difficulty understanding the perspectives of others, poor social cognition skills, initiating inappropriate interactions, and not learning from experience (NCBDDD, 2004; Schonfeld et al., 2006) suggest delayed or abnormal development of social-emotional skills leading to deficits in social-emotional functioning.

Chapter II. Facial Emotion Processing and Socio-Emotional Development

Initiating inappropriate interactions and an inability to move beyond superficiality in

social interactions, characterizations often associated with FAS (NCBDDD, 2004), could

indicate difficulty with facial emotion processing. Facial emotion processing is an

important component of socio-emotional development and success in relationships

(Denham, 1998; Halberstadt, Denham & Dunsmore, 2001; Izard, Schultz, Fine,

Youngstrom, & Ackerman, 1999/2000).

Processing During Social Interactions

While interacting with adults and peers, a typically developing child is receiving,

interpreting, and reacting to social cues from the environment. Some of the most

informative social cues is facial expressions (Izard et al., 1999/2000). Believing this

process is central to functional peer relationships and social-emotional competence, Crick

and Dodge's (1994) social information processing (SIP) model focuses on how social

cues (including facial expressions of emotion) are encoded (Step 1) and interpreted (Step

2) and the child's reactions based on his or her interpretation of these social cues.

Reaction and interpretation of social cues (including facial expressions of emotion) are

also incorporated in Halberstadt et al.'s (2001) model of affective social competence.

Awareness and interpretation, two abilities found in all three components (sending,

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receiving, and experiencing) of the affective social competence model (Halberstadt et al., 2001) are used in recognition of facial expressions of emotions.

Importance of Theory of Mind

One component of success in social encounters relevant to affective social competence is "theory of mind," the capacity to understand that others have their own motivations, attitudes, emotions, and impressions, and to deduce the nature of those motivations, attitudes, emotions, and impressions (Stone, Baron-Cohen, Calder, Keane, & Young, 2003). To assess the presence and development of three aspects of theory of mind, several tasks have been developed and are currently in use.

The first aspect of theory of mind is being able to *attribute epistemic mental states referring to things outside of the person,* including knowledge, attention and belief (Stone et al., 2003). Attributing mental states also includes deducing inaccurate knowledge and misguided beliefs. False-belief tasks, which are used to assess theory of mind, place the individual in a situation in which he or she knows something another person does not know. False-belief tasks require the individual to realize that the other person might have a different belief and realize the other person's belief may be wrong based on his or her lack of knowledge or incorrect knowledge. A second aspect of theory of mind is being able to *attribute intention* to another person's behavior, which includes recognizing when something was done on purpose or by accident and recognizing deception (Stone et al., 2003). One common test for the presence of attribution of intention are the false belief tasks that require the participant to collaborate in deceiving some one else. Another test for attribution of intention requires the individual to watch scenarios of social encounters

(e.g. bumping into someone in the school hallway during class change or hitting another child with a ball during recess) and asking the individual to decide whether the encounter was on purpose or by accident (Crick & Dodge, 1994). A third aspect of theory of mind is being able to *attribute affective mental states,* including an understanding of emotional states like desire, fear, and anger (Stone et al., 2003). To assess for attribution of affective mental state, individuals are asked to infer affective mental state from stories or the gaze of others in photographs (Campbell et al., 2006; Stone et al., 2003).

Support for a connection between theory of mind and emotion recognition is found in studies that demonstrate a similar pattern of brain activation when asked to engage in a theory of mind task or recognize the emotion of a photographed person or from a person in a scenario (Campbell et al., 2006; Koshino et al., 2008; Olson, Plotzker, & Ezzyat, 2007; Stone et al., 2003). These same studies also reveal concurrent difficulties in emotion recognition and theory of mind in individuals diagnosed with autism or Williams syndrome. (Campbell, et al., 2006; Dyck, Piek, Hay, Smith, & Hallmayer, 2006; Koshino et al., 2008; Karmiloff-Smith, Klima, Bellugi, Grant, & Baron-Cohen, 1995) A connection between emotion recognition and theory of mind has also been found in individuals with brain injury to the amygdala and surrounding areas including the frontal lobe and temporal pole (Stone et al. 2003; Koshino et al., 2008; Olson et al., 2007). Theory of Mind deficits likely contribute to difficulties encoding attributions and interpreting behaviors, both part of the social information processing represented in Crick and Dodge's SIP model.

Social Information Processing in Prenatally Exposed Children

Social information processing (SIP) in children with prenatal alcohol exposure was the focus of a recent study based on the Crick and Dodge's (1994) SIP model (McGee, Bjorkquist, Price, Mattson & Riley, 2009). This study found evidence of problematic processing of social interactions and supports the social-emotional deficits reported in many studies of FASDs (see also Coggins, Olswang, & Olsen, 20003; Kodituwakku et al., 1995; O'Connor et al., 2002; Thomas, Kelly, & Mattson, 1998; Whaley, O'Connor, & Gunderson, 2001). The responses of school-aged "children with heavy prenatal alcohol exposure… defined by at least 4 drinks per occasion at least once per week or 14 drinks per week during pregnancy" (McGee et al., 2009, p. 819) were interviewed using the Social Information Processing Interview developed by one of the authors (Keil & Price, 2009). As a part of the SIP interview, children watched previously recorded scenarios of problematic social interactions and then answered questions pertaining to each of the 6 steps of Crick and Dodge's (1994) SIP model as if the child was the main character in the interaction. The responses of children with significant prenatal alcohol exposure were compared to the responses of a control group of non-exposed peers (McGee et al., 2009). The children with prenatal alcohol exposure were found to have pervasive SIP deficits based on their interview responses. The prenatally exposed children were "less skillful .. in goal selection, response generation and response evaluation steps" when responding to clips depicting group entry; and were less competent than typically developing children in "encoding, attributions, response evaluation, and enactment steps" when responding to clips depicting provocation (McGee et al., 2009, p.819). Emotions are one of the social

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cues to be encoded during social interactions. Children who demonstrate difficulties early in the SIP process (including encoding) will be unsuccessful with later stages of the model (Crick & Dodge, 1994; McGee et al., 2009). Problems with encoding could include facial expressions of emotion and be the catalyst for continued difficulties in the social interactions.

Face Processing in Typical Children

The development of facial emotion recognition is preceded by devopment in general processing of faces. In typically developing children, the process of generic facial processing begins in early infancy and develops as the child matures. There is a significant development in facial processing in the second half of the first year of life, when human facial processing begins to be specialized; however, the child continues to refine human face processing ability until at least late childhood (8-10 years) and likely into adulthood (Bruce, et al., 2000; Cohen & Cashon, 2001; de Heering, Houthuys, & Rossion, 2007; Donnelly & Hardin, 2003; Maurer, Le Grand, & Mondloch, 2002; Pascalis, de Haan, & Nelson, 2002; Passarotti et al., 2003). The development of facial emotion recognition begins with face recognition and there is evidence of progressive maturation in both brain and behavior starting in early infancy (Karmiloff-Smith et al., 2004). Preferential looking tasks reveal typically developing one-month-old infants demonstrate a propensity for novel faces and habituation towards previously seen faces (de Haan, Johnson, Maurer, & Perrett, 2001).

Another significant development is the progression from discrimination of faces across species to specialized discrimination of human faces. Pascalis et al. (2002) compared the ability to distinguish human faces from one another with the ability to distinguish monkey faces from one another in 6- and 9-month-old infants and adults and found evidence for a developmental change between six and nine months-of-age. The ability of the 6-month-old group to recognize human faces was equivalent to their ability to recognize monkey faces in both the upright and inverted orientations. The 9-month-old group demonstrated better recognition for the human faces in both the upright and inverted conditions. This specialization in recognizing human faces found in 9-month-old infants is consistent with the performance of adults (Pascalis et al, 2002; Passarotti et al., 2003).

Many researchers have designed studies to gain a better understanding of when the specialization in human face processing begins and how it develops. Fagan (1976) studied 7-month-old infants' ability to recognize faces based on invariant features including the position of facial features relative to each other (recognizing that the eyes are above the nose, which is above the mouth) and the spacing between facial features (the distance between the left and right eye). All experiments began with a familiarization phase in which the same face was repeatedly shown until each infant habituated. Then in the probe phase, the familiar face was paired with a novel face. Experiment 1 tested whether infants could distinguish a male face presented in a habituation phase from a novel male face. The infants were able to distinguish between the two male faces; however, similarity between the familiar and novel face had an effect on the infants'

discrimination ability. Those infants who were presented with the photographs of males

with similar facial features were less able to discriminate between the two faces than

those infants who were presented with photographs of males with very different facial

features. The results of Experiment 2 suggested orientation (full-front, ¾ , and profile)

did not affect infants' ability to perceive a habituated face as familiar when presented in a

different orientation from the habituated orientation and paired with a novel face (Fagan,

1976).

There has also been much research determining how individuals process faces.

Featural processing (also called analytical processing) is processing a single feature of the

face independently without considering the context of the facial feature (being able to

recognize a previously seen nose whether on a face, by itself, or on a different face). The

configuration of the facial components is not a factor in featural processing. Configural

processing (also called holistic processing) is based on the typical face configuration and

the position of facial features relative to each other (recognizing that in the facial

configuration, the eyes are above the nose, which is above the mouth; detecting the length

among features of a specific face) (Cohen & Cashon, 2001; Fagan, 1976; Schwarzer &

Zauner, 2003). Brain studies of typically developing babies show right hemisphere

specialization for configural face processing as early as 4 to 5 months (Deruelle & de

Schonen, 1998; de Schonen & Mathivet, 1990).

One study that illustrates these two processes was conducted by Cohen and

Cashon (2001) who developed a procedure that creates a composite or "switch" face by

combining the facial features of two faces in an effort to test both featural and configural

processing in older infants. The first part of the "switch design" is to show two adult

faces until the infant habituates. Once habituated, the infant is shown one of the familiar

(habituation) faces and a composite or "switched" face combining the internal features of

one habituated face and the external features of the other habituated face.

If the "switch" face is perceived as a novel stimulus, there is evidence of

configural processing (Cohen & Cashon, 2001). Based on the principles of habituation

studies, Cohen and Cashon (2001) assumed the infants perceived the "switch" face as

novel if there was a longer looking time for the "switch" face than one of the faces to

which the infant was habituated. If the "switch" face was not perceived as novel, it

suggests the infants processed the individual features separately (featural processing) and

did not process the face as a whole (configural processing).

In their study, 7-month-old infants were tested using the "switch design" (Cohen

& Cashon, 2001). One group of infants was presented with upright faces; the other group

was presented with inverted faces. The group of infants in the upright condition looked

longer at the switched face when paired with a habituation face, which suggests these

infants used configural processing. The group of infants in the inverted face condition did

not look longer at the switched face, which indicates these infants did not perceive the

switched face as novel and used featural processing (Cohen & Cashon, 2001).

Using the switch design (Cohen & Cashon, 2001), Schwarzer and Zauner (2003)

conducted two experiments with 8-month-old infants in which single features were

switched. All stimuli were presented in the upright position. In the first experiment, only

the eyes and mouth were switched (e.g., male mouth on female face). An adult male and

an adult female were used in the habituation phase and a second female face served as the novel face in Experiment 1. Each face was individually photographed from the shoulder up and cropped so that the individual's hair was not visible. In the second experiment the nose and facial contour, as well as the eyes and mouth, were switched. The stimuli used in the habituation phase of Experiment 2 were an adult and child face drawn by hand with correct proportions and edited with Photoshop. A third hand drawn face served as the novel face in Experiment 2. When presented with photographs of adults (Experiment 1), the participants looked longer at the "switch face" than one of the habituation faces, which is evidence of configural processing; however, when presented with the hand drawn faces (Experiment 2), the participants did not look longer at the "switch" face, evidence for featural processing (Schwarzer & Zauner, 2003). This discrepancy in habituation could indicate the infants were treating the actual faces differently than the hand drawn faces, which may support the idea of a specialized ability to process faces because the infants processed "real faces" differently than drawings of faces.

Expanding upon prior research, Rose and colleagues compared the ability of 7- and 12-month-old infants to recognize infant faces when configural and featural alterations were made to the faces (Rose, Jankowski, & Feldman, 2002). Both experiments began with a habituation phase in which the same infant face was repeatedly paired with novel infant faces until the participant showed consistent preference for the novel face. The faces shown in the habituation phase were all presented in a frontal pose and in an upright orientation (Rose et al., 2002).

Rose and colleagues found evidence for the emergence of limited configural processing by 7 months of age (2002). When a previously seen infant face was presented in ¾ pose and paired with a novel face, both 7- and 12-month-old infants spent more time looking at the novel face. This preference for novelty indicates the infants did not perceive the previously seen face as new and suggests the infants used configural processing when viewing faces presented in a new pose. The finding of a preference to novelty in the 12-month-old group when presented with faces in the profile pose also provides evidence for continued development in configural processing between 7 and 12months of age. Rose and colleagues also found evidence for featural processing in the 12-month-old group. Although infants in both the 7- and 12-month-old groups perceived the previously seen face as novel when broken into pieces, the 12-month-old group of infants did demonstrate a preference for novelty when the familiar face was rotated. The preference of novelty in the 12-month-old group indicates the infants did not perceive the previously seen face as new and suggests they used featural processing when viewing the rotated faces.

These studies provide a glimpse into the development of face processing and demonstrate an initial featural processing of faces that progresses to primarily configural processing when faces are encountered in typical (presented in upright, frontal orientation) situations within the first year. Many of the studies also point out that infants are able to engage in both featural and configural processing by the end of the first year of life; however, the method used to process faces (featural or configural) depends on several factors including orientation, pose, and fragmentation of facial features. Although

infants show significant face processing ability, typically developing individuals continue

to augment configural processing with featural processing; and the development of face

processing extends beyond infancy (Bruce et al., 2000; de Heering et al., 2007; Donnelly

& Hadwin, 2003; Friere & Lee, 2001; Maurer et al., 2002; Mondloch, Grand, & Maurer,

2002; Pascalis et al., 2002; Passarotti et al., 2003; Sangrigoli & de Schonen, 2004).

Facial Emotion Processing in Typical Children

Building on a typically developing child's ability to engage in generic facial

processing and discern featural and configural differences between faces, there is also

evidence of emotion recognition that begins in infancy and progresses through early

childhood. In an effort to condense the vast literature on the development of emotion

processing, the following studies are presented to highlight various aspects of children's

abilities to process and respond to facial expressions of emotion.

Serrano, Iglesias, and Loeches (1995) looked at the reactions of two groups of

infants (18 infants ranging in age from 4 to 6 months and 18 infants ranging in age from 7

to 9 months) in response to happy, neutral, and angry faces. The three subgroups of

infants were shown color images of female models depicting two of three emotions.

Subgroup 1 saw only happy and angry expressions, Subgroup 2 saw only happy and

neutral expressions, and Subgroup 3 saw only angry and neutral expressions. Both the

patterns of visual fixation and the types of behaviors (positive / negative) exhibited by the

infants were recorded and analyzed. After habituating to three facial depictions of one

emotion, all three subgroups of infants demonstrated recognition of the same emotion by

another model (Serrano et al. 1995). Based on these results, Serrano et al., 1995) conclude infants can discriminate happy, angry, and neutral facial expressions as early as four months of age.

The infants in Serrano et al's (1995) study also differentially responded to happy, angry, and neutral facial expressions. Infant behaviors were videotaped and later categorized as positive or negative by raters blind to the study goals and the facial expression being shown. When shown happy faces, significantly more of the infant behaviors were positive ("sustained approaching movements of head, trunk, or limbs to the [image] and/or smiles") (Serrano et al., 1995, p.480). Infants displayed significantly more negative behaviors ("sustained avoidance movements to the back of the chair of head, trunk, or limbs and/or precries defined by frowning the eyebrows and eventually, accompanied by protruding lips") in response to angry facial expressions (Serrano et al., 1995, p.480). The authors also note no significant difference in the amount of positive and negative behaviors in response to neutral facial expressions (Serrano et al., 1995). The results of Serrano et al.'s work gives credibility to the argument that typically developing infants not only engage in facial processing, they also able to participate in the more cognitively complex process of facial emotion processing.

A further step in facial emotion processing is the ability to use recognized facial expressions in others to inform one's own behavior, a process known as social referencing. Studies of social referencing necessitate putting the infant in an ambiguous or unfamiliar situation and asking the parent to express certain emotions. The infant's responses to the parent's facial expression are recorded and allow researchers to conclude

whether the child can differentiate facial expressions. These responses also indicate whether the infant can use this information to guide his or her own behavior (Nelson, 1987). Klinnert (1984) found that 12- and 18-month-old infants in an unfamiliar room were more likely to move away from their mothers when the mothers showed happiness and were less likely to leave when their mothers showed fear. Sorce, Emde, Campos, and Klinnert (1985) studied the effect of maternal facial expressions on the behavior of 12-month-old infants when faced with a visual cliff. All infants were persuaded to come to the edge of the visual cliff (within 15 inches), then the mothers showed either a happy or fearful expression. Although most of the infants (14 out of 19) whose mother showed happiness crossed the deep side of the visual cliff, not one of the 17 infants whose mother showed fear crossed the deep side of the visual cliff (Sorce et al., 1985). These studies provide evidence that one-year-old infants can discriminate between happiness and fear.

Research has also been done to establish the emotion processing abilities in preschool children. Denham (1986) studied the emotion processing abilities of young children (24 to 48 months) and obtained data from multiple sources, including independent observers and the participating child. Observations of the participating children were conducted in their daycare classrooms. The children in this study participated in planned situations in which the female experimenter and a confederate child acted out emotion displays in response to common situations; and a puppet task that tested receptive and expressive knowledge of four emotions (happiness, sadness, anger, and fear) along with knowledge of how someone would feel in 14 situations. The participants performed above chance level on the puppet task indicating children as young as 2 years of age are able to

recognize happiness, sadness, anger, and fear (Denham, 1986). The findings also reveal a relation between performance on the puppet task and prosocial behavior (Denham, 1986). Although the research mentioned in this section is not exhaustive, it demonstrates research trends that confirm the existence of higher level emotion processing in early childhood. Emotion processing continues to develop beyond early childhood; however, these studies have shown that emotion recognition begins early in life and can be demonstrated by infants and young pre-school children.

Face Processing in Atypical Populations

The development of facial emotion recognition in typically developing children begins with face recognition. The contingency between face recognition and emotion recognition is significant because a difficulty in facial processing or face recognition would also result in deficits in facial emotion recognition. The facial processing ability of several atypical populations has been investigated.

Autism

The finding that autistic infants (as young as 6-months-old) spend less time looking at faces compared to typically developing infants is well documented. (Campbell et al., 2006; Goin & Myers, 2004; Sigman, Dijamco, Gratier, & Rozga, 2004; Volkmar, Chawarka, & Klin, 2005). Difficulty in face recognition has also been found in children with Autism (Chawarska & Volkmar, 2007; Dawson, Webb, & McPartland, 2005; Hobson, Ouston, & Lee, 1989; Osterling, & Dawson, 1994). A study conducted by Chawarska and Volkmar (2007) that compared the ability to process human and monkey

faces in autistic, developmentally delayed, and typically developing toddlers (14 to 35

months) and preschoolers (36 to 59 months) indicates impairment in young autistic

children and reveals a possibility of delayed facial recognition development. Similar to

many studies of face recognition, trials consisted of a familiarization phase followed by a

recognition phase. Trials only compared faces within species (human face – human face

or monkey face – monkey face). During the familiarization phase, participants were

presented with one face for 20 seconds (to allow for habituation). During the recognition

phase, the familiar face is paired with a novel face and looking time for each face is

recorded.

Consistent with Charwarska and Volkmar's prediction, the autistic toddlers did

not display a novelty preference for either human or monkey faces (2007). The lack of a

novelty preference when viewing any of the faces indicates these autistic toddlers did not

reliably distinguish human or monkey faces from one another. There was also no novelty

preference in the typically developing toddlers when viewing monkey faces; however, the

typically developing toddlers displayed a preference for the novel face when viewing

human faces, indicating recognition of the familiar face. The performance across the

preschool groups revealed a different pattern. The group with Autism performed similarly

to the typically developing children and demonstrated a novelty preference in both the

human face and monkey face conditions. The finding of a novelty preference in autistic

and developmentally delayed preschoolers for human faces suggests that the ability to

discriminate human faces does eventually emerge in autistic and developmentally

delayed populations (Chawarska & Volkmar, 2007). Unfortunately, this study did not examine the type of processing (configural or featural) used by the participants.

The difficulty with face processing observed in individuals with autism has also been linked to abnormal brain functioning. Koshino et al. (2008) compared the fMRI patterns of brain activation in a group of high functioning adults with autism with the fMRI patterns of brain activation in a normal control group of individuals matched on age and cognitive functioning (full scale IQ) when viewing faces. The participants were instructed to view the face and determine whether it matched: a target face seen at the beginning of the trial (condition 1), the face seen immediately before (condition 2), and the face seen two faces ago (Condition 3). The normal control participants showed activation in the right fusiform in an area associated with face perception; however, the participants with autism showed activation in a portion of the right fusiform near an area typically activated during object recognition.

Many converging areas of research have demonstrated that individuals with autism do not process faces as efficiently as typically developing individuals. Autism is not the only atypical population that has been linked to abnormal face processing. Face processing has also been investigated in Williams syndrome.

Williams Syndrome

Williams syndrome is a genetic disorder that is characterized by poor overall intellectual functioning and by significant deficits in visuospatial processing and executive functioning (planning and problem solving) (Karmiloff-Smith, Brown, Grice, & Paterson, 2003; Karmiloff-Smith et al., 2004). Despite their deficiency in visuospatial

cognition, individuals with Williams syndrome appear to show relative strengths in "face processing" via average or close to average scores on standardized measures such as the Benton Facial Recognition Test (Karmiloff-Smith et al., 2003; Rosen, Jones, Wang, & Klima, 1995). The Benton Facial Recognition Test presents the individual with a target person photographed in the frontal view from the shoulders up. Below the target photo is an array of 6 photographs of other people. The target and stimulus array are presented simultaneously. All of the black and white photographs have a black background and the hair and clothing are shaded out. The Benton Facial Recognition Test is composed of three phases in which the individual is asked to match the target face with another photograph of the target: in the frontal view (phase 1), three different angles (phase 2), and under different lighting conditions (Duchaine & Weidenfeld, 2003).

Due to their performance on the Benton Facial Recognition Task and descriptions of individuals with Williams syndrome that include gregarious and pleasant in social encounters, some researchers hypothesize that the facial processing abilities of individuals with Williams syndrome might be spared. Since many populations characterized by atypical cognitive development show impairment in facial processing (Barton, Hefter, Cherkasova, & Manoach, 2007; Chawarska & Volkmar, 2007; Moore, Hobson, & Lee, 1997; Turk & Cornish, 1998), the possibility of intact face processing abilities has made Williams syndrome an appealing population for facial recognition research. A population with documented cognitive deficits and intact face processing would be a potential source of information about what aspects of cognitive processing are involved in face processing.

However, evidence from recent studies indicates the face processing competence found in the Williams syndrome population may stem from an altered process. Several studies have found that as normal children develop, they move from facial processing and recognition based on specific features (featural processing) to facial recognition dominated by the relation of features to one another on the face (configural processing); however, individuals with Williams syndrome seem unable to progress from featural processing to configural processing of facial stimuli (Deruelle, Mancini, Livet, Casse-Perrot, & de Schonen, 1999; Karmiloff-Smith et al., 2003).

In a study comparing the ability of individuals with Williams syndrome (7-23 yrs.) and typically developing individuals to recognize images of faces and buildings in their normal orientation and when the images were inverted, Derulle et al. (1999) found a discrepancy. The typically developing individuals demonstrated a clear inversion effect for faces such that they were significantly faster and more accurate when the images of the faces were presented in their normal, upright orientation compared to their speed and accuracy when the images of faces were up-side-down (Deruelle et al., 1999). It is important to note that this inversion effect was limited to faces. There was no difference in accuracy or speed of processing or recognition between the upright and inverted images of buildings in typically developing individuals. The individuals with Williams syndrome did perform better when presented with upright images of faces than when the faces were inverted, but the difference in recognition of upright and inverted faces was not statistically significant.

In addition, the performance of individuals with Williams syndrome on a match-to-sample task with "schematic faces," in which half of the faces contain a configural change and the other half of the faces contained a featural change was compared to normal controls (Deruelle et al., 1999, p. 289). The results indicated that individuals with Williams syndrome had significant shortcomings when configural changes were made to the faces (Deruelle et al., 1999, p. 292). Karmiloff-Smith (1998) found a similar pattern with a group of adults with Williams syndrome and a control group matched on chronological age. There was no significant difference between the groups on a matching faces task when there were featural changes; however, when configural changes were made to the faces, the performance of the Williams syndrome group was well below the performance of the control group. Together, these finding led Deruelle et al. (1999) to propose the existence of "a selective configural processing impairment" in individuals with Williams syndrome (p. 293). This finding demonstrates individuals with select cognitive visuospatial impairments are in fact less able to process faces and facial emotion using configural processing, which indicates a significant impairment.

Deruelle's hypothesis of selective configural processing was tested and confirmed through a series of additional work in the same area. A series of studies comparing face processing in individuals with Williams syndrome with that of two control groups (mental age matched and chronological age matched) of individuals with no disabilities was conducted by Karmiloff-Smith et al. (2004). In the first study, participants were shown 30 trials of two faces presented successively and were instructed to indicate whether the two images were the same or different by pressing one of two keys on a

computer keyboard. The second of the two images was one of three possibilities: identical to the previous face, different due to a featural change (different nose, mouth, eyes), or different due to a configural change (parts of face in a different position). There was no significant difference in the ability of the groups to recognize faces that were identical to the previous face or different due to a featural change; however, the adult participants with Williams syndrome were significantly less accurate than the CA control group when the second face was different due to a configural change.

In a second experiment, adolescents and adults with Williams syndrome and typically developing children (ranging in age from 3 to 12) matched to the Williams syndrome individuals on mental age were presented with a story about a witch who captures a boy and "hides" him by changing his face and putting him with several other boys. Participants then played a game in which they were asked to "find" the captured boy. In the game, participants had to choose the target face from an array of 9 faces shown on a computer screen. The target face could have a featural or configural alteration and the stimulus set could be inverted or upright. Within the control group of children, speed of response and accuracy increased with age. In addition, there was a "progressive emergence" of an "inversion effect," the greater the age of the child, the less accurate and the greater the amount of time was required to find the target face when the images were inverted compared with accuracy and speed when the images were upright (Karmiloff-Smith et al., 2004). The group of adolescents and adults with Williams syndrome did demonstrate the same trajectory as the control group of children when the images were upright; however, the pattern deviated from control group when the images were

inverted, with no inversion effect (Karmiloff-Smith et al., 2004). Thus, the selective configural processing impairment was again demonstrated to lend support to Deruelle's hypothesis that individuals with Williams syndrome have difficulty with tasks that rely on processing the configuration of the components of an object or face holistically.

Facial Emotion Processing in Atypical Populations

Difficulty with face recognition implies a difficulty with facial emotion recognition; however, there may be dissociation between recognizing faces and recognizing facial emotion displays. Many studies on atypical populations demonstrate a competence in face recognition ability but a deficiency in facial emotion recognition.

Intellectual Disabilities

Although developmentally delayed individuals' face recognition improves during the preschool period (Chawarska & Volkmar, 2007), this general finding does not seem to extend to facial emotion recognition. Several studies of emotion recognition in individuals with intellectual disabilities have in fact found deficits. (Adams & Markham, 1991; Hobson et al., 1989; Matheson & Jahoda, 2005; Rojahn, Rabold, & Schneider, 1995; Simon, Rosen & Ponipom, 1996). Although several earlier studies (Adams & Markham, 1991; Hobson et al., 1989; Yirmiya, Kasari, Sigman, & Mundy, 1989) of facial emotion recognition have had methodological problems, such as control tasks that were not equivalent to facial emotion recognition in cognitive demand or confounds in matched samples, recent studies of emotion recognition in individuals with intellectual

disabilities have included better methodology and also revealed deficits in emotion

recognition (Matheson & Jahoda, 2005; Rojahn et al., 1995).

In a study comparing the performance of individuals with intellectual disabilities

to the performance of a group of children matched on mental age and the performance of

a group of adults matched on chronological age, Rojahn et al. (1995) found evidence that

individuals with intellectual disabilities are poor perceivers of facial emotions. Although

the group of individuals with intellectual disabilities performed slightly better on the

emotion recognition than they did on the age recognition task, that difference was not

significant. There was a significant difference between the performance of both control

groups and the performance of the group of individuals with intellectual disabilities on

the facial emotion recognition task indicating the individuals with intellectual disabilities

had a relative deficit in emotion recognition.

A recent study of emotional understanding in individuals with intellectual

disabilities compared the emotion recognition abilities of a group of aggressive adults

with intellectual disabilities with a non-aggressive group of adults with intellectual

disabilities serving as a mental age matched control (Matheson & Jahoda, 2005). Emotion

recognition was assessed using a variety of tasks, including photographs of facial

emotions both in and out of context and cartoon depictions of emotions. Both groups

showed deficits in emotion recognition, but the non-aggressive group performed better

than the aggressive group. In both groups, the overall level of performance improved

when contextual cues were present. In addition, the results revealed an angry bias in the

aggressive group of individuals with intellectual disabilities, such that individuals in the aggressive group were much more likely to mislabel the cartoon depiction as angry.

Although aggressive behavior may magnify difficulties in emotion recognition, the underlying emotion recognition deficits found in individuals with intellectual disabilities are present regardless of propensity towards aggression. Intellectual disabilities are a component of many atypical populations and emotion recognition in some of these populations has also been the subject of research.

Autism

Though a disorder characterized by a different set of cognitive impairments, several studies of facial emotion processing have found emotion recognition deficits in individuals with autism. Hobson and colleagues found deficits in the ability of autistic individuals to discriminate facial expressions from photographs and deficits in the ability to match facial expressions to vocal, gestural, and situational cues; relative to individuals with intellectual disabilities who were matched on mental age. These deficits have been linked to the "abnormal or impaired development in social interaction and communication" that is part of the diagnostic criteria of autism (American Psychiatric Association [APA], 2000, p. 70; Hobson et al., 1989).

In a similar study of emotion processing in atypically developing children, Moore, et al. (1997) compared the abilities of individuals with autism, individuals with "non-autistic" intellectual disabilities, and typically developing children and adolescents (matched to the autistic individuals and individuals with intellectual disabilities on mental age) to recognize the following emotional states: happy, sad, scared, angry, cold, tired,

itchy and hurt. In one experiment, participants were shown a series of video segments, each showing a person portraying one of the emotional states and prompted to tell "what's happening here?" (Moore et al., 1997, p. 409). There was no significant difference between the number of individuals in the typically developing group (10 out of 13) and the number of individuals with non-autistic intellectual disabilities (12 out of 13) that described the emotion being portrayed without being prompted; however, only 3 out of 13 individuals in the autistic group described the portrayed emotion and each individual only described the emotion in one video segment (Moore et al., 1997).

In a subsequent experiment, Moore et al. (1997) presented these same participants with a series of video segments, each showing a person portraying one of the emotion states and asked the participants to tell how the person in the segment was feeling. The authors also included video segments of individuals performing "non-emotional actions" with the instruction to tell what the person in the segment was doing, to serve as a control task. A comparison of the non-autistic mentally impaired group and the typically developing group revealed no significant differences in performance on the emotion states task or the actions task. A comparison of the autistic group and the non-autistic group of individuals with intellectual disabilities revealed a statistically significant deficit in performance on the emotion states task in the autistic group. There was no significant difference in performance on the actions task (Moore et al., 1997).

The performance of high functioning boys diagnosed with autism on a task designed to test emotional understanding was compared to the performance of children with Attention Deficit Hyperactivity Disorder and Oppositional Defiance Disorder, and

typically developing children (Downs & Smith, 2004). The authors intentionally choose

high functioning individuals who completed at least two years of social skills training for

the autistic group. The other two groups of participants received no specialized training in

social skills. All participants were between 5 and 9 years of age. The participants were

presented with stimuli designed to test emotional understanding at 5 levels: 1- facial

emotion recognition based on photographs, 2 – emotion recognition based on drawings of

facial expressions of emotion, 3 – identification of emotion based on stories depicting

emotion eliciting situations, 4 – identification of desire based emotions based on stories,

and 5- identification of belief based emotions based on stories (Downs & Smith, 2004).

Each participant was presented with the Level 1 task and progressed through all five

tasks. The participant "passed" a level if all tasks at that level were completed. The

highest completed level became the participant's level of emotional understanding

(Downs & Smith, 2004). The children in the autism group and the group of typically

developing children had the same average level of emotional understanding (mean =

4.40, *SD*=0.52); but the children in the ADHD/ODD group had a statistically significant,

slightly lower average level of emotional understanding (mean = 4.00, *SD*= 0.63).

Although not a statistically significant difference, the children in the autism group

were less accurate overall with an average of 17.80 correct answers than the group of

typically developing children with an average of 18.80 correct answers. Notably, the

children in the autism group were more accurate than the children in the ADHD/ ODD

group with an average of 17.50 correct answers. The autism group was statistically less

accurate on Level 1 items with an average score of 3.30 (*SD*= 1.16) than the group of typically developing children with an average score of 4.00 (*SD*= 0.00).

One explanation for the relative strengths in overall performance on the emotional understanding task put forward by Downs and Smith (2004) is that the children in the Autism group all received considerable instruction in an effort to enhance their ability to function in social situations prior to participating in this study. This unique experience may have helped the autistic children to function at more a normal level for their age. However, the finding of a deficit on Level 1 items (identifying photos of facial emotion expressions) despite the instruction lends support to the common assertion that individuals with autism have a specific deficit in facial emotion recognition (Downs & Smith, 2004). This assertion of a specific deficit in facial emotion recognition, by Downs and Smith (2004) is the essence of what Rojahn et al. (1995) referred to as the emotion specificity hypothesis. Whether explained as permanent deficits or delays that improve with time and under certain conditions, children with autism clearly demonstrate difficulties with facial emotion processing. Autism is not the only atypical population that has been linked to abnormal facial emotion processing and the emotion specificity hypothesis.

Down Syndrome

Despite the perception of interpersonal understanding, sociability, and empathy as areas of strength for individuals with Down syndrome (Wishart, Cebula, Willis, & Pitcairn, 2007), several studies point to limitations in facial emotion processing (Kasari, Freeman, & Hughes, 2001; Williams, Wishart, Pitcairn, & Willis, 2005; Wishart et al.,

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2007). These deficits emerge as early as 3 to 4 years of age, and unlike the pattern of development for typically developing individuals, individuals with Down syndrome do not show continuing improvement with increasing mental or chronological age (Wishart et al., 2007).

A series of studies on emotion recognition in children with Down syndrome, conducted by Kasari et al. (2001), used the puppet measure developed by Denham and colleagues (Denham, 1986). Despite the significantly different types of errors made by children with Down syndrome and mental aged matched typically developing children (confusing positive and negative emotions versus confusing two negative emotions), the mental age of a child with Down syndrome was s a good indicator of ability to recognize facial emotions (Kasari et al., 2001). Although deficient in emotion recognition when compared to typically developing children of their chronological age, children with Down syndrome were comparable to children with intellectual disabilities matched on mental age, and typically developing children matched on mental age when presented tasks that require labeling, recognizing, and identifying the four basic emotions: "happy," "sad," "angry," and "afraid" (Kasari et al., 2001).

Consistent with typically developing preschoolers, children with Down syndrome demonstrated more difficulty when asked to label the emotion being displayed (an expressive task) than when asked to point to the facial emotion display that matches a named emotion (a receptive task). Also consistent with typically developing preschoolers, children with Down syndrome found the labeling and recognizing "happy" and "sad" easier than labeling and recognizing "angry" and "afraid" (Kasari et al., 2001). However,

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the ability to process and identify emotions in children with Down syndrome did not improve in a two-year follow-up study, despite an improvement in mental age over the same two-year period. This lack of improvement in emotion recognition and labeling may have applications for research on children with prenatal alcohol exposure because several studies report arrested social-emotional development in children with prenatal alcohol exposure (Coggins et al., 2003; Jacobson & Jacobson, 2002; Kelly, Day, & Streissguth et al., 2004; Streissguth et al., 1991; Thomas et al., 1998).

Smith and Dodson (1996) used a puppet task with vignettes designed to elicit various emotions (happiness, sadness, neutral) in which the faces of the characters were visible in only half of the vignettes. When the adult participants were asked to rate the intensity of facial emotions expressed by a character in the vignette, individuals with Down syndrome rated happy and neutral characters in the vignettes as happier than the individuals in the control group did (Smith & Dodson, 1996). The individuals with Down syndrome also rated the sad characters within the vignettes as less sad than individuals in the control group (Smith & Dodson, 1996). The happy bias found by Smith and Dodson (1996) was supported by other studies of emotion processing in individuals with Down syndrome. Kasari et al. (2001) compared the emotion recognition abilities of young school-age children with Down syndrome (average chronological age of 76.7 months; average mental age of 40.25 months) and typically developing preschool children. Children with Down syndrome were more likely to mix up "happy" and "sad" (i.e. labeling or choosing "happy" when "angry" was correct); whereas typically developing

children were more likely to mix up emotions in the same valence (i.e. labeling or choosing "sad" for "angry").

Williams et al. (2005) studied the emotion recognition abilities of 34 young individuals (ranging in age from 7.67 to 17.67 years) with Down syndrome (DS) and two comparison groups: individuals (ranging in age from 6 to 17.42) with nonspecific intellectual disabilities (NSID; n=53) and typically developing (TD) individuals (ranging in age from 2.75 to 5.58) matched to the Down syndrome group on mental age (n=39). Participants were shown a target photograph of a person displaying an emotion. Participants were instructed to look at three pictures presented below the target picture and asked, "Can you find another picture of a man/ woman who looks _____ (emotion)?" (Williams et al., 2005, p. 381). The authors also included an identity matching task to serve as a control. Williams et al. (2005) found a significant main effect of group membership (DS, NSID, TD) on emotion matching performance. Post hoc analyses revealed the DS group performed significantly below the TD group; however, there was no significant difference in performance between the DS group and the NSID group. An analysis of the types of errors TD individuals made in the emotion matching task revealed "a single most common error for all target emotions: disgust for both sadness and anger, surprise for fear, fear for surprise, and sadness for disgust" (Williams et al., 2005, p. 385). The NSID group had an error pattern very similar to that of the TD individuals. The individuals with DS did not show a distinct error pattern (Williams et al., 2005).

Another study comparing the performance on an identity matching task and a facial emotion matching task (happy, sad, angry, surprise, fear, and disgust) used four

groups: fifteen adolescents with Fragile X syndrome (FXS), 15 adolescents with Down syndrome (DS), 15 adolescents with non-specific intellectual disability (NSID), and 15 typically developing (TD) children matched to the other 3 groups (FXS, DS, NSID) on cognitive age and language ability. Wishart et al. (2007) found no significant difference among the four groups on the identity matching task. There was also no main effect of group identity on emotion matching; however, post hoc analysis revealed a significant difference between the TD group and the DS group, with the DS group performing significantly worse than the TD group (Wishart et al., 2007). An analysis of error patterns also revealed a pattern for the DS group that was different from the other groups. Individuals with NSID and TD individuals frequently confused surprise with fear in response to fearful faces, whereas the individuals with DS often confused sad with fear in response to fearful faces. This finding is consistent prior studies that find individuals with Down syndrome have delayed development of emotion recognition and relatively poorer performance compared to typically developing children of the same mental age; however, it contradicts the findings of other studies that find individuals with Down syndrome make response errors that are incongruent with the valence of the expressed emotion (Kasari et al., 2001; Smith & Dodson, 1996). Although there are some discrepancies, all of these studies show individuals with Down syndrome have facial emotion processing deficits despite being described as empathetic and social (Wishart et al., 2007).

Fragile X Syndrome

Individuals with Fragile X syndrome (FXS) are comparable to individuals with DS on level of intellectual functioning; however, there is a perception of relative strength

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in interpersonal understanding associated with DS, whereas Fragile X syndrome has been associated with impaired interpersonal understanding ("shyness and communication difficulties" and significant anxiety in social situations) (Mazzocco, Pennington, & Hagerman 1994; Wishart et al., 2007, p. 553). A comparison of individuals with Fragile X syndrome, Down syndrome, non-specific intellectual disability, and typically developing individuals, conducted by Wishart et al. (2007) demonstrated no significant difference in overall emotion matching ability between individuals with Fragile X syndrome and typically developing individuals. When the error patterns were compared, individuals with Fragile X syndrome often confused surprise with fear, consistent with the errors made by individuals with non-specific intellectual disability and typically developing individuals. Individuals with Fragile X syndrome also frequently confused sadness with fear, consistent with the error pattern of individuals with Down syndrome (Wishart et al., 2007).

Williams Syndrome

Similar to individuals with Down syndrome, individuals with Williams syndrome are often described as affectionate and companionable individuals (Gagliardi et al., 2003; Plesa-Skewerer, Faja, Schofield, Verbalis, & Tager-Flusberg, 2005). In fact, an overly friendly reaction towards strangers is also part of the Williams syndrome personality profile (Gagliardi et al., 2003). A mastery of linguistic tools including emotionally referenced language is also found in the Williams syndrome population (Gagliardi et al., 2003). Based on these personality characteristics and skills, several researchers have speculated about the emotion recognition ability in individuals with Williams syndrome

(Gagliardi et al., 2003; Plesa-Skewerer et al., 2005; Porter, Colthart, & Langdon, 2007). Although many suggest individuals with Williams syndrome have intact face processing ability because they are highly social and seek out interactions with others; the research on emotion recognition ability in individuals with Williams syndrome is inconsistent with the behaviors demonstrated during social interactions.

In a study of facial processing and emotion recognition ability, Plesa-Skewerer et al. (2005) found that individuals with Williams syndrome were less able to recognize facial displays of emotion (measured by the DANVA) than a group of typically developing individuals matched on chronological age; however, performance of the individuals with Williams syndrome did not differ from the mental age matched group of individuals with mixed etiology. One limitation of this study was that the mental age matched group included individuals with varied diagnoses including dyslexia and other learning disabilities, obsessive-compulsive disorder, Down syndrome, and low IQ.

Porter et al. (2007) also compared the abilities of individuals with Williams syndrome, Down syndrome, typically developing individuals matched on chronological age, and typically developing individuals matched on mental age. Similar to Plesa-Skewer et al. (2005), the chronological age matched control group performed significantly better than the mental age matched control group and the Williams syndrome group, which had equivalent performance. However, the individuals with Williams syndrome were more accurate than a group of individuals with Down syndrome who were also included in the study (Porter et al., 2007).

Gagliardi et al. (2003) compared the facial processing and emotion recognition abilities of individuals with Williams syndrome to CA matched and MA matched control groups. The performance of the Williams syndrome group was significantly worse than a chronological age matched control group on facial emotion recognition, but equivalent to a mental age matched control group. Gagliardi also found that facial processing (verbal receptive knowledge measured by the Benton test of facial recognition) was not related to facial emotion recognition (measured by the AFFECT expression task). Facial processing was correlated with chronological age, but facial emotion recognition was correlated with IQ. According to Gagliardi et al. (2003), performance on both tasks can be explained by the finding that individuals with Williams syndrome are able to use featural face processing, but are unable to progress to configural processing. The correlation between facial processing and chronological age is explained by the perfecting of featural processing associated with more experience. Gagliardi suggests configural processing ability is linked to brain functioning and the lack of configural processing ability cannot be improved by experience. Those individuals with higher IQ probably have less brain damage or malfunction which would increase the likelihood of intact configural processing ability. This finding is consistent with the research by Deruelle and colleagues (1999) presented earlier and confirms Duerelle's hypothesis of impaired configural processing in Williams Syndrome.

Research on facial emotion processing abilities in individuals with atypical cognitive development (including DS, WS, and autism) have demonstrated that across these different cognitive impairments, individuals struggle with the processing of faces.

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Although in most cases featural processing seems minimally affected by cognitive impairments, the lack of configural processing impedes individuals' ability to recognize and interpret emotion displays.

Emotional Development in Individuals with FASDs

A literature search on emotion recognition in individuals prenatal alcohol exposure failed to yield a single study that used direct measures of emotion recognition indicating a dire need for more research in this area. Emotion recognition is a critical component of socio-emotional competence and influences emotion understanding and emotion regulation (Halberstadt et al., 2001). Although there is a lack of research on emotion recognition in individuals with prenatal alcohol exposure, the body of research on the process of social emotional development in prenatal alcohol exposed population is growing. Reviewing this literature can provide a more complete picture of the child with a FASD and will put the results of this study in context.

Most assessments of social emotional development in children and adolescents with prenatal alcohol exposure have used parent and/or teacher ratings on standardized tests of adaptive behaviors, such as the *Vineland Adaptive Behavior Scales* (VABS) (Sparrow, Balla, & Cicchetti, 1984, p. 1) and behavior checklists, such as the *Child Behavior Checklist* (CBCL) (Streissguth et al., 1991; Thomas et al. 1998; Kelly et al., 2000). The VABS assesses how well an individual is able to function in four "domains" ("daily living skills, communication skills, social skills, and motor skills") of a typical age appropriate environment (Sparrow et al., 1984). The CBCL lists a series of distinct

behaviors; the focus child's behavior is rated by parents and teachers (Thomas et al., 1998). The VABS and CBCL both screen for a broad range of behaviors and skills deficits, and they are intended to be used part of a multifaceted evaluation of the focus individual. Although the VABS and CBCL do not provide sufficient evidence of a disorder or developmental disability, scores on both of these assessments can flag children that should be evaluated further and inform the subsequent evaluation.

Despite the limited measures of adaptive behaviors, research using the VABS and CBCL has shown evidence of social and emotional impairments in individuals with FAS. Several studies on individuals with prenatal alcohol exposure that include measures of adaptive behavior find clear evidence of problems in understanding emotions and engaging in social interactions. For instance, Streissguth et al. (1991) found adolescents and adults diagnosed with FAS or Partial FAS were impaired across all levels of adaptive functioning when compared to normal controls, but showed relative strength in the "daily skills" domain and relative weakness on the "social skills" domain of the VABS. They found consistent answers among those evaluating sample individuals on some items of the VABS that pertain to social skills, including "show unresponsiveness to social cues, lack of reciprocal friendships, lack of tact, and difficulty in cooperating with peers" (Streissguth et al., 1991, p. 1965). The participants in this study ranged in age from 13 to 33 years (mean age of 17 years), but their scores on the "social skills" domain of the VABS indicated their level of social functioning was equivalent to a 6-year-old. Another significant finding was that the social deficiencies were found in individuals with IQ

scores in the normal range and not just those with intellectual disabilities (Streissguth et al., 1991).

Expanding on the findings of Streissguth et al. (1991), Thomas and colleagues (1998) used the VABS to compare caregiver reports of the abilities of children with a diagnosis of FAS (5-13 years) to children without alcohol exposure who were matched on verbal IQ, and to typically developing children with average to above-average IQs. Verbal IQ matching was chosen for the first control group because scores on verbal domains of intelligence measures have a stronger correlation with social abilities than scores on performance domains or overall scores on intelligence measures (Thomas, et al., 1998). Consistent with the findings of Streissguth et al. (1991), Thomas et al. (1998) found children with FAS scored lower than children matched on verbal IQ without prenatal alcohol exposure and typically developing children with average to above-average IQs on the "social skills" domain of the VABS. Specifically, on the "interpersonal skills" subdomain of the "social skills" domain, children with FAS had lower scores than children matched on verbal IQ which were lower than the scores of the normal control (Thomas, et al., 1998). On the "play and leisure" subdomain, the FAS group had lower scores than the group matched on verbal IQ and the scores of normal control group, which were equivalent (Thomas, et al., 1998). Another significant finding is that the FAS group showed more severe problems and social-emotional deficits than the group of individuals with intellectual disabilities but no history of alcohol exposure who were matched to the FAS group on verbal IQ (Thomas et al., 1998). Lower scores on these subdomains support Thomas et al.'s claim that the social emotional problems found

in individuals with FAS are not solely explained by a general cognitive impairment or below average intelligence (1998). The implication of a dissociation between social abilities and general cognitive functioning is also strengthened by the finding that even those individuals who score within the normal range on measures of IQ demonstrate deficits in social emotional competence (NCBDDD, 2004; Streissguth et al., 1991; Weinberg, 1997).

Like Streissguth et al. (1991), Thomas et al. (1998) found the scores of children with FAS on the "interpersonal skills" and "play and leisure" subdomains of the "social skills" domain of the VABS indicated their level of social functioning stopped increasing and was equivalent to typically developing 4- to 6-year-olds. Thomas et al. (1998) believe this finding indicates more than a delay in social abilities. If the social abilities of individuals with FAS continue to decline relative to normal peers, then the social abilities of individuals with FAS must stop or "arrest" at some point (Thomas, et al., 1998). This significant gap between the social skills of individuals with FAS and typically developing peers continues to widen as these individuals move into adolescence and adulthood, when increased skill is expected of the typically developing individuals.

Measures of adaptive functioning, such as the Vineland Adaptive Behavior Scales (Sparrow et al., 1984) and behavior checklists, such as the Child Behavior Checklist CBCL (Achenbach & Edelbrock, 1986) tap emotion and behavior regulation and social skills. However, they provide very little information about the child's ability to understand emotions. If measures of adaptive functioning do not help explain emotion processing, cues must be taken from studies of other aspects of emotional and social

functioning. Many characteristics of prenatally exposed children and the interaction of these characteristics with environment may shed some light on potential emotion processing difficulties in children with prenatal alcohol exposure.

Predictions Based on Prior Research with Typical Populations

Child Characteristics

Although there is no clear model, those researchers beginning to study social-emotional development in individuals with prenatal alcohol exposure have discovered numerous intrapersonal and interpersonal influences that are consistent with social deficits and later maladjustment in typically developing children. For example, prenatal alcohol exposure contributes to several characteristics of child temperament that are associated with maladjustment within normal children. Within the first two days after birth, infants with prenatal alcohol exposure show interrupted patterns of sleep and feeding problems in infants with prenatal exposure to alcohol, including feeble and delayed sucking (Kelly et al., 2000). According to Kelly et al. (2000), these abnormalities in sleeping and eating could be early signs of poor self-regulation. Prenatal alcohol exposure is also associated with heightened irritability in infants (Weinberg, 1997; Jacobson & Jacobson, 2002; Kelly et al., 2000; O'Connor & Paley, 2006). These temperamental characteristics (abnormal sleeping and feeding patterns, irritability) are potentially damaging to the child's attachment and relationship with the parent and are associated with later behavioral problems and maladjustment in the child (Denham, 1998; Kelly et al., 2000; O'Connor et al., 2002; O'Connor & Paley, 2006). The lack of a secure

attachment relationship would limit the types of interactions that allow the child to learn about emotions from parents. In addition, the irritability would inhibit peer interactions and increase the child's exposure to negative feedback.

Parent-Child Relationship

There also are several aspects of the parent-child relationship that interact with child-level factors to guide social-emotional development (Denham, 1998). One important area of research into social-emotional development of typically developing children is the nature of the parent-child dyad (Denham, 1998; Kelly et al., 2000; O' Connor & Paley, 2006). Within the parent-child dyad, there are bidirectional interactions between the temperamental characteristics and self-regulatory abilities of the child and the mother's sensitivity to and ability to meet the child's needs (Kelly et al., 2000; O'Connor & Paley, 2006).

One aspect of the parent-child dyad is the parent's interactions with the child (Kelly et al., 2000; Koponen et al., 2009; O'Connor & Paley, 2006). In a study of Caucasian middle-class mothers' behavior, while in interaction with their one-year-old infants, researchers found that alcohol consumption has a negative effect on maternal behavior. Mothers who drank heavily during pregnancy spent less time elaborating on their children's behavior and provided less cognitive stimulation to their infant children compared to mothers who only drank occasionally or abstained during pregnancy (O'Connor & Paley, 2006). Thus, a caregiver's sensitivity to the child, one aspect of the parent-child dyad, can be adversely affected by alcohol consumption, such that high

levels of alcohol consumption leads to low levels of sensitivity (Kelly et al., 2000; O'Connor & Paley, 2006).

Child abuse or maltreatment, an extreme extension of the poor caregiver insensitivity, is identified in literature of typically developing children as an environmental or interpersonal factor that influences social-emotional development (Denham, 1998). Child abuse and maltreatment are common in alcoholic mothers (Kelly et al., 2000; Koponen et al. 2009; O'Connor & Paley, 2006). In a study of 38 prenatally exposed children who were in long-term foster care at the time of the study, Koponen et al. (2009) found 37% of the children had been exposed to family violence, 58% had experienced "neglect of daily care" and 16% had experienced physical abuse (p.1052). Although a caregiver's sensitivity to the child is not a direct result of the child's prenatal alcohol exposure, there is a connection. Those mothers who expose their children to alcohol in the womb usually continue to drink following the birth of the child (Kelly et al., 2000; O'Connor & Paley, 2006). All 38 of the mothers whose children were studied by Koponen et al., (2009) continued to drink following the birth of the child. These mothers are most likely lacking normal levels of patience, so it stands to reason they do not have the extreme patience required to respond sensitively to an irritable child with poor sleep and feeding patterns (Kelly et al., 2000, O'Connor & Paley, 2006)

There is also a connection between attachment, another aspect of the parent-child dyad, and a child's prenatal exposure to alcohol (O'Connor et al., 2002). Middle class mothers who self-reported they engaged in social drinking participated in the Strange Situation experiment with their children. Despite the protective factor of moderate to high

SES, and the low levels of alcohol exposure, the children of these mothers were much more likely to be classified as having a disorganized style of attachment rather than a secure attachment based on the Strange Situation experiment (O'Connor et al., 2002). Disorganized attachment is marked by abnormal and contradictory or confusing patterns of behavior. Another important finding from this study is that those mothers who reported the heaviest drinking compared to others in the study had even higher rates of disorganized attachment styles in their children (O'Connor et al., 2002). O'Connor and colleagues believe a difficult child temperament and the types of interactions the child has with his or her mother mediate "the association of prenatal alcohol exposure and child attachment security" (Kelly et al., 2000; O'Connor et al., 2002, p.1599). Prenatal alcohol exposure was associated with greater frequency and intensity of negative affect in the child when in interaction with his or her mother. The child's negative affect decreased the mother's "supportive presence" or capacity to give emotional support and assist the child in performing the task in addition to fostering autonomy in the child (O'Connor et al., 2002, p.1599).

Many researchers of social-emotional development view parent-child interactions as the foundation for the child's subsequent social interactions (Denham, 1998; Kelly et al., 2000). From studies of typically developing children, we know during the parent-child interaction, the child often matches his or her affect to that of the parent (Denham, 1998; Cicchetti & Toth, 1998). The parent becomes a model of emotion expression and emotion regulation for the child (Denham, 1998). Children also create an internal working model of a relationship from the emotion information via interactions with

caregivers. This internal working model is then applied to future interactions, including those in which the parent is not present (Cicchetti & Toth, 1998; Denham, 1998). A child with a secure attachment to a caregiver develops an internal working model that includes the expectation that people are generally trustworthy and reliable; thus, the child will likely seek out interactions with others (O'Connor et al., 2002; Thompson, 2000; Waters & Cummings, 2000). A secure attachment allows children to exhibit positive affect and effectively handle negative emotions, both of which promote social interaction (Denham, 1998; O'Connor et al., 2002). The child with a disorganized attachment style develops an internal working model that includes the expectation that other people cannot be trusted to meet his or her needs so the child is unlikely to seek out interactions with others (Cicchetti, & Toth, 1998; Denham, 1998; O'Connor et al., 2002; Thompson, 2000). Overall, the lack of a secure attachment relationship limits the quantity and quality of the child's interpersonal interactions, from which the child can learn about emotions.

The impact of prenatal alcohol exposure on the mother-child relationship has been seen in children of mothers who report a range of alcohol consumption during pregnancy. Disorganized attachments have been found in children of mothers reporting high levels of alcohol ingestion (binge drinkers who ingest large amounts of alcohol in a single sitting or chronic drinkers who ingest moderate amounts of alcohol continuously) as well as in children of mothers who identified themselves as "social drinkers" (occasional drinkers who consume only small amounts) (Kelly et al., 2000). The increased risk of insecure attachment styles in children with prenatal alcohol exposure is a significant concern

because parent-child interactions are crucial to the child's later ability to succeed in social interactions (Denham, 1998).

Thus, there is a bidirectional interaction between individual risk factors such as irritability, difficult temperament, and neurological impairment; and environmental risk factors such as a lack of sensitive care giving, an insecure attachment, poor modeling of emotion regulation, and other risks associated with living with a parent who abuses alcohol including high levels of stress and conflict. The combination of infant temperamental characteristics and potentially erratic behavior characteristic of maternal alcohol intoxication leads to a downward spiral in which the infant's temperamental characteristics result in negative maternal responses, which then leads to more abnormal behavior in the infant (Kelly et al., 2000; O'Connor et al., 2002). Knowledge of emotion recognition in typically developing children provides a clear picture against which the differences in individuals with FASDs can be contrasted. Similarities between individuals with FASDs and other diagnoses offer possible explanations for potential emotion recognition deficits associated with FASDs.

Predictions Based on Prior Research on Atypical Populations

Despite the consistent problems in understanding emotions and engaging in social interactions found in individuals with FAS, there is a lack of research on the specific emotion recognition processes in children with prenatal alcohol exposure. This lack of research on emotion recognition in individuals with FAS limits insight of how the acknowledged deficits in understanding emotions relate to the inappropriate behaviors

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during social interactions. However, the literature on other special populations with cognitive and adaptive limitations and developmental difficulties can shed light on the potential problems and maladaptive processes associated with emotion recognition difficulties. Kasari & Sigman (1996) believe individuals diagnosed with Down syndrome or autism are prototypes for the possible types of delays and abnormalities in emotional expression because many of the distinct characteristics found in the Down syndrome and Autistic populations have been linked to deficits in certain aspects of emotion understanding. These two groups may be particularly relevant to emotion understanding in individuals with prenatal alcohol exposure because FAS shares several important characteristics with Down syndrome and Autism. The literature on individuals with intellectual disabilities (etiology not due to autism and Down syndrome) is also a source of information about potential issues for individuals with prenatal alcohol exposure.

Facial Display Limitations

A review of literature in the area of facial display limitations reveals that individuals with Down syndrome have problems with creating facial emotion displays, presumably due to poor muscle control, particularly in the midface (Denham, 1998; Smith & Dodson, 1996). The lack of facial expression found in individuals with Down syndrome could be one source of the problems in social interaction for these individuals because the lack of facial expression deprives social partners of an important source of information about affective state (Denham, 1998; Smith & Dodson, 1996). Emotional understanding in children with Down syndrome may be inhibited because the response from others may not match the affective message they intended to send out; so, these

children may not develop the correct associations between a sent affective message and its typical response. The inability to effectively display facial expressions not only inhibits effective communication of affective state, but these children also miss out on the feedback from parents and other adults who help children understand their emotions by identifying them when displayed (Denham, 1998).

Children with FAS have flat midfaces as well as two other facial characteristics similar to those of Down syndrome: epicanthal folds at the corners of the eye (NCBDDD, 2004) and small palpebral fissure length or "the distance from the endocanthion [innermost corner of the eye] to the exocanthion [outermost corner of the eye]" (Astley & Clarren, 2001, p. 148; NCBDDD, 2004). The presence of the same facial features in FAS that inhibit emotion expression in Down syndrome suggests a common source of impairment for individuals with Down syndrome and FAS. Individuals with prenatal alcohol exposure also share commonalities with other atypical populations.

Knowledge of Facial Display Rules

Individuals with autism are able to display the same basic facial emotions (happiness, sadness, anger, and neutral) as typically developing children, but they often display a facial emotion that is inappropriate for situation (Denham, 1998; Kasari & Sigman, 1996). Children with autism also have trouble determining the cause of emotions particularly for situations that require them to consider beliefs, an integral part of an understanding of Theory of Mind (Campbell et al., 2006; Denham, 1998, Ozonoff, Pennington & Rogers, 1991; Thomas et al., 1998). Recently, Coggins et al. (2003) reported preliminary evidence that children with FAS have difficulty on false-beliefs

tasks that are used to assess Theory of Mind. Problems with mental representation have also been included in the NCBDDD (2004) diagnostic guidelines for FAS. Streissguth et al (1991) found high endorsement of VABS items that indicate a lack of facial display rules and understanding the consequences of behavior, including "unresponsive to subtle social cues… lack of reciprocal friendships… social withdrawal… lack of consideration…and crying or laughing too easily" by the guardians of individuals with FAS (p.1965). These descriptions of individuals with FASDs would make sense if prenatal alcohol exposure affects Theory of Mind and an inability to comprehend the cause of emotions. Misinterpreting the social cues of peers may lead to negative responses to peer invitations to interact and "inappropriate or ineffective strategies for enactment" (McGee et al., 2009, p.825).

Cognitive Processing Limitations

Similar to Williams Syndrome, individuals with a FASD demonstrate impairments in visual-spatial processing and executive functioning. The visual-spatial impairments in Williams Syndrome have been linked to the configural processing deficits found in this population. As described previously, configural processing has been implicated as central to facial emotion recognition. Therefore, documented visual-spatial impairments deficits found in individuals with a FASD diagnosis suggest possible deficits in facial emotion recognition (Carmichael-Olson, Feldman, Streissguth, Sampson, & Bookstein, 1998; Mattson, Schoenfeld, & Riley, 2001; Uecker & Nadel, 1996).

Numerous studies of individuals with a FASD, both those with FAS and those with prenatal alcohol exposure who do not meet the diagnosis of FAS, have revealed deficient executive functioning (Burden, Jacobson, Sokol, & Jacobson, 2005; Kelly et al., 2000; Kodituwakku et al., 1995; 2001a; 2001b; Lee et al., 2004; Maier & West, 2001; Stratton et al., 1996). In a study of planning ability, children with prenatal alcohol exposure and typically developing children were presented with a task that required them to plan a series of steps to solve a problem, called the Progressive Planning Test (Kodituwakku et al., 1995). The children with prenatal alcohol exposure were unable to solve the more complicated problems and broke the rules of the task more frequently (Kodituwakku et al., 1995; Kodituwakku, Kalberg, & May, 2001). Perserverative errors are also common when individuals with prenatal alcohol exposure are presented with conceptual set shifting tasks, such as the Wisconsin Card Sort Test (Carmichael-Olson et al., 1998) and a Visual Discrimination Reversal Task, in which a previously rewarded pattern is now punished and the previously punished pattern is now rewarded (Phase 1) and neither pattern is rewarded (Phase 2) (Kodituwakku, May et al., 2001). Executive functioning deficits are often linked to difficulties with social functioning in children with prenatal alcohol exposure (Kelly et al., 2000; Kodituwakku May et al., 2001) and other atypical populations (Downs & Smith, 2004; Dyck et al., 2006; Karmiloff-Smith et al., 2004; Koshino et al., 2008)

In summary, there is abundant evidence of alcohol-related deficits in social functioning, which have been linked to impaired emotional recognition in other populations. Depression and behavioral disorders, such as ADHD, Oppositional Defiant

Disorder, and Conduct Disorder, which are characterized by difficulties with self-regulation and linked to poor social functioning, are often comorbid with a FASD diagnosis. There are also findings of specific deficits in visual-spatial processing within FASDs similar to those that have been implicated in configural face processing deficits and difficulties with facial emotion recognition in individuals with Williams Syndrome. Finally, individuals with FAS share facial features with individuals with Down syndrome that may impact an individual's ability to properly express emotion and thus receive accurate feedback. Yet, these numerous factors have not led to research that directly assesses emotion recognition in individuals with FASDs. Thus, there is a strong need for observational and laboratory studies that specifically focus on emotion recognition in individuals with prenatal alcohol exposure (Kelly et al., 2000).

Chapter III. Relevant Methodological Issues

Although these studies provide evidence of specific deficits in facial emotion recognition, many of these studies have theoretical and methodological problems that confound the results and prevent researchers from knowing the true source of deficits in emotion recognition. In designing a study to examine emotion processing in children with FASDs and test the emotion specificity hypothesis, it is important to minimize the potential methodological problems. The attempts to address the following methodological problems in the current study will be discussed in the relevant portions of the Methods section.

Matching Groups

An important part of emotion recognition research is the inclusion of control groups. According to Hodapp and Dykens (2001), to truly assess whether there is a deficit in some domain of functioning in special populations, such as autism, Down syndrome and intellectual disabilities, studies should include two control groups. One group should consist of typically developing individuals that are matched to individuals with the target syndrome on relevant variables such as IQ and language ability. The other control group should be typically developing individuals matched to the target group on chronological age (Hodapp & Dykens, 2001).

When matching typically developing individuals to a target group of individuals with cognitive deficits, it is important to ensure the matching criteria do not include items that tap into emotion knowledge. Thomas et al. (1998) recommend using verbal IQ as the matching criteria in studies of emotion recognition because verbal IQ has a stronger correlation with scores on measures of social ability, such as the Vineland Adaptive Behavior Scale (VABS).

To tease out the effects of a particular disorder on facial emotion recognition, individuals with the target disorder should also be matched on relevant variables (age, IQ, language ability), to individuals with other disorders that have established deficits in emotion recognition. For example, to determine whether individuals with FASDs have deficits in emotion recognition, comparisons to other groups with established deficits in emotion recognition such as Down syndrome and autism could be made. The comparison to individuals with Down syndrome and autism is particularly relevant for studies of emotion recognition because Kasari & Sigman (1996) have suggested that autism and Down syndrome are the prototypical conditions for emotion deficits. Autism is particularly relevant to understanding potential emotion processing problems in children with prenatal alcohol exposure because several studies have found that individuals with prenatal alcohol exposure have difficulties with Theory of Mind consistent with those of autistic individuals. Down syndrome is particularly relevant to understanding potential emotion processing problems in children with prenatal alcohol exposure because the two conditions share some facial features (flat midface and epicanthal folds) that may impair proper expression of emotions.

The use of verbal ability as matching criteria may also be an issue because many tests of verbal ability that are used to match participants on mental age include emotion knowledge as part of the measure. For example, in a study of emotion recognition, Hobson et al. (1989) matched autistic individuals with two groups: non-autistic individuals with intellectual disabilities, and typically developing children. The participants were matched on verbal ability using the British Picture Vocabulary Scale (BPVS). Although the results of the study by Hobson et al (1989) did find an emotion recognition deficit in both the autistic and non-autistic group of individuals with intellectual disabilities compared to the typically developing individuals, the use of a measure that taps emotion knowledge as the matching criteria confounds the results. There are other common components of emotion recognition studies that can obscure research findings.

Ambiguous Stimuli

The ambiguity of emotions included in the stimulus array of emotion recognition studies is also an issue. In a study of facial emotion processing, Rojahn et al., (1995) instructed participants to look at a series of photographs and determine whether the facial emotion display of the person in each photograph was "happy," "sad," or "not happy and not sad" and rate the degree of happiness or sadness using a 5 point scale. The participants with intellectual disabilities, mental age (MA) matched normally developing children, and chronological age (CA) matched normal adults had equivalent performance on "happy" faces. The group of individuals with intellectual disabilities also performed

slightly higher than the MA matched group on sad faces. The main difference between the group of individuals with intellectual disabilities and the matched groups was found on neutral faces (Rojahn et al., 1995). The response choice "not happy and not sad" may not have been understood by some of the participants.

Hobson et al. (1989) also included ambiguous emotion stimuli. The participants were instructed to identify whether the people displayed "happiness, unhappiness, fear, anger, surprise, or disgust" (Hobson et al., 1989, p.240). The use of "unhappiness" as one of the categories may have been confusing to the participants. One potential problem is that unhappiness may not have been considered an emotion by the participants. Another potential confound is that fear, anger, and disgust all belong to the group called negative emotions, thus it is possible that the participants grouped all negative emotions under the label of unhappiness.

Moore (2001) believes there is a problem of ambiguity in emotion recognition tasks that include neutral faces, such as Rojahn et al. (1995) because the participants with intellectual disabilities may have believed they were supposed to pick an emotion for every face. Rojahn, et al. (2002) reduced the chance of misinterpretation of task directions by using a practice session with feedback regarding performance after each item in the practice session. Rojahn et al. (2002) also allowed participants to ask questions during the practice session. Including practice items also provides a quick indicator about whether the task can be used or if it is too cognitively complex for the population of interest.

Cognitive Task Demand

In addition to ambiguous stimuli that may include response choices that are vague ("unhappy" used in Hobson et al., 1989) or include rating scales that imply an emotion should be identified (rating the degree of happiness and sadness for each face used in Rojahn et al., 1995), the difficulty of the tasks must be considered. Moore (2001) has also criticized the cognitive demand of both the experimental and control tasks used in studies of emotion recognition, making the point that the emotion-recognition task demands are too high, meaning performance on these tasks is based on information processing capacity (related to IQ) in addition to emotion perception ability.

On identification tasks, in which the participant is asked to choose which of several pictured emotions matches the target emotion word, the individual must be able to keep the verbal target emotion in working memory while accessing the emotional meaning of both the word and the various pictures, and then choose the correct picture. Moore (2001) notes that the simple task of labeling a photograph of a facial emotional expression involves maintaining the contents of the photograph in working memory, accessing the emotional meaning of the facial expression in the photograph, choosing the appropriate emotion label, and giving a verbal response. On matching tasks in which the participant is asked to choose which of several pictured emotions matches a target pictured emotion, the individual must keep the visual information for the target emotion and the visual information of the array of possible matches in working memory, compare the target emotion to the array of possible matches, and choose the correct match. When using rating tasks to assess emotion recognition ability, the individual must keep the

visual information in working memory, "make a non-categorical judgment, and select their response on a scale that may include distracters" (Moore, 2001, p. 495).

Moore (2001) also believes many emotion recognition tasks make the extra cognitive demand of requiring cross-modal matching because the participant is required to look at visual stimuli and respond verbally. A significant relation between emotion recognition ability and IQ, suggests information processing ability impacts performance on facial emotion recognition tasks (Simon, Rosen, Grossman, & Pratowski, 1995); this observation lends support to Moore's (2001) claim that facial emotion recognition tasks also tap into general cognitive ability. Although the effect of cognitive demand in facial recognition tasks cannot be eliminated, matching the target and comparison groups on intellectual functioning (mental age) may control for some of the variation in performance between groups due to task's level of cognitive demand.

A difference in cognitive complexity between experimental and control tasks is also a methodological issue. In Hobson et al.'s (1989) study of autistic, non-autistic individuals with intellectual disabilities, and normal controls all three groups had lower score on the emotion recognition tasks (naming emotion displayed in photos, naming emotion heard on tape) compared with the non-emotion recognition control tasks (naming photographed objects, naming bird calls heard on tape). When analyzed, the within group differences in score across the two types of tasks was larger than the between group differences for all three groups (Hobson et al., 1989). The finding of significantly lower scores on the emotion recognition tasks than on the non-emotion

recognition tasks, even in the normal control group, suggests the tasks are not equivalent in cognitive demand.

Moore (2001) has also criticized the control tasks used in other studies of facial emotion recognition for being less cognitively complex than the emotion recognition tasks. Specifically, Moore (2001) believes level of difficulty in the age recognition control task used by Rojahn, et al. (1995) was not equal to the facial emotion recognition task because these tasks do not make the same response demands on the individual - identifying the emotion displayed via facial expression is more abstract than identifying a person's age. However, unlike the results of Hobson et al. (1989), the results of Rojahn et al. (1995) do not support Moore's claim. The normal adults had similar performance on the emotion recognition task and the age recognition task. Both the typically developing child group and the group of individuals with intellectual disabilities had slightly better performance on the emotion recognition task than on the age recognition task. When the performance of the three groups was statistically analyzed, Rojahn et al. (1995) found the between groups differences were larger than the within group differences. Further analyses revealed the group of individuals with intellectual disabilities had a deficit in emotion recognition compared to the child and adult control groups. This finding is consistent with emotion specificity hypothesis. In addition, the similar performance on the two tasks in the adult control group suggests the tasks are equivalent in cognitive demand.

The problem of control tasks that are not equivalent to facial emotion recognition tasks in cognitive complexity can be addressed by using more than a single control task

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to minimize the confounding effects of intellectual disabilities on IQ and information-processing. Rojahn, Esbensen, and Hoch (2006) used two non-emotion control tasks in their study of facial discrimination. The first control task used was an age picture-labeling task in which the participants rated photographs of faces as young, middle-aged, or old. This task was similar in complexity and design to an emotion picture labeling task in which the participants rated photographs of faces as "happy," "sad" or "not happy" "not sad" (Rojahn, et al., 2006). The second control task was an identity picture-picture matching task in which participants matched a target face to one of five faces in a row beneath the target face. The identity matching task was a control for an emotion recognition task in which participants matched the emotional expression of a target face to the emotional expression of one of five faces in a row beneath the target face. Using paired tasks similar to those found to be equivalent in prior studies may increase the likelihood of equivalency in cognitive demand between emotion and control tasks.

Ecological Validity

Even when a researcher is able to minimize the variance due to dissimilar cognitive functioning between groups, discrepancies in task difficulty (cognitive demand), and misinterpretation of the task (ambiguous stimuli), the results of emotion recognition studies are only useful if the type and format of the stimuli presented are relatively similar to the stimuli encountered in the normal environment. Moore (2001) has criticized the ecological validity of the stimuli used to assess emotion processing. Most studies of emotion recognition used photographs of facial expressions. Moore

believes a static photograph of a facial display of emotion is not a fair representation of the entire emotion experience because photographs lack dynamic movement. In addition, Moore argues that normal situations provide the individual with more information than is present in a photograph of a face. The facial expression of emotion is paired with other nonverbal information (body movement and vocal information), both of which provide important information to the individual who must perceive the emotion being expressed (Moore, 2001).

Moore et al. (1997) attempt to deal with the lack of ecological validity in photographs of facial emotions by having children with autism, children with intellectual disabilities, and typically developing children matched on mental age view videotapes of individuals performing an action or expressing an emotion. Moore et al. (1997) found that the individuals with intellectual disabilities were equivalent to the typically developing children in their ability to comment spontaneously on the emotions expressed by the individuals in the videotapes. Both groups were also equivalent in their ability to label the specific emotional expressions seen in the videotape; however, despite the dynamic motion provided by the video segments, the autistic children were significantly impaired in their ability to discuss or label the emotional expressions presented in the videotape.

Matheson and Jahoda (2005) attempt to address the problem of ecologically invalid measures of emotion recognition by comparing the performance of individuals with intellectual disabilities on three tasks: photographs of facial expressions, photographs of individuals expressing an emotion in context, and drawings of individuals

expressing an emotion in context. The results of this study revealed improved ability to recognize emotions when the contextual information was present (Matheson & Jahoda, 2005) and suggests that researchers studying emotion recognition should consider using tasks that provide contextual information. One assessment tool that has been used successfully with individuals diagnosed with Down syndrome (Kasari et al., 2001) is a puppet measure developed for use with preschool children (Denham, 1998). The puppet measure includes a series of vignettes that the experimenter acts out through a puppet. The child is presented with four felt faces displaying "happy," "sad," "angry," and "afraid." After each performance, the experimenter asks children to respond to the emotion vignette by putting the correct face on the puppet.

The four major methodological issues: inclusion and matching of groups, ambiguous stimuli, cognitive task demand (in general and discrepancies between the various tasks), and ecological validity were all considered when designing this study. Decisions about the populations from which participants were drawn and the tasks chosen as a part of this study were made in an effort to use the best practices that have emerged from prior research into face and emotion recognition.

Chapter IV. Study Purpose and Research Hypotheses

Emotion Specificity Hypothesis

The emotion specificity hypothesis states that certain groups of individuals with intellectual disabilities have deficiencies in processing facial emotional expressions, which cannot fully be explained by the current level of intellectual functioning (Rojahn et al., 1995; Rojahn & Zaja, 2008). In other words, the deficiency in processing facial emotional expressions is not simply a secondary effect of intellectual deficiencies. Experimentally, the emotion specificity hypothesis was supported by Rojahn et al. (1995), who showed that a group of adults with intellectual disabilities performed relatively more poorly on an emotion recognition task compared to a group of mental age matched children; however, the performance of the two groups on a control task (matched for cognitive demand) were more similar. Subsequent research findings from studies with other groups (Williams Syndrome, Down syndrome, and Fragile X Syndrome) also support the emotion specificity hypothesis (Gagliardi et al., 2003; Williams et al., 2005; Wishart et al., 2007).

The main purpose of this study is to investigate whether the emotion specificity hypothesis can be demonstrated in a group of participants with FASDs. Phrased differently, do individuals with FASDs have deficiencies in recognizing facial emotional

expression that cannot fully be explained by their current level of intellectual functioning? This question can be reformulated into the following null hypothesis:

H_10: There will be no performance difference between participants with a FASD diagnosis and participants in a control group of typically developing children on either portion of the Facial Processing Task-Emotion (labeling and matching) or the three control facial processing tasks (age labeling, gender labeling and identity matching).

The alternative hypothesis that would demonstrate the emotion specificity hypothesis in a group of participants with FASDs is:

H_11: Participants with a FASD diagnosis will show a relatively poorer performance on both portions of the Facial Processing Task-Emotion (labeling and matching) compared to the typically developing control group; however, participants with a FASD diagnosis will show relatively similar performance on the three facial processing control tasks (age labeling, gender labeling and identity matching) compared to the typically developing control group.

The secondary purpose of this study is to investigate whether the emotion specificity hypothesis can be demonstrated in a group of participants with Down syndrome. The null hypothesis formulated for this purpose:

H_20: There will be no performance differences between participants with a Down syndrome diagnosis and participants in the control group of typically developing children on either portion of the Facial Processing Task-Emotion (labeling and matching) or the three facial processing control tasks (age labeling, gender labeling, and identity matching).

The alternative hypothesis that provides evidence for the emotion specificity hypothesis:

H_21: Participants with Down syndrome will show a relatively poorer performance on both portions of the Facial Processing Task-Emotion (labeling and matching) compared to the typically developing control group; however, participants with Down syndrome will show relatively similar performance on the facial processing control tasks (age labeling, gender labeling and identity matching) compared to the typically developing control group.

The tertiary purpose of this study is to investigate whether individuals with a FASD diagnosis and Down syndrome differ in facial processing ability, which has been reformulated into the following null hypothesis:

H_30: There will be no performance differences between participants with a diagnosis of Down syndrome and a diagnosis of FASD on either portion of the Facial Processing Task-Emotion (labeling and matching) or the three facial processing control tasks (age labeling, gender labeling, and identity matching).

Two opposing alternative hypotheses would each provide evidence of facial processing differences between individuals with a FASD diagnosis and individuals with a Down syndrome diagnosis:

H_31: Participants with Down syndrome will show relatively poorer performance on both portions of the Facial Processing Task-Emotion (labeling and matching) compared to the FAS group; however, participants with Down syndrome will show

relatively similar performances on the facial processing control tasks (age labeling, gender labeling, and identity matching) compared to the FASD group.

$H_3 2$: Participants with FASD will show relatively poorer performance on both portions of the index task (emotion labeling and emotion matching) compared to the Down syndrome group; however, participants with FASD will show relatively similar performances on the three facial processing control tasks (age labeling, gender labeling, and identity matching) compared to the Down syndrome group.

In addition to testing the emotion specificity hypothesis, this study also seeks to add to the literature on behavior problems and adaptive behavior deficits associated with prenatal alcohol exposure. The fourth purpose of this study was to investigate whether symptoms of Attention Deficit Hyperactivity Disorder (ADHD), Conduct Disorder (CD), Oppositional Defiant Disorder (ODD), and Depression are more prevalent in individuals with a FASD diagnosis than in individuals with a DS diagnosis or typically developing individuals. This has been reformulated into the following null hypothesis:

$H_4 0$: There will be no difference in the scores of participants with a FASD diagnosis, the scores of participants with a DS diagnosis, and the scores of typically developing participants on the following subscales of the Conners' Comprehensive Behavior Rating Scale-Parent (Conners' CBRS-P): ADHD (Predominantly Inattentive and Predominantly Hyperactive-Impulsive), CD, ODD, and Major Depressive Episode.

The alternate hypothesis that would support prior findings of higher rates of ADHD, CD, ODD, and Depression in individuals with FASDs:

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H_41: Participants with a FASD diagnosis with have higher scores than the participants with a DS diagnosis and typically developing participants on the following subscales of the Conners' CBRS-P: ADHD (Predominantly Inattentive and Predominantly Hyperactive-Impulsive), CD, ODD, and Major Depressive Episode.

The final purpose of this study is to determine whether face recognition ability is related to adaptive social behavior. Does an individual's ability to process faces predict the individual's adaptive social functioning? This question can be rephrased as the following null hypothesis:

H_50: There will be no difference in the Social Responsiveness Scale (SRS) scores of participants with high FPT percent correct scores and the SRS scores of participants with low FPT percent correct scores.

The alternative hypothesis that provides evidence for a relation between facial processing ability and adaptive social behavior:

H_51: Participants with more developed facial processing ability, as evidenced by high FPT percent correct scores, will have more developed adaptive social behavior demonstrate fewer problems in social interactions, as evidenced by low SRS standard scores; and participants with less facial processing ability, as evidenced by low FPT percent correct scores will have less developed adaptive social behavior and demonstrate more problems in social interactions, as evidenced by higher SRS scores.

Chapter V. Methods

Participants

　　Three groups of children participated in this study. Children with Fetal Alcohol Spectrum Disorders (FASD Group) were the focus group of the study. Children with Down syndrome (DS Group) matched to the children in the FASD group on mental and chronological age served as one comparison group. Down syndrome was chosen as a comparison group because Kasari and Sigman (1996) identified Down syndrome as one of the prototypical conditions for emotion deficits; and because individuals with FASD and Down syndrome share some facial features. Typically developing children (TD Group) matched to the children in the FASD group on mental age also participated in this study and served as a second comparison group. The inclusion of a chronological and mental age matched control group of atypically developing individuals (DS Group) and a mental age matched control group of typically developing children (TD Group) was done to address the methodological issue of poorly matched groups and is consistent with Hodapp and Dykens (2001) specification that emotion recognition research should include a control group of typically developing individuals and an atypical population (Down syndrome) with similarities to the population of interest.

　　To be included as a participant, individuals had to demonstrate sufficient intellectual, sensory, and physical capacities to perform the study tasks; and thus be able

to indicate which of five faces displayed matches a target face (verbally stating "one" "two" "three" "four" or "five" or pointing to the correct picture on a computer screen).

Fetal Alcohol Spectrum Disorder (FASD) Group

Twenty-five individuals, (7 males) between 5 (66 months) and 14 (173 months) years of age with confirmed prenatal alcohol exposure participated in this study. The participants were recruited from the National Organization on Fetal Alcohol Syndrome (NOFAS) in Washington, D.C. and state affiliates in Virginia, Maryland, North Carolina, and Ohio (see Table 1). The primary researcher attended NOFAS support group meetings in Northern Virginia and Maryland with the permission of NOFAS. At these support group meetings, the study was explained and a brief handout was distributed. The handout briefly described the study and asked parents to contact the researcher if they were interested in having their child participate in this study. The researcher was also available after the support group meetings to talk to those interested in participating. The NOFAS affiliates, who worked directly with individuals with FASDs, also posted information about the study to their listserves, distributed the recruitment letter (with the primary investigator's contact information) and told potential participants to contact the researcher if they were interested in participating in the study.

All participants reported having a FASD diagnosis; however, information on the diagnostic process was not collected for any of the participants. Nine children (36%) reported a Fetal Alcohol Syndrome (FAS) diagnosis (see Table 1). Seven children (28%) were diagnosed with Partial Fetal Alcohol Syndrome (PFAS, formally know as Fetal

Alcohol Effects FAE). Five children (20%) reported a diagnosis of Alcohol Related

Neuro-Developmental Disorder (ARND). The remaining 4 children (16%) were

diagnosed with abnormal brain development (structural and functional anomalies) and

had confirmed prenatal alcohol exposure; thus these individuals were identified as having

a FASD, but did not receive one of the recognized diagnoses (FAS, PFAS, ARND,

ARBD) on the Spectrum. The age of diagnosis was not reported for two of the children.

Of the 23 children who reported an age of diagnosis, over half of the individuals in the

sample (52%) were diagnosed within their first 48 months of life, and thus before

beginning formal education. Since all FASD participants were recruited through NOFAS

and state affiliates, all participants had access to intervention services.

Twenty-one (84%) of the FASD participants were adopted and three (12%)

participants were living with a familial legal guardian. Only one participant with FASD

was in the custody of and resided with the birth mother (Table 1). The adoptive parents

and familial legal guardians were asked what age the child was when he or she came to

live with the adoptive parent or legal guardian; however this information was only

provided for 21 of the 24 children not living with his or her birth mother. Thirteen of the

21 (62%) were placed with their adoptive parent/ legal guardian within the first year of

life; and 4 (19%) were placed between the first and second year of life. The remaining 4

children living with adoptive parents or legal guardians were placed at 30 months (2

children) and 60 months (2 children). Age of placement was used in lieu of age of

adoption because the age at which the child was placed in the current environment was

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believed to be more important than the age at which the child's formal adoption or the court's formal custody decision occurred.

The developmental age equivalent from the PPVT-III was used as the measure of mental age (MA). The average MA of the individuals in the FASD group was 7 years (84.44 months, *SD* = 26.48, range 30-148 months) (see Table 2).

Studies comparing children with various FASDs have found consistent impairment in all children with prenatal alcohol exposure regardless of actual diagnosis (Schonfeld et al., 2006; Whaley et al., 2001). Schonfeld et al. (2006), in particular found a connection between deficits in executive functioning and social difficulties in "all participants regardless of FASD Diagnosis – there was no significant difference between the child participants with a FAS diagnosis, partial FAS, and ARND on any of the study measures" (Schonfeld et al., 2006, p.447). Based on these findings, this study did not limit recruitment, inclusion in the study, or inclusion in final analyses to only those children with a formal FAS diagnosis.

Down Syndrome Group

Fourteen individuals with Down syndrome (3 male) between 6 (75 months) and 11 (142 months) years of age matched to the participants with a FASD on chronological age (CA) and MA participated in this study. Participants were recruited from Virginia, North Carolina, and Tennessee (Table 1). Participants with Down syndrome were recruited through parent support groups and other professionals working directly with individuals with Down syndrome, who were given copies of the Down syndrome

recruitment letter to distribute to any potential participants. Prospective participants were provided with the primary investigator's contact information (which is included in the recruitment letter), and told to contact the researcher if they were interested in participating in the study.

All participants reported a diagnosis of Down syndrome; however, information on the type of Down syndrome (Trisomy 21, Mosaicism, Translocation) and the diagnostic process was not collected for any of the participants. All 14 of the children with a diagnosis of Down syndrome were identified at birth or within the first three days of life; however parents reported the diagnosis based on the results of formalized karyotype analysis ranged from prenatal to two weeks of age. All of the participating children with a DS diagnosis lived with their biological parents (Table 1). The average MA of the individuals in the DS group, measured by the PPVT-III developmental age equivalent, was 5.5 years (67.14 months, SD = 22.90, range 40-104 months) (see Table 2). The researcher matched each Down syndrome participant to a FASD participant on PPVT-III Developmental Age Equivalent within the 68% confidence interval for the FASD participant. Due to the cognitive deficits associated with Down syndrome, the researcher was unable to find individuals with Down syndrome who could serve as MA matches for the higher functioning FASD participants.

Typically Developing Mental Age Matched Group

Thirty typically developing children (13 male) between 27 and 151 months were assessed for this study. Typically developing participants were recruited from Virginia

and North Carolina (see Table 1). Typically developing participants were recruited from local pre-school and after school programs in Fairfax County, Virginia and throughout North Carolina. Upon obtaining permission from the proper personnel, the primary investigator sent letters home to the parents of children who attend the pre-school or after school program via the teachers. This letter explained the project and asked parents to reply (using the contact information included in the letter) if they were interested in having their child participate in this study. A few local professionals who work with children or families also allowed the primary investigator to display a flyer that described the study and included contact information for the primary investigator in their offices. Some participants were also obtained through individuals who passed information about the study to families with young children who then contacted the primary investigator and communicated their interest and willingness to participate in the study.

Each typically developing participant was matched to a FASD participant on PPVT-III Developmental Age Equivalent within the 68% confidence interval for the FASD participant. Four individuals were excluded because their PPVT--III developmental age equivalent exceeded the developmental age of the FASD participants; thus, they were not good MA matches to the FASD group. Three individuals were excluded from the study because they did not complete the study tasks.

The final sample consisted of twenty-three (11 male) typically developing children between 2.5 (30 months) and 9.75 (117 months) years of age who were matched to the participants with FASD and Down syndrome on mental age. Two (9%) of the twenty-three typically developing participants were adopted and both came to live with

their adoptive parents within the first month of life. The remaining 21 children lived with their birth parents (none were in the custody of legal guardians). The average developmental age of the individuals in the TD group was 7 years (88.33 months SD = 27.47, range 32-141 months) (see Table 2).

Measures and Assessments

Intellectual Functioning

The Peabody Picture Vocabulary Test--III (PPVT--III) can be used to assess English language receptive vocabulary (word knowledge) in individuals ranging from 2.5 years of age to 90 years of age (Dunn, Dunn, Williams & Wang, 1997). "Correlations [of the PPVT--III] with the Wechsler Intelligence Scale for Children, Third Edition (WISC-III) are .91 and .92 for Forms III A and III B respectively," which is evidence of criterion-related validity of the PPVT--III as a measure of cognitive functioning (Bessai, 2001). The PPVT--III (Form A) was individually administered was administered to all participants to assess intellectual functioning and to match the groups on mental age.

Moore (2001) notes that the experimental tasks used in studies of emotion recognition should be equivalent in cognitive demand to the other measures used in the study. Thompson et al. (1998) also believes it is important that measures of intellectual functioning are consistent with the experimental measures being used. A second reason the PPVT--III was chosen is that it does not require high verbal response rates from participants because they can respond by saying "one" "two" "three" or "four" or by pointing to one of four pictures (Bessai, 2001, Dunn et al., 1997), The PPVT--III is also

consistent with the verbal response demands of the facial processing tasks. Researchers have begun to recognize that the use of verbal ability as a matching criterion can confound the results of studies of emotion recognition because many tests of verbal ability used to match participants on mental age include emotion knowledge as part of the measure – some of the items on these measures are emotion words (Moore, 2001; Thomas et al., 1998). Finally, the PPVT-III was chosen because it includes minimal items that tap state, feeling, or emotion knowledge, particularly items that tap knowledge of basic emotions.

Adaptive Social Functioning

Formerly labeled the Social Reciprocity Scale, the Social Responsiveness Scale (SRS) indexes deficiencies in reciprocal social behavior within a naturally occurring environment (Constantino & Gruber, 2005). The reciprocal social behaviors assessed by the SRS fall into 5 domains: Social Awareness, Social Cognition, Social Communication, Social Motivation, and Autistic Mannerisms. The SRS is completed by a person who is familiar with the focus individual's behaviors and mannerisms. The SRS can be used to assess social responsiveness in individuals between 4 and 18 years-of-age and is often used to screen for autism spectrum disorders. For each of the 65 items, scores correspond to the severity/ frequency with which the focus individual performs the behaviorand range from: 1= "Not True" to 4="Almost Always True" (Constantino & Gruber, 2005). Standard scores are calculated in the process of scoring the SRS and are used to classify individual children as either within the normal range (T-score of 59 or less), within the

"mild to moderate range" (T-score of 60 to 75), or within the "severe range" (T-score of 76 or higher) (Constantino & Gruber, 2005). In addition to the total score, domain scores are also calculated. Standard scores are preferred when discussing an individual profile and possible interventions; however, raw scores have been reported (see Table 3) to remain consistent with past research (Constantino & Gruber, 2005).

Internal consistency for the SRS items is high across both parent and teacher ratings with α coefficients ranging from .93 to .97 (Constantino & Gruber, 2005; Venn, 2007). Internal consistency for the SRS items with a sample of children which included some diagnosed with autism spectrum disorders and some with other psychiatric conditions produced a coefficient of .97 (Constantino & Gruber, 2005; Venn, 2007). The test-retest reliability over a period of 17 months was also high (.85 for males, .77 for females). A clinical sample was also used to assess test-retest reliability. A comparison of two administrations of the SRS separated by 2 years resulted in a Pearson's correlation of .83. Discriminant analyses revealed scoring high on the SRS was significantly associated with an autistic disorder, but not with intelligence or other recognized psychiatric disorders/ conditions (Constantino & Gruber, 2005). Scores on the SRS and the Autism Diagnostic Interview-Revised (ADI-R) were highly associated when completed on the same individual (Constantino & Gruber, 2005). "The SRS has been concurrently validated with the Autism Diagnostic Interview-Revised (ADI-R) where differences in mean scores among those with developmental disorders differed significantly from those with the diagnosis (F= 72.95, DF =2.58; p < .0001)" (Conway, 2007).

The SRS was included in this study to test for the presence of behaviors consistent with autism in the participants in this study. Deficits in emotion recognition would be consistent with poor functioning in social interactions and poor social skills. Thus, the SRS was chosen over other assessments of autistic behaviors because the social interaction skills of all the children in this study could be relevant to emotion recognition ability and the SRS provides information on reciprocal social behaviors (Constantino & Gruber, 2005).

Disordered Behavioral Functioning

The Conners' Comprehensive Behavior Rating Scale for Parents (Conners CBRS-P) indexes childhood behavior problems within 8 domains, including the following that may be relevant to individuals with prenatal alcohol exposure: "Aggressive Behaviors," "Hyperactivity/ Impulsivity," and "Emotional Distress," which includes the subdomains "Upsetting Thoughts," "Worrying," and "Social Problems" (Conners, 2008). Items on the Conners CBRS-P also correspond to the diagnostic criteria for 12 psychiatric disorders/ conditions recognized by the American Psychiatric Association; including: Autistic Disorder and Aspergers Disorder (Pervasive Developmental Disorders), Attention-Deficit and Disruptive Behavior Disorders, Conduct Disorder, and Oppositional Defiant Disorder, and the presence of a Major Depressive Episode, Manic Episode, and Mixed Episode, which are part of the DSM-IV-TR diagnostic criteria for a Mood Disorder (APA, 2000; Conners, 2008).

The Conners CBRS-P can be used to assess individuals between 6 and 18-years-of age and is completed by a parent or guardian who is familiar with the focus individual's behaviors. For each item, scores correspond to the frequency with which the focus individual performs the behavior and range from: 3 = "Very much true (Very often, Very frequently)" to 0 = "Not true at all (Never, Seldom)" (Conners, 2008). The CBRS-P has good internal consistency including Cronbach's alphas ranging from .78 to .95 across the eight domains; and Cronbach's alphas ranging from .73 to .93 across the 12 DSM-IV-TR disorders (APA, 2000; Conners, 2008). The two to four week test-retest reliability ranges from .70 to .96 across the domains and from .66 to .95 across the DSM-IV-TR disorders, which is evidence to support its reliability across time. Discriminant analyses revealed 78.4% of the individuals assessed were correctly classified using the CBRS-P (Conners et al., 2000).

The Conners CBRS-P was chosen to indicate which participants displayed behaviors associated with other conditions or disorders that may influence performance on the study tasks. Specifically, the researcher was interested in the possible presence of symptoms associated with attention disorders, mood disorders, and autistic spectrum disorders because these disorders have been shown to affect face recognition performance.

Facial Processing

Four facial processing tasks (FPTs) developed for this dissertation and based on the tasks that prior studies have shown to be equivalent in cognitive demand were

administered to child participants (Moore, 2001; Rojahn et al., 1995; 2006). All of the

FPTs were presented on a 2006 Gateway MX6426 Notebook PC with a 15.4 inch screen.

The child participant was seated at arms length directly in front of the laptop screen to

maximize visibility of the task stimuli and allow the child to point to their response

choice in matching tasks (if they desired).

Participants were allowed to indicate response choice by pointing in an effort to

minimize cross-modal matching and reduce the cognitive complexity of the task. To

further reduce cognitive demand, the target stimuli remained visible throughout each

trial. In labeling tasks, the target face remained visible until the child gave an answer. In

matching tasks, the target face remained visible along with the array of possible matches

until the child responded (verbally said the number underneath the chose face or pointed

to the chosen face).

The faces used in the FPTs came from the NimStim database of faces created by

Nim Tottenham and colleagues (2009). The NimStim database consists of adults

photographed from the shoulders up and includes Caucasian, African American, and

Asian individuals of both genders. Forty-three actors were asked to display a closed and

open mouth version of eight facial expressions: "happy, sad, angry, fearful, surprised,

disgusted, neutral, and calm" which resulted in 672 total images across the 43 actors

(Tottenham et al., 2009). The primary researcher and author of this dissertation

corresponded with Nim Tottenham via email and received the "NimStim Set of Facial

Expressions" directly from Nim Tottenham. As of 2009, these faces were made available

to the scientific community and can be accessed from the follow website:

http://www.macbrain.org/resources.htm (Tottenham et al., 2009).

Tottenham et al. (2009) conducted studies with two young adult samples (47 participants with a mean age of 19.4 years; and 34 participants with a mean age of 25.8 years respectively) to provide psychometric data for the NimStim faces. Mean proportion correct and kappa scores for 672 images ranged from .47 to .98 for mean proportion correct "(mean=.81 (S.D.= .19), median = .88)" and .54 to .95 for "concordance between raters' labels and the intended expressions…(mean kappa across stimuli = .79, (S.D. = .17), median kappa = .83)" (Tottenham et al., 2009, p.245). Although the range of kappas is large, only 3 types of the emotion expressions used in this dissertation study had mean kappas lower than .70: Fear (closed mouth) = .54, Fear (open mouth) = .67, and Sad (open mouth) = .62 (Tottenham et al., 2009). The corresponding mean proportion correct values were Fear (closed mouth) = .47, Fear (open mouth) = .73, and Sad (open mouth) = .60 (Tottenham et al., 2009). Test-retest reliability was assessed by two presentations of the faces 20 minutes apart in which the sequence of faces in the second presentation differed from the sequence in the first presentation. Average proportion agreement across the two presentations was calculated for each image and ranged from .68 for Fear (closed mouth) to .98 for Happy (open mouth) (Tottenham et al., 2009). Fear (closed mouth) was the only image with an average proportion agreement below 0.7 (Tottenham et al., 2009).

The primary investigator chose to use the NimStim faces despite Moore (2001)'s criticism that static photographs lack dynamic movement because many researchers believe facial expressions are a rich and salient source of emotion information (Eckman

& Friesen, 1975; Eckman & Rosenberg, 1997; Ludemann & Nelson, 1988; Soken & Pick, 1999). Although the task designs (labeling and matching) used in the FPTs have been used in numerous previous studies of emotion recognition (Moore, 2001; Rojahn, et al., 1995; 2006), this set of NimStim faces has not been used in prior studies of emotion labeling and matching. In the creation of the FPTs, all photographs were cropped so that only the face (without the hair) was visible. In an effort to increase the likelihood of equivalency in cognitive demand between emotion and control tasks, the tasks were paired by design, and similar to those found to be equivalent in prior studies.

Facial Processing Task – Emotion (FPT-Emotion). The Facial Processing Task-Emotion (FPT-Emotion), created using the NimStim database of faces, is a combined labeling and matching task that requires discrimination of affect-relevant facial cues. In the FPT-Emotion, participants are shown a target human adult face. This target face was positioned top center on a computer screen against a white background. Participants were instructed to look at the face and asked to label the emotion (happy, sad, angry, afraid, calm) of the face pictured. Participants were told: "This is a picture of Mary. How does Mary feel?" After the participant responded, correct responses were affirmed: "That's right, Mary is feeling happy; incorrect responses were corrected: "Let's look at Mary again. Mary is feeling happy." Then five other faces appeared in a row across the bottom of the computer screen. Each of these faces displays one of five emotions (happy, sad, angry, afraid, and calm) and each emotion is represented in each array. The participant was instructed to look at the target face and point to the face (on the bottom) that depicts a person expressing the same emotion as the target face: "Can you point to some one who

feels happy like Mary?" There are 33 items (5 practice items and 28 test items) in this task. The FPT- Emotion took about 30 minutes to complete.

To address the problem of ambiguity in emotion recognition tasks that include neutral faces (raised by Moore, 2001) and the possibility that participants might assume they should pick an emotion (as opposed to neutral) for every face, the five FPT-Emotion practice items included identification of a calm face. In addition, to further reduce the chance of confusion in participants, "calm" was used (instead of neutral, "unhappy" used in Hobson et al., 1989; or "not happy and not sad" used in Rojahn, 1995) to describe these faces because "calm" is a response to the question "How do you feel?" in normal conversation.

Facial Processing Task-Gender (FPT-Gender). The Facial Processing Task-Gender (FPT-Gender) presented participants with a target human adult face in the center of the computer screen. Participants were instructed to look at the target face and asked to identify the Gender of the face. "Is this a man or a woman?" The faces used in this task are the same faces (cropped so hair and body is removed) used in the FPT-Emotion; however, the faces were presented in black-and-white to eliminate gender cues (lipstick, stubble); and against a green background to enhance the contrast of the face with the background. The FPT-Gender took about 10 minutes to complete and served as the control task for the Labeling portion of the FPT-Emotion.

Facial Processing Task-Identity (FPT-Identity). The Facial Processing Task-Identity (FPT-Identity), a matching task, presented participants with a target human adult face against a white background. Participants were instructed to look at the face and told

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"This is a picture of Tom." Then five other faces appeared in a row across the bottom of the computer screen. Participants were instructed to point to the matching face on the bottom of the screen: "Can you point to another picture of Tom?" There were 18 items (3 practice items and 15 test items) in this task. The faces used in this task are the same stimuli (NimStim photographs cropped so the hair and body is removed) used in the Emotion Task. In an effort to reduce confusion between the emotion and identity tasks, the human adult faces used in the identity task all display a calm or neutral expression. The FPT-Identity took about 15 minutes to complete and served as the control task for the Matching portion of the FPT-Emotion.

Facial Processing Task-Age (FPT-Age). In the Facial Processing Task-Age, a labeling task (Rojahn et al., 2006) presented participants with a target picture of a human adult photographed from the shoulders up. This black and white picture is positioned top center on a computer screen. The participant is instructed to look at the picture and is asked to label the age range of the person pictured. Participants are told: "This is a picture of Bob. How old is Bob? Do you think he is young (18-30 years old), middle-aged (31-50 years old), or old (51-70 years old)?" There are 24 items in this task 12 featuring female Caucasian actors and 12 featuring male Caucasian actors. These pictures were originally used by Erwin and colleagues, thus a more detailed description of the creation of the pictures is available in Erwin et al. (1992).

Seven (11.3%) of the final 62 children who participated in this study were no longer willing to participate when the FPT-Age task was introduced, and one child answered only 3 of the 5 FPT-Age practice items before refusing to continue with the

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task. Thus, eight (12.9%) of the children (2 FASD, 4 TD, 2 DS) did not complete the

FPT-Age task. Many others seemed to perseverate, giving the same answer for multiple

items. Five of the 54 participants who did complete the FPT-Age Task gave the same

answer for at least 20 (83%) of the 24 items; and responded with the same answer on 14

consecutive items on average (range 9 to 22 consecutive items). Two other participants

gave the same answer on 18 (75%) of the items and 9 and 12 consecutive items,

respectively. Thus, seven (13%) of the 54 participants who completed the FPT-Age Task

gave the same answer for at least 75% of the items. Taken together, 22 (41%) of the

participants who completed the FPT-Age Task gave the same answer for at least half of

the items (5 gave the same answer for 15 items, 5 gave the same answer for 14 items, and

5 gave the same response for 13 items). Only 32 (52%) of the 62 children in the final

sample produced useable data on the FPT-Age. Therefore, it was decided that this task

did not produce useful results and the task was dropped from further analyses

Procedure

After presenting the informed consent document and obtaining signed parental

consent, the parent or guardian was given the Conners CBRS-P, the SRS and a

demographics survey to complete while the primary investigator interacted with the child

participant. Each child participant was presented with the informed assent document

using the informed assent script approved by the George Mason University Human

Subjects Review Board. Once informed assent was obtained from the child (via a

signature or other mark), the PPVT-III was administered to the child. Following

administration of the PPVT-III, the child was allowed to take a break while the primary researcher set up her laptop and prepared to administer the facial processing tasks. The FPTs were administered to all participants in the following order: Gender, Identity, Emotion, and Age.

The order of the tasks was chosen to minimize confusion and influence on the other tasks. The FPT-Gender was administered first because the faces were presented in black and white and there was a concern that seeing the faces in color, as they are presented, in the identity and emotion tasks, would provide information about the faces (some females wore lipstick and some males had stubble that could be seen in color photographs) that could aid gender identification. The FPT-Identity was presented before the Emotion task to minimize familiarity with the faces which might influence identity recognition. It was speculated that exposing the participants to the emotion task would prime the participants and make identity recognition easier. In an effort to maximize interest and reduce response sets, the tasks were ordered to alternate between task designs (labeling or matching). The FPT-Age was presented last to be maintain a pattern of alternating between labeling and matching tasks.

VI. Data Analyses

Preliminary Analyses

      A series of analyses were computed to compare the groups on a variety of demographic variables (see Table 1). A Kruskal-Wallis test of mental age (PPVT developmental age equivalent) and indices of socioeconomic status (SES; household income, highest level of education completed by the mother and father) revealed a significant difference between the groups for household income ($H(2) = 16.14$, p $< .01$) and highest level of education completed by the mother ($H(2) = 9.84$, p $< .01$). There was no significant difference between the 3 groups on highest level of education completed by the father ($H(2) = .10$, p= .95). Consistent with expectations, there was also no significant difference between the three groups on mental age (PPVT-III developmental age equivalent, ($H(2) = .48$, p= .79), indicating efforts to match the groups on mental age were successful and resulted in relatively similar cognitive ability across the three groups.

      Post-hoc Mann Whitney tests were computed to directly compare the groups on household income and highest level of education completed by the mother. Three post hoc analyses to look at each two-group combination were planned; thus, a Bonferroni correction was calculated and .017 (.05/3) was used as the critical value for all post hoc Mann-Whitney tests. Household income was significantly different across groups ($H(2) =$ 16.14, p$< .01$). Three post hoc Mann-Whitney tests of household income revealed the

group of children with a FASD diagnosis (Mdn = $40,001 to $60,000) came from

families with significantly less income than the families of the typically developing

children (Mdn = More than $80,000) ($U$= 107.00, p< .01); and the families of children

with a DS diagnosis (Mdn = More than $80,000) ($U$=59.00, p< .01). There was no

significant difference in family income between the group of typically developing

children and the group of children with a DS diagnosis (U=118.50, p= .78).

Maternal education was also significantly different across groups ($H(2)$ = 9.84,

p<.01). Three post hoc Mann-Whitney tests of highest level of education completed by

the mother revealed the group of children with a FASD diagnosis (Mdn = 5; M= 4.4)[1]

was significantly different than the group of typically developing children (Mdn = 5; M=

5.48) (U= 150.50, p< .01); however, the group of children with a FASD (Mdn = 5; M=

4.4) was not significantly different than the group of children with DS (Mdn = 5;

M=5.29) (U=110.00, p= .06); and the group of typically developing children did not

differ significantly from the group of children with DS (U=154.00, p= .84).

Pearson's Chi-Squares were run to compare the three groups on child gender and

child race. There was not an association between group and child gender $\chi^2(2)$ = 3.35, p=

.19. The lack of a significant gender difference between the participants, based on their

age, was expected, because there was an emphasis to match on gender as well as mental

age when possible. There was a significant association between group and child race

$\chi^2(6)$ = 15.00, p= .02. Subsequent comparison of the groups revealed greater variation in

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[1] 4 = some college, 5 = 2 year Associates Degree

the FASD group (only 52% Caucasian) compared to the TD (91% Caucasian) and DS (100% Caucasian) groups (See Table 1).

Exploratory Data Analyses of the Facial Processing Tasks (FPTs)

Prior to conducting major analyses on the facial processing task performance of the three groups (FASD, DS, and TD), basic descriptive analyses were performed to gain information about the nature of the data and determine whether the data could be analyzed using the planned tests. To determine whether the items on the facial processing tasks measured the full range of abilities within the three groups, descriptive information about performance scores were obtained. Exploration of the range of FPT percent-correct scores (see Table 4) and the Facial Processing Task error patterns (see Table 5) data revealed ceiling effects and one floor effect in the data, which leads to restriction of the range of scores.

Eight of the participants in the TD group correctly answered more than 90% of the FPT-Gender items (six participants correctly answered 20 items, two correctly answered 21 and one participant correctly answered all 22 items). Thus, there was a ceiling effect on the FPT-Gender percent-correct score for the TD group. There was also a ceiling effect on the FPT-Identity percent-correct score for the FASD group (one participant correctly matched all 15 items). Finally, seven of the participants in the TD group correctly answered more than 90% of the FPT-Emotion matching items (two participants correctly answered 26 items, three participants correctly answered 27 items, and two participants in the TD group correctly answered all 28 items) indicating there was a ceiling effect on the FPT-Emotion matching percent-correct score for the TD

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group. There was a floor effect on the FPT-Identity for the DS group (one participant failed to correctly match any of the FPT-Identity items, and two participants only correctly matched one of the 15 identity items). To control for restricted ranges the percent-correct scores for the four FPTs were transformed using arcsine transformations, a data transformation that is frequently used to make proportions appropriate for ANOVA or regression analyses (Cohen, Cohen, West & Aiken, 2003). All subsequent analyses that incorporated the facial processing tasks used the arcsine transformed FPT percent-correct scores.

Reliability tests of the facial processing tasks with these samples revealed all had high reliabilities. The FPT-Gender Cronbach's $\alpha = .76$ and the Guttman Split-Half coefficient was .72. The FPT-Identity Cronbach's $\alpha = .78$ and the Guttman Split-Half coefficient was .80. The FPT-Emotion Labeling Cronbach's $\alpha = .81$ and the Guttman Split-Half coefficient was .69. The FPT-Emotion Matching Cronbach's $\alpha = .90$ and the Guttman Split-Half coefficient was .85.

Preliminary analyses to determine whether the facial processing task percentage correct scores were normally distributed, an analysis of variance (ANOVA) assumption, were also conducted. The four arcsine transformed facial processing task percentage-correct scores for each group did not meet the normal distribution assumption of ANOVA based on the results of a series of Kolmogorov-Smirnov tests which revealed significance on several of the FPTs.[2] The Kolmogorov-Smirnov test on these scores for the FASD group revealed the FPT-Gender percent-correct score, $D(25) = 0.25$, p< .01

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[2] The original FPT percentage correct scores were also analyzed using the Kolmogorov-Smirnov test.

was significantly non-normally distributed. The Shapiro-Wilk test revealed significance, and thus a non-normal distribution, for the FPT-Gender percent-correct score and also indicated the FPT-Identity percent-correct score, and the FPT-Emotion matching percent-correct score were significantly non-normal (see Table 6). Within the TD group, non-normality in distribution for the FPT-Emotion labeling percent-correct score was indicated by both the Kolmogorov-Smirnov test $D(23) = 0.21$, p< .01, and the Shapiro-Wilk test. Neither the Kolmogorov-Smirnov tests nor the Shapiro-Wilk tests were significant on any of the four Facial Processing Task percent-correct scores for the DS group (see Table 6).

The data analyses section is organized according to the proposed hypotheses.

Major Analyses

Test of Hypothesis 1

The purpose of this study was to investigate whether the emotion specificity hypothesis can be demonstrated in a group of participants with Fetal Alcohol Spectrum Disorders and answer the question: Do individuals with FASDs have deficiencies in recognizing facial expressions of emotion that cannot be fully explained by the current level of intellectual functioning?

$H_1 1$ (or alternative hypothesis that would be consistent with the emotion specificity hypothesis): Participants with a FASD diagnosis will show a relatively poorer performance on both portions of the FPT-Emotion (labeling and matching) compared to the performance of the typically developing control group; however, participants with a

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FASD diagnosis will show relatively similar performance on the two FPT control tasks (Gender and Identity) compared to the typically developing control group.

Despite the violation of the assumption of normally distributed data, MANCOVA, a parametric test, was used to analyze the performance on the FPTs for all three groups because MANCOVA is robust to violations of assumptions (Cohen et al., 2003; Field, 2009) and MANCOVA could account for the influence of developmental age, which might be accounting for some of the variance in performance on the FPTs. The FPT percent correct-scores did meet the homogeneity of variance assumption of ANOVA based on the Levene's Test of Equality of Error Variance, which revealed non-significant results on the percent-correct scores for the FPT-Gender ($F[2,59]= .18$, p= .84), the FPT-Identity ($F[2,59]= .71$, p= .50), and both the Labeling ($F[2, 59]= .54$, p= .59) and the Matching portion ($F[2,59]= 1.97$, p= .15) of the FPT-Emotion. The Box's Test of Equality of Covariance was also nonsignificant ($F[20, 7248.34] = 30.45$ p= .13) indicating the FPT percent-correct scores had relatively equal covariance, further supporting the assumption of homogeneity of variance. A Kruskal-Wallis test and post hoc Mann-Whitneys were run to test portions of the MANCOVA using non-parametric statistics, and resulted in the same pattern of significance which supports the decision to use parametric analyses.

Although the participants in the TD and DS groups were matched on developmental age to the FASD group, mental age across the groups ranged from 2 years (30 months) to 12 years (148 months) and may be influencing the relations between the groups' performance on the facial recognition tasks. To address the possibility of an

influence of developmental age a MANCOVA was computed with PPVT-III developmental age equivalent as the covariate and group membership as the predictor of thee four FPT percent-correct scores (gender, identity, emotion labeling and emotion matching). A significant overall effect was found for PPVT-III developmental age (Wilks' λ = .49, $F[4,55]$ = 14.32, p< .01). The effect of the covariate "developmental age" was significant for all facial processing tasks: FPT-Gender ($F[1,58]$ = 28.44, p< .01), FPT-Identity ($F[1,58]$ = 35.19, p< .01), FPT-Emotion Labeling ($F[1,58]$ = 31.67, p< .01), and FPT-Emotion Matching ($F[1,58]$ = 36.73, p< .01). These significant findings indicate PPVT-III developmental age equivalent did account for some of the variance explained by the model and supported the decision to include it as a covariate.

A significant overall main effect was found for the "group" factor (Wilks' λ = .63, $F[8,110]$ = 3.63, p< .01). There were significant group differences on both FPT-Emotion Labeling ($F[2,58]$ = 3.62, p<.05) and FPT-Emotion Matching ($F[2,58]$ = 12.39, p<.01). There was also a significant overall effect for FPT-Identity ($F[2,58]$ = 10.04, p< .01); but no significant group difference was found for FPT- Gender ($F[2,58]$ = .73, p= .48).

Post hoc ANCOVAs with group using only FASD and TD groups on each of the facial processing tasks (FPT-Emotion Labeling, FPT-Emotion Matching, the FPT-Gender, and FPT-Identity) revealed the significant performance differences on the emotion focused facial processing tasks were not between the children with a FASD diagnosis and typically developing children of the same mental age (FPT-Emotion Labeling: $F[1,45]$=.002, p= .97; FPT-Emotion Matching: $F[1,45]$=.02, p = .90). There were also no significant performance differences on the non-emotion facial processing

tasks (FPT-Gender: $F[1,45] = .02$, p = .90; FPT-Identity: $F[1,45] = .43$, p= .52). As seen in Table 4, the FASD and Typically Developing Group performed similarly on all four FPTs and failed to show support of the emotion specificity hypothesis for individuals with FASD. [3]

Test of Hypothesis 2

The second purpose of this study was to investigate whether the emotion specificity hypothesis can be demonstrated in a group of participants with Down syndrome and answer the question: Do individuals with DS have deficiencies in recognizing facial expressions of emotion that cannot be fully explained by the current level of intellectual functioning? This question resulted in the following hypothesis:

$H_2 1$ (alternative hypothesis that would confirm that the emotion specificity hypothesis if it was demonstrated in a group of participants with Down syndrome): Participants with a diagnosis of Down syndrome will show a relatively poorer performance on both portions of the FPT-Emotion (labeling and matching) compared to the performance of the typically developing control group; however, participants with a DS diagnosis will show relatively similar performance on the two control tasks (FPT-Gender and FPT-Identity) compared to the performance of the typically developing control group.

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[3] It is also noteworthy that the pattern of findings on the Mann-Whitney tests comparing the percent correct scores of the FASD group and the TD group on each of the Facial Processing Tasks is consistent with the ANCOVAs comparing the FASD and TD groups on the facial recognition tasks.

As already reported, the MANCOVA with PPVT-III developmental age equivalent as the covariate (overall effect: Wilks' λ = .49, $F[4,55]$ = 14.32, p< .01) and a significant overall effect for group (Wilks' λ = .63, $F[8,110]$ = 3.63, p< .01) also addressed this set of hypotheses.

Post hoc ANCOVAs with group using only TD and DS groups on each of the facial processing tasks (FPT-Emotion Labeling, FPT-Emotion Matching, the FPT-Gender and the FPT-Identity) revealed there were significant performance differences between the children with a DS diagnosis and typically developing children of the same mental age on both the emotion-focused facial processing tasks (FPT-Emotion Labeling: $F[1,34]$ = 5.41, p< .05; FPT-Emotion Matching: $F[1,34]$ = 15.44, p< .01). There was also a significant performance difference between the children with a DS diagnosis and typically developing children of the same mental age on one of the non-emotion facial processing tasks (FPT-Identity: F[1,34] =22.79, p < .01). Consistent with the overall result of non-significance of group on the gender task, there was no significant difference between the children with a DS diagnosis and typically developing children of the same mental age (FPT-Gender: $F[1,34]$ =.98, p = .33). A comparison of group means reveal participants with Down syndrome did not perform as well as typically developing children on both the emotion-focused facial processing tasks and the non-emotion FPT-Identity (see Table 4).[4]

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[4] The pattern of findings on Mann-Whitney tests comparing the percent correct scores of the DS group and the TD group on each of the Facial Processing Tasks is consistent with the ANCOVAs comparing the TD and DS groups on the facial recognition tasks.

The tertiary purpose of this study is to investigate whether individuals with a FASD diagnosis and Down syndrome differ in performance on facial processing tasks and answer the question: Do individuals with FASDs have greater deficiencies in recognizing facial expressions of emotion relative to the ability of individuals with DS to recognize facial emotion expressions? This question resulted in the following set of hypotheses:

$H_3 1$: Participants with Down syndrome will show relatively poorer performance on both the FPT-Emotion (labeling and matching) compared to the performance of the FAS group; however, participants with Down syndrome will show relatively similar performances on the two control tasks (FPT-Gender and FPT-Identity) compared to the performance of the FASD group.

$H_3 2$: Participants with FASD will show relatively poorer performance on both portions of the FPT-Emotion (labeling and matching) compared to the performance of the Down syndrome group; however, participants with FASD will show relatively similar performances on the two control tasks (FPT-Gender and FPT-Identity) compared to the performance of the Down syndrome group.

As already noted, the significant overall effect for group found in the MANCOVA with PPVT-III developmental age equivalent as the covariate also addressed this set of hypotheses.

Post hoc ANCOVAs with group on each of the facial processing tasks (both the emotion-focused facial processing tasks and the non-emotion focused facial processing tasks) revealed there were significant performance differences between the children with a FASD diagnosis and children with a DS diagnosis of the same mental age on both the emotion-focused facial processing tasks (FPT-Emotion Labeling: $F[1,36] = 6.91$, p<=.01; FPT-Emotion Matching: $F[1,36]= 40.18$, p<.01). There was also a significant performance difference between the children with a FASD diagnosis and the children with a DS diagnosis of the same mental age on one non-emotion facial processing task (FPT-Identity: $F[1,36]=15.63$, p<.01). Consistent with the overall result of non-significance of group on the gender task, there was no significant difference between the children with a FASD diagnosis and the children with a DS diagnosis of the same mental age (FPT-Gender: $F[1,36] = 1.76$, p = .19). A comparison of group means reveal participants with a DS diagnosis did not perform as well as children with a FASD diagnosis on both the emotion-focused facial processing tasks and the non-emotion facial processing tasks[5] (see Table 4).

Other Analyses

Exploratory Data Analyses of Emotion Valence Percent Correct. Scores

To look at whether the participants in each group were able to recognize the correct emotion valence displayed, a valence percent correct score was calculated for

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[5] The pattern of findings on Mann-Whitney tests comparing the percent correct scores of the FASD group and the DS group on each of the Facial Processing Tasks is consistent with the ANCOVAs comparing the FASD and DS groups on the facial recognition tasks.

both the labeling and the matching-to-sample portions of the FPT-Emotion. Kolmogorov-Smirnov tests were run on valence percent correct scores for both the labeling and matching-to-sample portions of the FPT-Emotion to determine whether the distribution of scores in each of the three participant groups (FASD, TD, DS) was too non-normal for parametric analyses. The Kolmogorov-Smirnov test on these scores for the FASD group revealed both the FPT-Emotion Valence Labeling percent correct, (D(25)= .22, p<.01) and the FPT-Emotion Valence Matching percent correct (D(25)= .30, p< .01) scores were significantly non-normal (See Table 6). The Kolmogorov-Smirnov test on these scores for the TD group revealed both the FPT-Emotion Labeling Valence percent correct, (D(23)= .23, p<.01) and the FPT-Emotion Valence Matching percent correct (D(23)= .26, p< .01) were also significantly non-normally distributed. The Emotion Valence Labeling percent correct and the Emotion Valence Matching percent correct scores were also significantly skewed in both the FASD and TD groups.

The Kolmogorov-Smirnov test on these scores for the DS group were not significant on either the FPT-Emotion Valence Labeling percent correct (D(14) = .18, p=.20) or the FPT-Emotion Valence Matching percent correct (D(14) = .13, p= .20) scores.

Arcsine transformations of the two FPT-Emotion Valence percent correct scores were not significantly skewed in any of the groups; however the Kolmogorov-Smirnov test on the arcsine transformation of scores for the FASD group revealed both the FPT-Emotion Valence Labeling percent correct, (D(25) = .23, p<.01) and the FPT-Emotion Valence Matching percent correct (D(25) = .19, p< .05) scores were significantly non-normal (See Table 6). The Kolmogorov-Smirnov test on the arcsine transformation of

scores for the TD and DS groups were not significant for either the FPT-Emotion

Valence Labeling percent correct or the FPT-Emotion Valence Matching percent correct

scores.

The FPT-Emotion Valence Labeling and FPT-Emotion Valence Matching

percent correct scores did partially meet the homogeneity of variance assumption of

ANOVA based on the Levene's Test of Equality of Error Variance, which revealed non-

significant results on the FPT-Emotion Valence Labeling percent correct score (F[2,59]=

1.09, p= .34), but a significant result of the Levene's Test of Equality of Error Variance

for the FPT-Emotion Valence Matching percent correct score (F[2,59]= 5.97, p< .01)

scores. The Box's Test of Equality of Covariance was also nonsignificant (F[6,

24802.45] = 1.50, p= .18) indicating the FPT-Emotion Valence Percent correct scores

had relatively equal covariance. A Kruskal-Wallis test and post hoc Mann-Whitneys were

run to test portions of the MANCOVA using non-parametric statistics, and resulted in the

same pattern of significance which supports the decision to use parametric analyses.

Analyses Emotion Valence Percent Correct. Scores

Despite the violation of the assumption of normally distributed data, parametric

analyses were used in order to address the possibility of an influence of developmental

age. A MANCOVA was computed with PPVT-III developmental age equivalent as the

covariate and group membership as the predictor of the two FPT-Emotion Valence

(labeling and matching) percent-correct scores. A significant overall effect was found for

PPVT-III developmental age (Wilks' λ = .65, F[2,57] = 15.20, p< .01). The effect of the

covariate "developmental age" was significant for both the FPT-Emotion Valence

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Labeling (F [1,58] = 6.55, p< .01), and FPT-Emotion Valence Matching (F [1,58] =

30.75, p< .01). These significant findings indicate PPVT-III developmental age

equivalent did account for some of the variance explained by the model and supported the

decision to include it as a covariate.

A significant overall main effect was found for the "group" factor (Wilks' λ = .73,

F[2,57] = 4.85, p< .01). There were significant group differences on the FPT-Emotion

Valence Labeling (F [2,58] = 3.45, p<.05) and the FPT-Emotion Valence Matching (F

[2,58] = 8.67, p<.01) percent correct scores.[6]

Post hoc ANCOVAs with group using only the FASD and TD groups on both the

FPT-Emotion Valence Labeling and the FPT-Emotion Valence Matching revealed the

significant performance differences on the FPT-Emotion Valence tasks found in the

MANCOVA were not between the children with a FASD diagnosis and typically

developing children of the same mental age (FPT-Emotion Valence Labeling:

F[1,45]=.35, p = .56; FPT-Emotion Valence Matching: F[1,45]=2.14, p = .15).

Post hoc ANCOVAs with group using only the TD and DS groups on both the

FPT-Emotion Valence Labeling and the FPT-Emotion Valence Matching revealed

significant performance differences between the children with a DS diagnosis and

typically developing children of the same mental age (FPT-Emotion Valence Labeling:

F[1,34]=5.76, p< .05; FPT-Emotion Valence Matching: F[1,34]= 8.10, p < .01). As seen

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[6] The pattern of findings on a Kruskal-Wallis Test and post hoc Mann-Whitney tests comparing the FPT-Emotion valence percent correct scores of the three groups (FASD, DS and TD) on both the FPT-Emotion Valence Labeling and FPT-Emotion Valence Matching percent correct scores are consistent with the MANCOVA and post hoc ANCOVAs.

in Table 4, the TD group performed better than the DS group on both FPT-Emotion

Valence tasks.

Post hoc ANCOVAs with group using only the FASD and DS groups on both the

FPT-Emotion Valence Labeling and the FPT-Emotion Valence Matching revealed

significant performance differences between the children with a FASD diagnosis and

children of the same mental age with a DS diagnosis (FPT-Emotion Valence Labeling:

$F[1,36] = 6.39$, p< .05; FPT-Emotion Valence Matching: $F[1,36] = 20.06$, p = .00). As

seen in Table 4, the FASD group performed better than the DS group on both FPT-

Emotion Valence tasks.

Analyses of DSM-IV Behavioral Disorder Symptoms

Test of Hypotheses 4

The fourth purpose of this study was to investigate the association between group

membership (FASD, DS, TD) and DSM-IV disorders and answer the question: Are

DSM-IV behavioral disorders are more prevalent in individuals with a FASD diagnosis

than in individuals with a DS diagnosis or typically developing individuals? This

question resulted in the following hypothesis:

The alternate hypothesis that would support prior findings of higher rates of

ADHD, CD, ODD, and Depression in individuals with FASDs:

H_41 (alternative hypothesis that would support higher rates of ADHD, CD, ODD,

and Depression in individuals with FASDs): Participants with a FASD diagnosis will

have higher scores than the participants with a DS diagnosis and typically developing

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participants on the following subscales of the Conners' CBRS-P: ADHD (Predominantly Inattentive and Predominantly Hyperactive-Impulsive), CD, ODD, and Major Depressive Episode.

A series of ANOVAs were run to compare the three groups (FASD, DS, TD) on the SRS and five of the Conners' CBRS-P scales that were deemed relevant based on prior studies that identified these disorders/ conditions as common in individuals with a FASD: ADHD Predominately Inattentive, ADHD Predominately Hyperactive-Impulsive, Conduct Disorder, Oppositional Defiant Disorder, Major Depressive Episode (Howell et al., 2006; Jacobson & Jacobson, 2002; O'Leary, 2004; Streissguth et al., 1991; 1998; Weinberg, 1997).

The ANOVA on SRS Total Standard Score revealed a significant effect of group, $F(2,52) = 94.24$, p< .01, r = .88. Planned comparisons revealed on average individuals with a FASD diagnosis had higher SRS Total Standard scores (M= 80.00, SE= 2.17) than typically developing individuals (M= 44.44, SE= 1.03). This difference was significant $t(39) = 13.58$, p<.01, r =.91. On average individuals with a DS diagnosis had higher SRS Total Standard scores (M= 62.36, SE= 2.14) than typically developing individuals (M= 44.44, SE= 1.03). This difference was significant $t(30) = 8.09$, p<.01, r =.83. On average individuals with a FASD diagnosis had higher SRS Total Standard scores (M= 80.00, SE= 2.17) than individuals with a DS diagnosis (M= 62.36, SE= 2.14). This difference was significant $t(35) = 5.44$, p<.01, r =.68.

The ANOVA on Conners' CBRS ADHD Predominantly Inattentive Type Standard Score revealed a significant effect of group, $F(2,51) = 40.81$, p< .01, r = .78.

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Planned comparisons revealed on average individuals with a FASD diagnosis had higher Conners' CBRS ADHD Predominantly Inattentive Type Standard scores (M= 87.46, SE= 2.95) than typically developing individuals (M= 52.09, SE= 2.32). This difference was significant $t(39) = 8.81$, p<.01, r =.82. On average individuals with a DS diagnosis had higher Conners' CBRS ADHD Predominantly Inattentive Type Standard scores (M= 64.38, SE= 3.54) than typically developing individuals (M= 52.09, SE= 2.32). This difference was significant $t(28) = 3.02$, p<.01, r =.50. On average individuals with a FASD diagnosis had higher Conners' CBRS ADHD Predominantly Inattentive Type Standard scores (M= 87.46, SE= 2.95) than individuals with a DS diagnosis (M= 64.38, SE= 3.54). This difference was significant $t(35) = 4.82$, p<.01, r =.63.

The ANOVA on Conners' CBRS ADHD Predominantly Hyperactive-Impulsive Type Standard Score revealed a significant effect of group, $F(2,52) = 30.47$, p< .01, r = .73. Planned comparisons revealed on average individuals with a FASD diagnosis had higher Conners' CBRS ADHD Predominantly Hyperactive-Impulsive Type Standard scores (M= 83.64, SE= 3.06) than typically developing individuals (M= 53.24, SE= 2.58). This difference was significant $t(40) = 7.11$, p<.01, r =.75. On average individuals with a DS diagnosis (M= 57.85, SE= 3.68) and typically developing individuals (M= 53.24, SE= 2.58) had similar Conners' CBRS ADHD Predominantly Hyperactive-Impulsive Type Standard scores. The difference between these two groups was not significant $t(28) = 1.06$, p=.30, r =.20. On average individuals with a FASD diagnosis had higher Conners' CBRS ADHD Predominantly Hyperactive-Impulsive Type Standard

scores (M= 83.64, SE= 3.06) than individuals with a DS diagnosis (M= 57.85, SE= 3.68). This difference was significant $t(36) = 5.15$, p<.01, r =.65.

The ANOVA on Conners' CBRS Conduct Disorder Standard Score revealed a significant effect of group, $F(2,51) = 10.64$, p< .01, r = .54. Planned comparisons revealed on average individuals with a FASD diagnosis had higher Conners' CBRS Conduct Disorder Standard scores (M= 75.25, SE= 6.66) than typically developing individuals (M= 46.94, SE= .80). This difference was significant $t(39) = 3.55$, p<.01, r =.49. On average individuals with a DS diagnosis (M= 47.77, SE= 1.35) and typically developing individuals (M= 46.94, SE= .80) had similar Conners' CBRS Conduct Disorder Standard scores. The difference between these two groups was not significant $t(28) = .56$, p=.59, r =.10. On average individuals with a FASD diagnosis had higher Conners' CBRS Conduct Disorder Standard scores (M= 75.25, SE= 6.66) than individuals with a DS diagnosis (M= 47.77, SE= 1.35). This difference was significant $t(36) = 3.00$, p<.01, r =.44.

The ANOVA on Conners' CBRS Oppositional Defiant Disorder Standard Score revealed a significant effect of group, $F(2,51) = 12.95$, p< .01, r = .58. Planned comparisons revealed on average individuals with a FASD diagnosis had higher Conners' CBRS Oppositional Defiant Disorder Standard scores (M= 73.71, SE= 4.06) than typically developing individuals (M= 47.77, SE= 1.35). This difference was significant $t(39) = 3.83$, p=.59, r =.52. On average individuals with a DS diagnosis (M= 51.54, SE= 2.91) and typically developing individuals (M= 47.77, SE= 1.35) had similar Conners' CBRS Oppositional Defiant Disorder Standard scores. The difference between these two

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groups was not significant $t(28) = .88$, p=39, r =.17. On average individuals with a FASD diagnosis had higher Conners' CBRS Oppositional Defiant Disorder Standard scores (M= 73.71, SE= 4.06) than individuals with a DS diagnosis (M= 51.54, SE= 2.91). This difference was significant $t(35) = 3.73$, p<.01, r =.53.

The ANOVA on Conners' CBRS Major Depressive Episode Standard Score revealed a significant effect of group, $F(2,51) = 18.86$, p< .01, r = .66. Planned comparisons revealed on average individuals with a FASD diagnosis had higher Conners' CBRS Major Depressive Episode Standard scores (M= 76.42, SE= 4.80) than typically developing individuals (M= 45.35, SE= .94). This difference was significant $t(39) = 5.38$, p<.01, r =.66. On average individuals with a DS diagnosis had higher Conners' CBRS Major Depressive Episode Standard scores (M= 53.46, SE= 2.96) than typically developing individuals (M= 45.35, SE= .94). This difference was significant $t(28) = 2.91$, p<.01, r =.48. On average individuals with a FASD diagnosis had higher Conners' CBRS Major Depressive Episode Standard scores (M= 76.42, SE= 4.80) than individuals with a DS diagnosis (M= 53.46, SE= 2.96). This difference was significant $t(35) = 3.32$, p<.01, r =.49.

Analysis of the relation between Face Processing and Adaptive Behavior.
Test of Hypotheses 5

The final purpose of this study is to determine whether face recognition ability is related to adaptive social behavior and answer the question: Does an individual's ability

to process faces predict the individual's adaptive social functioning? This question resulted in the following hypothesis:

H$_5$1 (alternative hypothesis that provides evidence for a relation between facial processing ability and adaptive social behavior): Participants with more developed facial processing ability, as evidenced by higher FPT percent correct scores, will have more developed adaptive social behavior, as evidence by lower scores on the SRS; and participants with less facial processing ability, as evidenced by lower FPT percent correct scores will have less developed adaptive social behavior, as evidenced by higher SRS scores.

In order to determine whether there is a relation between face recognition ability and adaptive behavior, a multiple regression was calculated with Social Responsiveness Scale (SRS) Total Standard Score (T-score) as the dependent variable and the Peabody Picture Vocabulary Test-III (PPVT-III) developmental age equivalent, the two ADHD Symptom Scales standard scores from the Conner's Comprehensive Behavior Rating Scales - Parent (Conners' CBRS-P), and performance on the Facial Processing Tasks (FPT-Gender, FPT-Identity, both portions of the FPT-Emotion) as predictors. The PPVT-III developmental age equivalent and Conners' CBRS-P ADHD Symptom Scales scores were entered in step 1 of the hierarchical regression so to control the variance due intellectual functioning and attention difficulties. The four task variables (gender labeling, identity matching, emotion labeling, and emotion matching) were entered in step 2 of the regression. The results of the regression revealed that PPVT – III developmental age equivalent and Conners' CBRS-P ADHD Symptom Scales scores

were significant predictors ($F[3,47] = 57.06$, p< .01) of SRS Total T-score ($R^2= .79$).

When the facial processing tasks were added to the model, it remained significant

($F[7,43] = 27.70$, p< .01); however, the facial processing tasks did not increase the ability

to predict SRS Total T-score ($R^2\Delta= .03$). Thus, mental age and ADHD symptomatology,

measured by the SRS total standardized score, predicted 79% of the variance in social

adaptive behavior problems (see Table 7). The addition of Facial Processing Tasks

predicts 82% ($R^2= .82$) of the variance in problems in social adaptive behavior; however,

the increased the ability to predict the variance in social adaptive behavior was not

significant.

Chapter VII. Discussion

The current study was the first to specifically look at facial emotion recognition in a group of children with FASDs. This study also attempted to determine whether individuals from two atypically developing populations (Fetal Alcohol Spectrum Disorders and Down syndrome) are deficient in facial emotion recognition relative to their overall face recognition ability, consistent with the emotion specificity hypothesis. Although prior studies have demonstrated behavioral and social skill deficits associated with prenatal alcohol exposure, no prior research linked these difficulties with facial emotion recognition; therefore, this study attempted to link facial processing abilities with adaptive social behavior. Finally, this study attempted to determine whether behavioral and mood disorders are more prevalent in children with FASDs than in typically developing and DS populations.

The emotion specificity hypothesis was not supported in the two groups of children with developmental disabilities (FASD and DS) who participated in this study; however, the performance of the children with a Down Syndrome diagnosis was below the performance of the children with a FASD diagnosis and typically developing children across all facial processing tasks. Contrary to expectations, the children with a FASD diagnosis had relatively similar performance on all facial processing tasks compared to the typically developing children.

Measures of verbal ability, such as the PPVT-III, are frequently used to match groups on mental age (MA) in comparison studies of two atypically developing populations and studies that compare one atypically developing population to typically developing children (Hobson et al., 1989; Hodapp & Dykens, 2001; Thomas et al., 1998). Although the children in this study were matched on developmental age using the PPVT-III, a measure of verbal receptive knowledge, the standard scores of the children were not consistent across the groups (See Table 2). The children in the FASD group and the TD group had average standard scores within the normal range (although the FASD group barely fell within the normal range); but the children in the DS group had an average standard score that was nearly 1.5 standard deviations below the normal range.

This combination of a significant difference between the children with a DS diagnosis and the other two groups and the lack of a difference between the children with a FASD diagnosis and typically developing children may be due to differences in flexibility of cognitive functioning not accounted for by a matching procedure based on verbal ability. The relatively normal intellectual functioning of the FASD children may have allowed them to utilize other cognitive skills to compensate for weaknesses or deficits. Individuals with Williams Syndrome are able to utilize featural processing to demonstrate intact facial recognition ability despite a deficit in configural processing (Dueruelle et al., 1999; Gagliardi et al., 2003; Porter et al., 2007).

Gagliardi and colleagues also found a correlation between intellectual functioning and emotion recognition ability in individuals with Willams Syndrome and proposed individuals with Williams Syndrome who possess higher levels of intellectual functioning

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may have less brain damage or malformation which would also mean a greater possibility of intact configural processing ability (2003). This connection between intellectual functioning and emotion recognition ability may also be present in participants with a FASD diagnosis in this study. The possibility of spared functioning within a group of children with a FASD diagnosis is also more likely because the areas the brain damaged by the effects of alcohol vary with timing of prenatal exposure (i.e. the severity and location of damage to the brain that occurs during the eighth week of prenatal development are not the same areas that would be damaged if exposure occurred during the twentieth week of prenatal development) (Maier & West 2001; O'Leary, 2004). Perhaps individuals with a FASD diagnosis who possess higher levels of intellectual functioning were exposed to alcohol during a less sensitive period of prenatal development.

The finding that PPVT-III developmental age equivalent did significantly contribute to the relation between group and task is consistent with the extensive research that finds development of face recognition continues throughout childhood (Bruce et al., 2000; de Heering et al., 2007; Donnelly & Hadwin, 2003; Friere & Lee, 2001; Maurer et al., 2002; Mondloch et al., 2002; Pascalis et al., 2002; Passarotti et al., 2003; Sangrigoli & de Schonen, 2004). Although it may be slower or via different mechanism, this continued development is also found in many atypically developing populations (Chawarska & Volkmar, 2007; Dawson et al., 2005; Hobson, Ouston, & Lee, 1989; Osterling, & Dawson, 1994).

The lack of a significant finding when comparing the performance of the three

groups on the Gender (labeling) task seems odd when one compares the performance

means of the three groups. The participants with a Down syndrome diagnosis (M= 66.23,

SD= 16.60) appear to demonstrate poorer performance on the FPT-Gender relative to the

participants with a FASD diagnosis (M= 77.82, SD= 15.32) and the typically developing

participants (M= 77.47, SD= 17.52). However, the FPT-Gender task is different from the

other FPT-Tasks in some potentially important ways. The faces in the FPT-Gender task

are presented in black-and-white but the FPT-Identity and the FPT-Emotion tasks are

presented in color. The FPT-Gender task is also the only task in which the participant has

a binomial choice (man or woman). The FPT-Identity task and the matching portion of

the FPT-Emotion present the participant with 5 faces to choose from when matching to

the target face. The Labeling portion of the FPT-Emotion also has five response choices

(happy, sad, angry, scared, and calm). It is possible that these task differences contributed

to the non-significant finding for the FPT-Gender.

The three groups had the same pattern of relative performances on both portions

of the FPT-Emotion Valence percent correct scores as the relative pattern of performance

among the groups across the FPTs. The children with a Down syndrome diagnosis were

more likely to label a face with an emotion in the opposite valence of the target face's

valence than both the children with a FASD diagnosis and the typically developing

children matched on mental age. The children with a Down syndrome diagnosis were

also more likely to choose a face displaying an emotion of the opposite valence than

children with a FASD diagnosis and typically developing children. The finding of a

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tendency to label a face with an emotion with a valence that is the opposite of the emotion displayed on the target face is consistent with findings of other studies (Kasari et al., 2001) that find individuals with DS are more likely to confuse emotions of different valences. The children with a FASD diagnosis were no more likely to label or choose a face of the opposite valence than the typically developing participants.

Although there was no significant difference between the performance of the children with a FASD diagnosis and typically developing children on the facial processing tasks, the children with FASD met more of the diagnostic criteria for several DSM-IV disorders according to their standard scores on the Conners' CBRS-P: ADHD Predominately Inattentive, ADHD Predominately Hyperactive-Impulsive, Conduct Disorder, Oppositional Defiant Disorder, and Depressive Episode. As expected, the children with a FASD diagnosis also had higher standard scores on these symptom scales of the Conners' CBRS-P than the children with a Down syndrome diagnosis (see Table 2).

The finding of significantly higher scores on the Conners' CBRS-P symptom scales that correspond to the DSM-IV criteria for ADHD in the children with a FASD diagnosis is consistent with numerous studies that found attention problems are prevalent in individuals with prenatal alcohol exposure (Howell et al., 2006; Jacobson & Jacobson, 2002; O'Leary, 2004; Streissguth et al., 1991; 1998; Weinberg, 1997). The finding of significantly higher scores on the Conners' CBRS-P symptom scales that correspond to the DSM-IV criteria for Conduct Disorder and Oppositional Defiant Disorder in the children with a FASD diagnosis are consistent with the reports of significant behavioral

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problems by professionals who work with individuals with prenatal alcohol exposure (Howell et al., 2006; Jacobson & Jacobson, 2002; O' Connor, et al., 2002; O'Connor & Paley, 2006; O'Leary, 2004; NCBDDD, 2004; Streissguth et al., 1991; 1998) and the findings of behavioral problems significant enough for a diagnosis of Conduct Disorder or Oppositional Defiant Disorder found in some studies (Ryan & Ferguson, 2006; Weinberg, 1997). Consistent with prior findings of elevated rates of depression associated with prenatal alcohol exposure, the children with a FASD diagnosis had higher scores on the symptom scales that correspond to the DSM-IV criteria for a Major Depressive Episode.

The children with a FASD diagnosis also had higher standard scores on the Social Responsiveness Scale (which measures deficiencies in reciprocal social behavior) than the children with a Down syndrome diagnosis and the typically developing children of the same developmental age. The finding of more difficulties in social reciprocity is consistent with the finding of delayed or abnormal development of social-emotional skills (Kodituwakku et al., 2001b; Thomas et al., 1998; Whaley et al., 2001) and specific social information processing deficits based on Crick and Dodge (1994)'s SIP model (McGee et al., 2009).

The results of the regression of CBRS ADHD symptom scales, PPVT-III developmental age equivalent, and the facial processing tasks on Social Responsiveness Scale Total standard score showed the presence of ADHD symptomotology and developmental age explained the vast majority (79%) of the difference between the groups on reciprocal social behavior. Performance on the facial processing tasks only

increased the variance in SRS Total standard score explained to 82%. Although these results do not support an relation between performance on facial processing tasks and adaptive behavior, the findings of higher standard scores on both the Conners'CBRS-P and SRS in children with FASD diagnosis compared to the children with a Down Syndrome diagnosis and typically developing children is consistent with the dual reports of children with prenatal alcohol exposure displaying attentional and behavioral problems, along with difficulty understanding the perspectives of others, and lacking meaningful social relationships.

Limitations/ Future Directions

Although there was some variation across the three groups the participants in this study came from families with relatively high levels of education and at least moderate incomes (see Table 1). A familial environment that includes educated parents and sufficient income likely increases children's access to services and interventions that maximize strengths within the child and address potential deficits as they emerge (Koponen et al., 2009; Larkby & Day, 1997; O'Connor et al., 2006; O'Connor & Paley 2006). The parents of the children in my study were well educated. Nineteen (76%) of the female guardians of the children with a FASD diagnosis had obtained either an Associates Degree or College / University degree (see Table 1). Educated parents are more likely to be engaged with the child and seek appropriate intervention services. In fact, the participants with a FASD diagnosis and the participants with a Down syndrome diagnosis were all recruited through parent support groups affiliated with organizations

that directly provide or connect individuals with services. Thus, the participants were recruited from subject pools that are already connected to interventions. Parents of all the childr participants in this study self-selected themselves and their children for participation, further evidence of their level of engagement.

Recent studies of individuals prenatally exposed to alcohol emphasize "the postnatal care giving environment combined with neurophysiological vulnerability" are the critical factors that determine prognosis (Koponen et al., 2009; p. 1050). In their study of the care giving environments of children with a FASD who were currently in long-term foster care, Koponen et al. (2009) found children who were in the current placement before their third birthday had fewer attention and emotional problems than children who were placed at an older age. The children who were removed from their birth parents early in life benefitted from the lessened exposure to an adverse environment and parents who were less sensitive and able to care for the child due to continued alcohol use (Coggins et al., 2007; Koponen et al., 2009).

The children with a FASD diagnosis who participated in the current study were almost exclusively (96%) in the custody of a non-birth parent; and 90% of the 21 parents/guardians who provided information about placement reported the child had been placed into the current environment within the first 2 ½ years (62% within the first year) of life. Although the children with a FASD diagnosis who participated in this study did have higher standard scores on measures of maladaptive behavior (Conners' CBRS-P, SRS) the behavior problems in these individuals was likely mitigated by the enriched environment and sensitive care giving provided by the child's adoptive parents or legal

guardian (Koponen et al., 2009). The connection of all FASD participants with NOFAS and state affiliates is evidence of an enriched environment and sensitive care giving. As a part of their connection with NOFAS, these families have access to intervention services that enhance the child's developmental potential as well as support groups that allow parents to learn how to support their children and handle the developmental issues that arise when parenting an atypically developing child. It is also possible that these enriched environments allowed for more typical development of facial emotion recognition and may have contributed to the lack of an emotion recognition deficit in the children with a FASD diagnosis who participated in this study. Future research on emotion recognition in children with prenatal alcohol exposure should incorporate children from less ideal environments.

In addition to the impact of an enriched environment, it is possible that the nature of the facial processing tasks used in this study did not tap the mechanisms responsible for emotion recognition in a naturalistic setting. Schonfeld et al. (2006) compared the executive functioning abilities and social skills of children (6-11 years old) prenatally exposed to alcohol. They found that deficits in Executive Functioning (measure by the Behavior Rating Inventory of Executive Functioning – BRIEF) were correlated with poor social abilities (measured by the Social Skills Rating System – SSRS). Despite finding a connection between executive functioning deficits and social skills difficulties, Schonfeld and colleagues point to a study, conducted by Sarazin et al. (1998), that indicates the areas of the frontal lobe that are activated when engaging in laboratory tasks may not be the same areas that are activated when engaging in actual behavior, including social

interaction. A dissociation between performance on laboratory-based tasks and natural behavior during social encounters could explain how this study could fail to find a deficit in emotion recognition (measured by the FPT-Emotion) despite reports of difficulties in social interactions and social competence (measured by the SRS and Conners' CBRS-P) from the parents of the FASD children in the study.

This study did not incorporate measurements of reaction time or record gaze patterns in an effort to make the study tasks portable and facilitate participation. In addition, participants were given unlimited time to look at the stimuli (faces) in this study. Rump, Giovannelli, Minshew, and Strauss (2009) have criticized tests of face processing that allow the participant to look at the faces for unlimited time periods, noting these tasks do not reflect face processing in the real world. When in a social interaction, the individual does not have unlimited time to process faces. Studies of the length reaction times of atypical populations during face processing tasks have revealed significant impairment to briefly presented and/ or subtle stimuli relative to typical individuals even when the atypical populations have high accuracy (Mazefsky & Oswald, 2007; Pelphrey et al., 2002; Rump et al., 2009). The lack of a time limit for responding in this study likely resulted in optimal performance for all participants, but may have been more beneficial and probably enhanced the performance of participants with face processing deficits. It is possible that limiting the length of time the participants were allowed to view the faces would expose more subtle deficits in facial processing and be more consistent with the face processing required in typical social interactions. Future

studies should determine if individuals with FASDs show impairment when required to recognize emotions after brief displays (i.e. few seconds).

The facial processing tasks presented in this study also included prototypical expressions of each of the emotions (happy, sad, angry, scared, calm). A study of facial emotion recognition in individuals with autism and typically developing individuals presented faces that morphed from neutral to one of six facial expressions (happy, sad, angry, afraid, disgusted, and surprised) over four levels. They found that individuals with autism required one level beyond that of typically developing individuals in order to identify the angry and afraid faces and often only when the faces had completely morphed into the emotional expression (Rump et al., 2009). Future studies should investigate the abilities of children with a FASD diagnosis to recognize facial expressions of emotion that vary in degree of subtlety.

Although the finding that children with a FASD diagnosis can perform as well as typically developing children of the same mental age under optimal conditions is worth noting, the results of this study do not provide insight into the face and emotion processing of children with a FASD diagnosis in typical social situations. The finding of significant deficits in reciprocal social behavior (measured by the SRS) suggests individuals with prenatal alcohol exposure are indeed having difficulties engaging in social information processing. Due to the limitations previously discussed, the results of this study did not conclusively rule out facial processing deficits as a source of the difficulties in social interaction experienced by individuals with FASDs. Facial processing tasks that vary in degree of subtlety and duration of exposure would be more

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ecologically valid and may shed more light on face processing in this population. The enriched environments, including well educated, sensitive parents, and the early interventions experienced by the children in this study may have lessened the impact of alcohol exposure on these children and allowed them to reach optimal levels of functioning. Individuals with prenatal alcohol exposure who do not have access to sensitive caregivers and interventions may demonstrate deficits not found in children with environments similar to those experienced by the participants in this study.

Table 1. Demographic information for child participants by group.

		FASD		TD		DS	
		n		*n*		*n*	
Gender	Female	18	72%	12	52%	11	79%
	Male	7	28%	11	48%	3	21%
State of Residence	Virginia	3	12%	17	74%	3	21%
	Maryland	1	4%	0	0%	0	0%
	North Carolina	7	28%	6	26%	8	57%
	Ohio	14	56%	0	0%	0	0%
	Tennessee	0	0%	0	0%	3	21%
Living Arrangement	Birth Parents	1	4%	21	91%	14	100%
	Adoptive Parents	21	84%	2	9%	0	0%
	Legal Guardian	3	12%	0	0%	0	0%
Race	Caucasian/ White	13	52%	21	91%	14	100%
	African American / Black	4	16%	0	0%	0	0%
	Multi-racial	4	16%	2	9%	0	0%
	Other	2	8%	0	0%	0	0%
	Not reported	2	8%	0	0%	0	0%
Household Income	Less than $20,000	1	4%	0	0%	0	0%
	$20,001 to $40,000	3	12%	0	0%	0	0%
	$40,001 to $60,000	8	32%	1	4%	1	9%
	$60,001 to $80,000	4	16%	4	17%	1	9%
	More than$80,000	7	28%	16	70%	10	73%
	Not reported	2	8%	2	9%	2	9%
Highest Level of Education Completed by Mother (or Female Legal Guardian)	Did not complete High School	0	0%	0	0%	0	0%
	High School/ GED	2	8%	0	0%	0	0%
	Some College	4	16%	0	0%	2	14%
	2 yr Associates Deg.	4	16%	1	4%	1	7%
	4 yr College Deg.	12	48%	14	61%	5	36%
	Masters Degree	3	12%	5	22%	4	29%
	Doctoral Degree	0	0%	2	9%	1	7%
	Professional Degree	0	0%	1	4%	1	7%
Highest Level of Education Completed by Father (or Male Legal Guardian)	Did not complete High School	0	0%	0	0%	0	0%
	High School/ GED	2	8%	0	0%	0	0%
	Some College	3	12%	4	17%	1	7%
	2 yr Associates Deg.	3	12%	1	4%	1	7%
	4 yr College Deg.	8	32%	9	39%	9	64%

	Masters Degree	3	12%	7	30%	0	0%
	Doctoral Degree	0	0%	2	9%	1	7%
	Professional Degree	0	0%	0	0%	2	14%
	No Male Guardian	6	24%	0	0%	0	0%
Other Diagnoses	Learning Disability	7	28%	1	4%	1	9%
	ADHD	11	44%	0	0%	1	9%
	Mood Disorder	3	12%	0	0%	0	0%
	Anxiety Disorder	1	4%	0	0%	0	0%
	Autistic Spectrum	2	4%	0	0%	0	0%
	Intellectual Dis	4	16%	0	0%	14	100%
	Epilepsy	2	8%	0	0%	0	0%
FASD Diagnosis	FAS	9	36%				
	PFAS (a.k.a. FAE)	7	28%				
	ARND	5	20%				
	Other FASD	4	16%				
Age of FASD Diagnosis	Less than 24 months	3	12%				
	24 to 48 months	9	36%				
	60 to 72 months	8	32%				
	72 to 108 months	3	12%				
	Not reported	2	8%				

Table 2. Standard scores on cognitive and adaptive functioning measures for child participants by group.

			Standard (T-Scores)								Pairwise Comparisons
		FASD			TD			DS			
		n	M	SD	n	M	SD	n	M	SD	
PPVT	Standard Score	25	85.72	20.39	23	106.80	9.25	14	64.86	11.49	TD > FASD > DS
	Percentile		29.69	30.82		65.00	20.84		2.94	4.33	TD > FASD > DS
	Developmental Age (months)		84.44	26.48		85.17	28.91		67.14	22.90	FASD / TD / DS
SRS	Total Score	23	80.00	10.39	18	44.44	4.38	14	62.36	8.01	FASD > DS > TD
	Social Awareness		69.30	15.09		49.94	7.46		54.29	7.15	FASD > TD / DS
	Social Cognition		80.78	10.99		42.50	10.72		63.71	18.90	FASD > DS > TD
	Social Communication		77.78	9.67		44.00	4.16		61.36	9.77	FASD > DS > TD
	Social Motivation		69.78	13.20		45.11	6.20		52.43	6.26	FASD > TD / DS
	Autistic Mannerisms		79.22	13.55		45.72	4.00		63.29	12.12	FASD > DS > TD
Conners' CBRS Content Scales	Emotional Distress Total Score	24	77.50	19.00	17	46.82	4.94	13	51.15	8.66	FASD > TD / DS
	Upsetting Thoughts (ED subscale)		70.54	27.39		50.11	8.19		45.92	0.49	FASD > TD / DS
	Worrying (ED subscale)		63.63	16.57		47.53	5.65		44.08	5.65	FASD > TD / DS
	Social Problems (ED subscale)		93.33	28.41		46.59	4.68		65.31	16.16	FASD > TD / DS
	Aggressive Behaviors	24	87.13	45.15	17	49.71	7.00	13	48.77	5.82	FASD > TD / DS
	Academic Difficult Total Score	23	91.04	20.60	17	49.71	9.05	13	83.31	15.00	FASD / DS > TD
	Language (AD subscale)	24	88.21	21.33	17	51.12	11.78	13	79.38	14.82	FASD / DS > TD
	Math (AD subscale)	23	90.87	24.65	17	47.88	8.45	13	88.62	23.31	FASD / DS > TD
	Hyperactivity/ Impulsivity	25	83.52	15.49	17	53.47	10.33	13	57.85	13.27	FASD > TD / DS
	Separation Fears	24	62.00	17.53	17	47.65	8.30	13	46.69	6.46	FASD > TD / DS

	Perfectionistic Compulsive Beh	24	67.96	18.01	17	49.53	8.97	13	50.69	6.26	FASD > TD / DS
	Violence Potential	24	88.21	28.94	17	52.24	7.78	13	52.62	11.06	FASD > TD / DS
	Physical Symptoms	24	72.13	18.58	17	49.00	7.57	13	48.54	8.17	FASD > TD / DS
Conner's DSM-IV-TR Symptom Scales	ADHD Inattentive Type	24	87.45	14.44	17	52.06	9.58	13	64.38	12.78	FASD > DS > TD
	ADHD Hyperactive-Impulsive	25	83.64	15.28	17	53.24	10.63	13	57.85	13.27	FASD > TD / DS
	Conduct Disorder	24	75.25	32.65	17	46.94	3.29	13	47.77	4.87	FASD > TD / DS
	Oppositional Defiant Disorder	24	73.71	19.91	17	54.35	7.02	13	51.54	10.51	FASD > TD / DS
	Major Depressive Episode	24	76.42	23.51	17	45.35	3.86	13	53.46	10.66	FASD > TD / DS
	Manic Episode	24	86.29	42.15	17	47.29	7.48	13	54.69	10.09	FASD > TD / DS
	General Anxiety Disorder	24	80.42	17.92	17	47.35	5.77	13	51.69	9.78	FASD > TD / DS
	Separation Anxiety Disorder	24	65.08	22.48	17	48.35	10.28	13	46.85	7.12	FASD > TD / DS
	Social Phobia	24	65.67	16.88	17	48.00	5.92	13	47.54	10.13	FASD > TD / DS
	Obsessive-Compulsive Disorder	24	77.38	42.46	17	48.59	7.78	13	45.54	1.94	FASD > TD / DS
	Autistic Disorder	24	92.83	25.58	17	45.18	7.15	13	68.69	13.77	FASD > DS > TD
	Asperger Disorder	24	80.46	19.98	17	44.82	6.00	13	56.77	7.78	FASD > TD / DS

All pairwise comparisons are significant p<.05.

Table 3. Standard and raw scores on the Social Responsiveness Scale (SRS) for child participants by group.

	Standard (T-Scores)									Raw Scores					
	FASD			TD			DS			FASD		TD		DS	
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Total Score	23	80.00	10.39	18	44.44	4.38	14	62.36	8.01	92.43	29.42	20.00	8.42	51.71	14.63
Social Awareness		69.30	15.09		49.94	7.46		54.29	7.15	11.61	4.70	5.94	2.26	6.86	1.96
Social Cognition		80.78	10.99		42.50	10.72		63.71	18.90	19.48	5.96	3.28	2.05	12.93	3.99
Social Communication		77.78	9.67		44.00	4.16		61.36	9.77	31.48	10.74	5.56	3.09	17.36	7.09
Social Motivation		69.78	13.20		45.11	6.20		52.43	6.26	13.57	6.00	3.11	2.49	6.07	2.59
Autistic Mannerisms		79.22	13.55		45.72	4.00		63.29	12.12	16.74	8.00	2.11	1.75	8.50	4.47

Table 4. Performance on the facial processing tasks (FPTs) by group.

			Number Correct			Percentage Correct			
		n	*M*	*SD*	Range	*M*	*SD*	Range	skew
FASD	Gender (Labeling)	25	17.1	3.4	11 to 21	77.8	15.3	50 to 95.5	-0.82
	Identity (Matching)		8.6	2.7	4 to 15	57.3	18.0	26.7 to 100	0.34
	Emotion Labeling		21.5	4.1	7 to 26	76.7	14.8	25 to 92.9	-1.92
	Emotion Matching		22.0	4.3	8 to 27	78.6	15.3	28.6 to 96.4	-1.63
	Emotion Valence Label		24.8	2.3	19 to 28	88.6	8.1	67.9 to 100	-0.94
	Emotion Valence Match		25.7	3.2	14 to 28	91.7	11.2	50 to 100	-2.46
TD	Gender (Labeling)	23	17.0	3.9	9 to 22	77.5	17.5	40.9 to 100	-0.90
	Identity (Matching)		9.1	3.5	2 to 14	60.9	23.2	13.3 to 93.3	-0.53
	Emotion Labeling		21.4	4.6	10 to 27	76.6	16.5	35.7 to 96.4	-1.30
	Emotion Matching		21.0	6.8	4 to 28	75.0	24.3	14.3 to 100	-1.30
	Emotion Valence Label		25.0	2.7	17 to 28	89.4	9.7	60.7 to 100	-1.32
	Emotion Valence Match		24.5	3.8	14 to 28	87.6	13.7	50 to 100	-1.36
DS	Gender (Labeling)	14	14.6	3.7	9 to 21	66.2	16.6	40.9 to 95.5	0.15
	Identity (Matching)		3.8	2.4	0 to 9	25.2	16.2	0 to 60	0.37
	Emotion Labeling		17.1	3.9	8 to 24	61.0	13.8	28.6 to 85.7	-0.56
	Emotion Matching		12.4	3.4	6 to 17	44.4	12.3	21.4 to 60.7	-0.51
	Emotion Valence Label		22.4	2.3	19 to 26	80.1	8.3	67.9 to 92.9	-0.09
	Emotion Valence Match		20.7	2.7	17 to26	74.0	9.7	60.7 to 92.9	0.24

Table 5. Error patterns for each emotion by group.

		Happy Items							Calm Items							
		3	8	12	18	27	Total	Percent	5	13	17	20	23	26	Total	Percent
FASD	Happy	25	23	23	24	24	119	95.2%	3	0	4	1	2	1	11	7.3%
(25)	Sad	0	1	0	1	0	2	1.6%	2	5	2	2	0	0	11	7.3%
	Angry	0	0	0	0	0	0	0.00%	0	0	0	0	1	3	4	2.7%
	Scared	0	0	0	0	0	0	0.00%	1	2	0	1	0	0	4	2.7%
	Calm	0	1	2	0	1	4	3.2%	16	15	19	21	21	17	109	72.7%
	Other/NR	0	0	0	0	0	0	0.00%	3	3	0	0	1	4	11	7.3%
TD	Happy	22	22	21	21	22	108	93.9%	4	0	4	1	1	1	11	8.0%
(23)	Sad	0	1	1	0	0	2	1.7%	1	2	1	1	0	1	6	4.3%
	Angry	0	0	0	0	0	0	0.00%	0	0	0	0	0	0	0	0.00%
	Scared	0	0	0	0	0	0	0.00%	0	2	2	0	1	0	5	3.6%
	Calm	1	0	1	1	1	4	3.5%	17	18	15	20	19	20	109	79.0%
	Other/NR	0	0	0	1	0	1	0.87%	1	1	1	1	2	1	7	5.1%
DS	Happy	13	14	13	14	14	68	97.1%	4	2	7	5	3	3	24	28.6%
(14)	Sad	0	0	0	0	0	0	0.00%	2	4	1	1	3	3	14	16.7%
	Angry	0	0	0	0	0	0	0.00%	1	2	0	2	2	3	10	11.9%
	Scared	0	0	0	0	0	0	0.00%	0	2	1	0	0	0	3	3.6%
	Calm	0	0	0	0	0	0	0.00%	4	2	4	5	5	4	24	28.6%
	Other/NR	1	0	1	0	0	2	2.86%	3	2	1	1	1	1	9	10.7%
ALL	Happy	60	59	57	59	60	295	95.2%	11	2	15	7	6	5	46	12.4%
(62)	Sad	0	2	1	1	0	4	1.3%	5	11	4	4	3	4	31	8.3%
	Angry	0	0	0	0	0	0	0.00%	1	2	0	2	3	6	14	3.8%
	Scared	0	0	0	0	0	0	0.00%	1	6	3	1	1	0	12	3.2%
	Calm	1	1	3	1	2	8	2.6%	37	35	38	46	45	41	242	65.1%
	Other/NR	1	0	1	1	0	3	0.97%	7	6	2	2	4	6	27	7.3%

Table 5. Error patterns for each emotion by group (continued).

				Sad Items								Angry Items								Scared Items				
		11	15	22	24	25	Tot	Percent	2	4	6	9	19	21	Tot	Percent	1	7	10	14	16	28	Tot	Percent
FASD (25)	Happy	0	0	0	0	1	1	0.80%	0	0	0	0	0	0	0	0.00%	0	1	1	0	0	1	3	2.0%
	Sad	22	9	20	21	20	92	73.6%	1	4	2	2	2	4	15	10.0%	1	2	1	5	3	0	12	8.0%
	Angry	0	1	2	0	1	4	3.2%	23	20	22	18	20	20	123	82.0%	2	0	1	1	0	1	5	3.3%
	Scared	3	10	2	2	1	18	14.4%	1	0	0	1	0	0	2	1.3%	14	20	8	17	13	22	94	62.7%
	Calm	0	4	0	1	1	6	4.8%	0	0	0	2	1	0	3	2.0%	1	0	8	0	4	0	13	8.7%
	Other	0	1	1	1	1	4	3.2%	0	1	1	2	2	1	7	4.7%	7	2	6	2	5	1	23	15.3%
TD (23)	Happy	0	0	0	0	0	0	0.00%	0	0	0	2	1	0	3	2.2%	1	0	1	0	1	1	4	2.9%
	Sad	23	9	15	21	19	87	75.7%	0	2	2	0	0	6	10	7.2%	1	2	3	8	2	5	21	15.2%
	Angry	0	0	4	1	0	5	4.3%	22	19	21	19	21	16	118	85.5%	0	1	3	0	0	0	4	2.9%
	Scared	0	12	1	0	1	14	12.2%	1	1	0	0	1	0	3	2.2%	8	16	7	14	11	15	71	51.4%
	Calm	0	2	2	1	2	7	6.1%	0	0	0	1	0	1	2	1.4%	2	1	3	0	2	0	8	5.8%
	Other	0	0	1	0	1	2	1.7%	0	1	0	1	0	0	2	1.4%	11	3	6	1	7	2	30	21.7%
DS (14)	Happy	0	1	0	1	0	2	2.9%	1	0	0	1	1	1	4	4.8%	2	1	2	0	0	1	6	7.1%
	Sad	13	5	7	11	8	44	62.9%	0	1	1	2	0	2	6	7.1%	0	1	0	1	5	1	8	9.5%
	Angry	0	1	3	0	0	4	5.7%	13	12	12	9	9	9	64	76.2%	1	1	0	3	0	1	6	7.1%
	Scared	0	4	0	1	2	7	10.0%	0	0	0	0	1	0	1	1.2%	6	10	5	7	4	6	38	45.2%
	Calm	0	1	1	0	0	2	2.9%	0	0	0	0	0	0	0	0.00%	1	0	1	1	1	1	5	6.0%
	Other	1	2	3	1	4	11	15.7%	0	1	1	2	3	2	9	10.7%	4	1	6	2	4	4	21	25.0%
ALL (62)	Happy	0	1	0	1	1	3	0.97%	1	0	0	3	2	1	7	1.9%	3	2	4	0	1	3	13	3.5%
	Sad	58	23	42	53	47	223	71.9%	1	7	5	4	2	12	31	8.3%	2	5	4	14	10	6	41	11.0%
	Angry	0	2	9	1	1	13	4.2%	58	51	55	46	50	45	305	82.0%	3	2	4	4	0	2	15	4.0%
	Scared	3	26	3	3	4	39	12.6%	2	1	0	1	2	0	6	1.6%	28	46	20	38	28	43	203	54.6%
	Calm	0	7	3	2	3	15	4.8%	0	0	0	3	1	1	5	1.3%	4	1	12	1	7	1	26	7.0%
	Other	1	3	5	2	6	17	5.5%	0	3	2	5	5	3	18	4.8%	22	6	18	5	16	7	74	19.9%

Table 6. Kolmogorov-Smirnov and Shapiro-Wilk Tests of facial processing tasks (FPTs) by group.

| | | Arcsine Transformed Facial Processing Tasks | | | | | | Facial Processing Tasks | | | | | |
| | | Kolmogorov-Smirnov | | | Shapiro-Wilk | | | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
		Statistic (D)	df	Sig.	Statistic	df	Sig.	Statistic (D)	df	Sig.	Statistic	df	Sig.
FASD	Gender	0.25	25	0.00	0.89	25	0.01	0.27	25	0.00	0.84	25	0.00
	Identity	0.17	25	0.05	0.87	25	0.01	0.11	25	0.20	0.97	25	0.66
	Emotion Labeling	0.14	25	0.20	0.90	25	0.02	0.17	25	0.05	0.82	25	0.00
	Emotion MTS	0.15	25	0.17	0.94	25	0.15	0.19	25	0.02	0.85	25	0.00
	Emotion Valence Label	0.23	25	0.01	0.90	25	0.02	0.22	25	0.01	0.91	25	0.03
	Emotion Valence Match	0.19	25	0.03	0.89	25	0.01	0.30	5	0.00	0.70	25	0.00
TD	Gender	0.15	23	0.20	0.96	23	0.45	0.17	23	0.08	0.89	23	0.02
	Identity	0.15	23	0.19	0.95	23	0.30	0.18	23	0.05	0.92	23	0.08
	Emotion Labeling	0.21	23	0.01	0.91	23	0.04	0.24	23	0.00	0.83	23	0.00
	Emotion MTS	0.17	23	0.11	0.96	23	0.52	0.24	23	0.00	0.85	23	0.00
	Emotion Valence Label	0.13	23	0.20	0.94	23	0.18	0.23	23	0.01	0.88	23	0.01
	Emotion Valence Match	0.16	23	0.13	0.94	23	0.16	0.26	23	0.00	0.82	23	0.01
DS	Gender	0.17	14	0.20	0.94	14	0.43	0.13	14	0.20	0.96	14	0.67
	Identity	0.17	14	0.20	0.95	14	0.50	0.18	14	0.20	0.95	14	0.59
	Emotion Labeling	0.18	14	0.20	0.96	14	0.68	0.18	14	0.20	0.95	14	0.51
	Emotion MTS	0.17	14	0.20	0.94	14	0.44	0.18	14	0.20	0.94	14	0.36
	Emotion Valence Label	0.18	14	0.20	0.94	14	0.41	0.18	14	0.20	0.93	14	0.34
	Emotion Valence Match	0.14	14	0.20	0.94	14	0.41	0.13	14	0.20	0.96	14	0.64

Table 7. Regression predicting SRS standard score from PPVT--III developmental age equivalent, standard scores on the ADHD subscales of the Conners' CBRS-P, and performance on the FPTs.

		B	*SE B*	β
Step 1	Constant	12.85	6.36	
	PPVT Dev Age	-0.05	0.05	-0.07
	CBRS ADHD Inattentive	0.58	0.10	0.68
	CBRS ADHD Hyperactive	0.20	0.10	0.23
Step 2	Constant	7.41	7.83	
	PPVT Dev Age	0.04	0.07	0.05
	CBRS ADHD Inattentive	0.58	0.10	0.68
	CBRS ADHD Hyperactive	0.21	0.1	0.24
	Gender	8.13	5.99	0.12
	Identity	-14.41	7.18	-0.24
	Emotion Labeling	0.31	7.47	0
	Emotion Matching-to-Sample	-2.47	6.5	-0.05

Note R^2 =.79 (*p*=.00) for Step 1; $R^2\Delta$=.03 (*p*=.11) for Step 2

(from http://www.nofas.org/MediaFiles/PDFs/factsheets/identification.pdf)
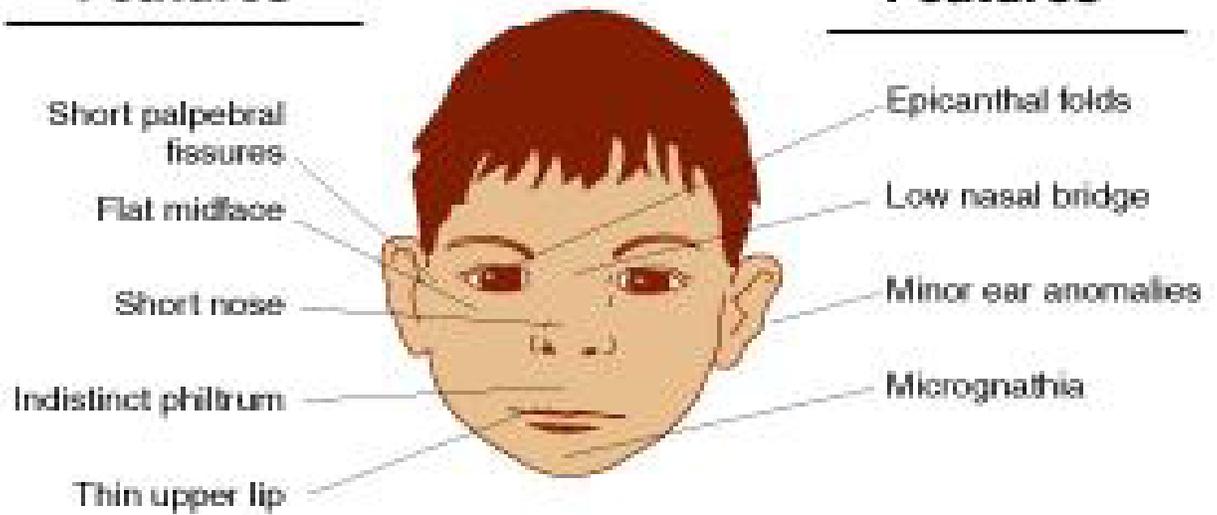
Figure 1. Facial anomalies commonly found in individuals with FAS.

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CURRICULUM VITAE

Erin Way graduated from Elon College in May of 2001 with a B.A. in Psychology and a B.A. in Human Services. While at Elon College, she assisted with research on scaffolding of children's cognitive development from a sociocultural perspective. After earning her M.A. in Applied Developmental Psychology from George Mason University in 2005, she became interested in children's emotional development. To further develop her research interests, she assisted with research assessing indicators of socio-emotional school readiness as a part of a NICHD grant. This dissertation also developed out of an interest in emotional development and sought to look at emotion recognition in an under-research population: children with Fetal Alcohol Spectrum Disorders.