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Gender/sex differences and disparities within autism spectrum disorder

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**GENDER/SEX DIFFERENCES AND DISPARITIES
WITHIN AUTISM SPECTRUM DISORDER**

by

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GENDER/SEX DIFFERENCES AND DISPARITIES

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PRAGATI KHANDELWAL

ABSTRACT

For a long time, autism spectrum disorder has been considered a predominantly male condition. However, emerging literature suggests that this imbalance is not due solely to etiological differences but rather to other factors. Disparity in diagnosis, because of biases, co-occurring psychiatric disorders, and limited understanding of autism manifestation in females, causes these individuals to be diagnosed with autism significantly later than their male counterparts, if at all. The delayed diagnoses or misdiagnoses of females contribute to later and lesser treatment and worsened outcomes. Furthermore, certain traits of autism in women, such as camouflage and a tendency toward internalized symptomology, exacerbate this effect. Unfortunately, this becomes a self-perpetuating issue: the reduction in the number of diagnosed females results in an underrepresentation of the sex in subsequent autism studies, and this, in turn, contributes to the misrepresentation of the female gender in autism. Thus, in addressing this complex issue, clinicians, researchers, and communities target these many intertwined challenges. Modifications and new initiatives continue to be developed to better accommodate autistic females and make strides to bridge the gender/sex gap.

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LIST OF ABBREVIATIONS

ABA	Applied Behavior Analysis
ADHD	Attention-Deficit-Hyperactivity Disorder
ADI-R	Autism Diagnostic Interview-Revised
ADOS.....	Autism Diagnostic Observation Schedule
APA.....	American Psychiatric Association
AQ.....	Autism Questionnaire
ASD.....	Autism Spectrum Disorder
CAT-Q	Camouflaging Autistic Traits Questionnaire
CBT.....	Cognitive Behavioral Therapy
CDC	Centers for Disease Control and Prevention
CF.....	Camouflaging Score
DIR.....	D1-Class Receptor
DOPAC.....	3,4-Dihydroxyphenylacetic Acid
DSM.....	Diagnostic and Statistical Manual of Mental Disorders
EA	Educational Attainment
EBI	Evidence-Based Intervention
EIBI.....	Early Intensive Behavioral Intervention
fMRI.....	Functional Magnetic Resonance Imaging
FQ	Friendship Questionnaire
GNO	Girls Night Out
ICD.....	International Classification of Diseases and Related Health Problems

IQ	Intelligence Quotient
L-DOPA	L-3,4-Dihydroxyphenylalanine
MAO-A.....	Monoamine Oxidase Isoform-A
MRI.....	Magnetic Resonance Imaging
OCD	Obsessive Compulsive Disorder
PDD.....	Pervasive Developmental Disorder
REMT	Reading the Mind in the Eyes Test
SES.....	Socioeconomic Status
SRY.....	Sex-Determining Region
TD	Typically Developing
UCLA.....	University of California, Los Angeles
Vineland-II.....	Vineland Adaptive Behavior Scales-II
WHO.....	World Health Organization

INTRODUCTION

Autism spectrum disorder (ASD) affects 1 in 58 children and is four times more likely to be identified in males than females (Maenner et al., 2020). The disorder can be diagnosed as early as the age of two years but is commonly diagnosed by physicians and health care professionals by the age of four years (Maenner et al., 2020).

There are three main factors of ASD to be analyzed: classification, diagnosis, and treatment. However, important and relatively recent discoveries have found that these factors differ between males and females. The different traits and manifestations of ASD in these two genders can lead to misdiagnoses and worse outcomes for females as opposed to their male counterparts (Loomes et al., 2017).

Autism Spectrum Disorder Classification, History, and Social Context

ASD is primarily classified by its distinct behavioral effects and patterns (American Psychiatric Association, 2013). In social settings, such indicative behaviors may include avoiding eye contact, aversion to loud sounds or sensory overload, and trouble understanding social cues (American Psychiatric Association, 2013). At home, traits may include repetitive behaviors, language delays, nonverbal responses, and self-abusive behaviors. (American Psychiatric Association [APA], 2013). According to the fifth edition (2013) of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*, the term ASD now encompasses previously separate conditions such as pervasive disorder, autistic disorder, Asperger's disorder, and childhood disintegrative disorder. (APA, 2013; Lai et al., 2013).

Autism was first distinctly described in 1943 by Dr. Leo Kanner, who specifically identified traits such as socio-communicative deficiencies and repeated behavior, especially in children. At the time, the disorder he was describing was termed “childhood schizophrenia” (Wolff, 2004). Later in 1956, Kanner, along with Dr. Leon Eisenberg, specified this classification to allow for diagnosis (Matson, 2016). Interestingly, in 1944, Dr. Hans Asperger in Vienna was also investigating “autistic psychopathy of childhood,” yet Kanner did not mention or credit his work (Wolff, 2004). Asperger’s work was smaller in scope (4 cases originally) and included children with savant-like qualities who excelled in math or science despite ASD-typical social deficits (Wolff, 2004). Asperger’s syndrome is similar to autism in that it is characterized by social/interpersonal deficits (Tantam, 1988). However, individuals with Asperger’s are also described as highly intelligent (especially in verbal/language domains), with “idiosyncratic interests” and “special abilities” such as the savant-like skills already mentioned (Tantam, 1988). This problematic stereotype of a “special gift or talent” of some sort in autistic children has persisted in modern times (mainly because of pop culture, movies, and media) and is one of the reasons that ASD and not Asperger’s is used as the official diagnosis (Roscigno, 2020). Some of the other documented but not always credited scientists involved in the field include G.E. Ssucharewa, a German who studied similar cases as early as 1926, and I. Kolvin, who differentiated between childhood autism and childhood schizophrenia (Wolff, 2004). Dr. Lorna Wing has done much to increase autism awareness and is largely responsible for the term used today: autism spectrum disorder (Wolff, 2004). At

present, this title has come to encompass a broad range of disorders that were previously separated (Wolff, 2004).

Since the time of this initial diagnosis and crude classification, a growing percentage of the population continues to be diagnosed as autistic (Maenner et al., 2020). Such growth rates, as demonstrated in Figure 1, can be due to many factors including but not limited to increased awareness, early diagnosis, and different classifications under psychological and medical guidelines (Maenner et al., 2020).

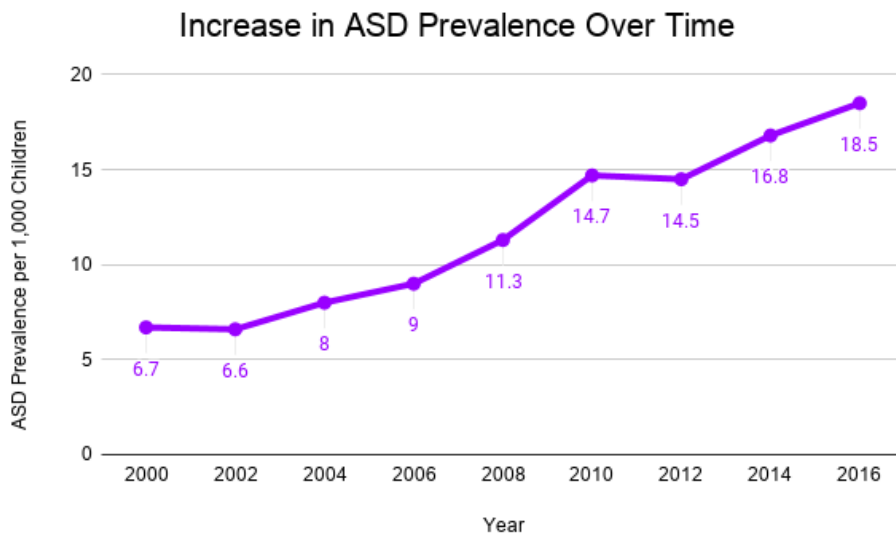


Figure 1. Increase in ASD Prevalence Over Time. ASD prevalence and diagnosis have increased over time, rising from 6.7/1000 children in 2000 to 18.5/1000 children in 2016. This increase is due in part to greater awareness about autism as well as broadened diagnostic criteria to encompass a larger range of symptoms. ASD = autism spectrum disorder. Adapted from Centers for Disease Control and Prevention (CDC) data from (Maenner et al., 2020).

Lowered thresholds for ASD diagnosis allow more children to fall within this category and be diagnosed accordingly (Russell et al., 2015). In addition, the number of children showing autistic traits is also increasing, a trend which may be due to certain environmental factors (e.g., later maternal age at childbirth) (Russell et al., 2015; Sandin

et al., 2012). This epidemiological increase simply means that the incidence of autism for various and still unknown reasons has increased in the population over time (Maenner et al., 2020; Russell et al., 2015; Sandin et al., 2012). Finally, there is the notion of “reporting drift” (Russell et al., 2015). This term implies that over time, the pattern of parents and physicians reporting and diagnosing such symptoms has changed, causing a systematic increase in the number of cases (Russell et al., 2015).

As ASD classification changes, so do the terminology and societal attitudes associated with the disorder (Mintz, 2017; Roscigno, 2020). Previously used terms, including but not limited to “high and low functioning,” are now outdated and avoided because of their ableist and offensive connotations and their deleterious assumptions of affected individuals (Hennekam, n.d.; Robinson, 2019). Instead, researchers and clinicians use different types of intelligence quotients (IQs), verbal and nonverbal abilities, and measures of cognitive function to better assess and categorize specific needs. Similarly, a more recent trend is the use of person-first language, saying “a person with autism,” rather than identity-first language, saying “an autistic person” (Roscigno, 2020). However, as many individuals on the spectrum have explained, they do not personally need or agree with that distinction. They reason that autism in itself is not a derogatory term, and so calling someone an “autistic person” is not in fact deprecating (Roscigno, 2020). Using person-first language can be considered diminutive. (Hennekam, n.d.; Robison, 2019; Roscigno, 2020). From her own experience with autism, Hennekam (n.d.) points out that the disorder is different from other medical diagnoses and terminology (e.g., saying “a person who has cancer”) because autism is not a disease that

can be cured or a condition that can be isolated from the individual. She says, “I cannot separate my autism from anything I do or anything I am, ever” (Hennekam, n.d.). Because autism is such a large part of her identity and life experiences, it is who she is and not what she has (Hennekam, n.d.). These identities, such as autism, are indicative of a community to which these individuals belong, and for this reason, the identity-first movement also exists in Deaf and Blind communities, among others (Rosignano, 2020).

Current ASD Diagnostic Criteria and Tools

The *DSM-5* classifies autism (specifically the umbrella-term ASD) based on a few main traits: (1) persistent social and communication deficits, including verbal and nonverbal interaction or behavior and ability to make and maintain interpersonal relationships; (2) restricted and repetitive behavior, including echolalia, special or fixated interests, and atypical sensitivity to sensory stimuli; (3) presence of some symptomology in early development, regardless of whether full manifestation occurs then or later in the individual’s life; and most important, (4) traits and symptoms causing an impairment to the individual in social, occupational, or other roles in daily function (APA, 2013). The *DSM-5*, unlike past versions, classifies a variety of previously separate disorders (e.g., autistic disorder, pervasive developmental disorder [PDD], and Asperger’s disorder) under one unified diagnosis of ASD (Grzadzinski, 2013). This change was made because the subdiagnoses were believed to be too difficult to differentiate without unique cognitive/behavioral profiles to reliably and accurately distinguish between them (Tsai & Ghaziuddin, 2014). Tsai and Ghaziuddin argued that they found no clinical or study data

to support this shift and that consolidating the subtypes into one diagnosis was in fact a step backward (Tsai & Ghaziuddin, 2014).

The eleventh revision of the *International Classification of Diseases and Related Health Problems (ICD-11)*, presented in 2018, follows the same pattern as the *DSM-5*, grouping the different sub-diagnoses under the broad label of ASD but with different “specifiers” to account for variability (Stein et al., 2020; World Health Organization [WHO], 2018). These “specifiers” include IQ, language ability, and concurrent psychiatric disorders (Stein et al., 2020). The diagnostic criteria for this tool also revolve around the two main themes of socio-communicative defects and restricted/repetitive behaviors (WHO, 2018).

Two current assessment tools commonly used to diagnose ASD, especially in young children, are the Autism Diagnostic Interview-Revised (ADI-R) and the Autism Diagnostic Observation Schedule (ADOS). The ADI-R is a parent or caretaker interview that is aimed to gather past and current data about an individual of at least two years of mental age (Le Couteur, 2008). The assessment itself contains a comprehensive set of 111 questions about the individual (Le Couteur, 2008). Items are scored on a scale of 0 to 3, with 0 indicating little to no impairment and 3 indicating severe impairment (Le Couteur, 2008). Interviewers maintain an inter-rater reliability and are trained on properly administering the test due to its potential for subjectivity (Le Couteur, 2008). However, because of this possible subjectivity, this form of assessment is particularly prone to parental bias (Le Couteur, 2008). As discussed in subsequent sections, parents may have different expectations of their children based on a variety of factors, including gender,

which may color how they frame or perceive their children's behaviors and possible symptomology (Bargiela et al., 2016; Kreiser & White, 2014; Rutter et al., 2003).

The ADOS, on the other hand, is a more objective assessment based on observation of a child's play, activity, and behavior (Lai et al, 2011; Le Couteur, 2008). For example, assessors may look for age-appropriate play patterns (parallel play, cooperative play, etc.), repetitive behaviors, or sensitivity to sensory stimuli (Le Couteur, 2008). These assessments can be modified according to the child's developmental progress and language skills, which are especially important for the neuro-atypical and autistic populations (Le Couteur, 2008). These observations are also scored on a 3- to 4-point scale; scores above a particular cut-off level (determined by the child's mental age, language skills, and development) indicate an ASD diagnosis (Le Couteur, 2008). Again, internal consistency and inter-rater reliability are important on the part of the observers assessing and scoring the child's behavior (Le Couteur, 2008).

Brief Survey of Autism Spectrum Disorder Treatments and Therapies

To match the wide range of traits and severities that ASD encompasses, health professionals employ many different techniques of treatment and evidence-based interventions (EBI). One of the first goals of a family physician or healthcare professional after diagnosing a patient with ASD is to explain to the patient and their family what the disorder entails and what they might expect moving forward (Yingling & Bell, 2019). Increasing this awareness helps the patient and their family manage expectations and traits, and this realization leads to better understanding of ASD and how to work with it. Therapies such as cognitive behavioral therapy (CBT), applied behavior analysis (ABA),

and early intensive behavioral intervention (EIBI) are used (McPhilemy & Dillenburger, 2013; Scarpa & Reyes, 2011; Wood et al., 2015). Finally, this allied health approach also involves speech language pathologists, occupational and physical therapists, and teachers and other education specialists (Choueiri & Zimmerman, 2017). These approaches are detailed further in later sections.

The common element among these various tools and methods is that they are most effective when initiated at a young age. Early intervention as soon as possible is the best indicator of positive outcomes for the patient (Rogers & Vismara, 2008).

SPECIFIC AIMS AND OBJECTIVES

The specific aims of this thesis are to investigate gender/sex disparities and their effects on individuals with ASD. To accomplish these aims, the objectives are as follows:

1. To contextualize and describe ASD classification and current diagnosis methods.
2. To investigate the differences in ASD manifestation, traits, and biological bases in males as compared with females.
3. To examine how such differences contribute to lack of diagnosis or misdiagnosis in females as opposed to their male counterparts.
4. To analyze published literature to determine in what ways the gender/sex-based differences in diagnosis contribute to different treatments and outcomes in the two groups.
5. To identify existing and possible future interventions and advancements to lessen these disparities.

PUBLISHED STUDIES

Disparities in Diagnosis

A formal diagnosis of ASD is important for many reasons. The diagnosis opens up pathways for early interventions and treatments and allows families to access additional medical, educational, and emotional support programs. Moreover, an ASD diagnosis helps the individual and their loved ones understand the condition, why the individual may exhibit certain behaviors, and how to adapt these behaviors to live and work in a society built for neurotypicals (Bagatell, 2007; Brownlow, 2010; Rosqvist, 2012). There is a discrepancy in diagnosis between the genders, and many girls and women are either misdiagnosed or never diagnosed (Bargiela et al., 2016; Fombonne, 2009). The lack of a diagnosis, in addition to being frustrating for the individual, hampers their ability to improve or learn to adapt to their disorder (Bargiela et al., 2016).

Currently, there is a ratio of 4-5 to 1 in boys to girls who are diagnosed as being on the autism spectrum (Fombonne, 2009). However, more recent studies have shown that the ratio should actually be closer to 2-3 to 1, accounting for possible etiological factors that disproportionately affect males (Lai et al., 2015; Loomes et al., 2017). The difference has changed over time: in 2000, the ratio of males-to-females with ASD was closer to 3.5 to 1; by 2010, it was about 4.5 to 1 (May & Williams, 2018; National Academies of Sciences, Engineering, and Medicine, 2015). In addition, the imbalance is more pronounced for individuals who are closer to typically developing (TD) peers in terms of IQ as compared with those of lower intellectual and cognitive function (Hiller et al.,

2014). The discrepancy between these proportions is in large part caused by discrepancies in diagnosis between the two genders (Lai et al., 2015; Loomes et al., 2017).

Historically, much of the research done in recognizing, classifying, and understanding ASD has been done predominantly on males. Kanner's original description of autism was based on the study of 8 boys and only 3 girls, whereas Asperger worked with 4 boys and no girls (Asperger, 1944; Kanner, 1943; Lai et al., 2011). This kind of gender/sex exclusion has continued in both epidemiological and psychological studies (Lai et al., 2011). For example, a systematic review found that 60% of ASD studies using functional magnetic resonance imaging (fMRI) did not have any female participants (Lai et al., 2011; Philip et al., 2012). Such biases entail an imbalance in knowledge of autism in girls and women. If women are underdiagnosed, there are fewer individuals from which to pool possible study participants. Thus, new research is often unbalanced because it cannot draw from a representative enough subject pool to provide meaningful results and knowledge (Kreiser & White, 2014; Rutter et al., 2003). Though the *DSM-5* is currently considered gender/sex blind, a significant portion of the ASD diagnostic criteria used for both genders references traits and behaviors stereotypical of the male manifestation of the disorder (Hartung & Lefler, 2019; Lai et al., 2013). However, this has raised concerns, and some posit that a gender-based subgrouping would be better to address the sex/gender based differences in ASD traits and distribution (Lai et al., 2013). Even as diagnostic tools shift to encompass new or different traits under the classification

of ASD, people who displayed these newly classified traits as children will have slipped through the gaps and now might be diagnosed differently (Begeer et al., 2013).

Though ASD can be diagnosed by 2 years of age, it is more frequently diagnosed by the age of 5 when children begin to enter school (May & Williams, 2018). This age can also vary based on a number of factors, including healthcare inequity and racial disparity. In regard to gender, males are diagnosed on average earlier and easier than females (Lai et al, 2015; Russell et al., 2011). Specifically, Petrou and colleagues (2018) observed that when diagnosed at an age younger than sixty months, boys and girls are similarly diagnosed with ASD. However, at ages older than sixty months, boys are diagnosed significantly earlier than their female peers—an average of at least 1 year ahead (Petrou et al., 2018). As a result, females with milder symptoms, who slip through the system and do not show enough autistic behavior to be diagnosed at younger ages, may then experience difficulty and delay in diagnosis (Kreiser & White, 2014). Meanwhile, their male counterparts, including those who missed diagnosis at a young age, are still able to attain a diagnosis easier and earlier because even their more subtle manifestations conform to the male-stereotyped external autistic criteria (Goldman, 2013). . When matched for age of initial parental concern and number of physician visits for diagnosis, girls are still diagnosed with ASD less often and approximately 2 years later than their male counterparts (Begeer et al., 2013; Hiller, 2015; Siklos & Kerns, 2007). Even with an early diagnosis, it takes time for individuals to attain and begin proper therapy (Zuckerman et al., 2014). This means that the later a child gets diagnosed, the later they have access to important and necessary interventions (Granpeesheh et al.,

2009). Girls, who are already statistically less likely to have a formal/documented diagnosis, will be unable to access these programs and therapies (Giarelli et al., 2010). Many of these programs are time-dependent: early intervention is the most effective and efficient form of treatment and must be started at a younger age. Furthermore, earlier diagnosis is correlated with greater and more frequent use of evidence-based therapy, which greatly helps the individual, whereas later diagnosis finds the individual relying more heavily on psychotropic medication (Zuckerman et al., 2017). Girls and women who go undiagnosed for years, if not decades, are missing important developmental periods in which early intervention would have greatly benefited them and helped them to adapt (Cridland et al., 2014). This delay in diagnosis and subsequent delay in treatment leads to worse long-term outcomes for these women (Begeer et al., 2013; Lord et al., 1995).

Another factor to consider is the presence of a comorbid psychological or intellectual disability in these individuals, alongside ASD. Often, such a condition becomes the instigator for females to be diagnosed with ASD (Ratto et al., 2018). When presenting with a concurrent psychological disorder, the ratio of male-to-female diagnoses becomes smaller at approximately 2:1 (Ratto et al., 2018). However, girls without other cognitive and intellectual disabilities are significantly less likely to be diagnosed with ASD, as reflected in a further disadvantaged male-to-female ratio of 9:1 (Giarelli et al., 2010; Hiller et al., 2015; Rivet & Matson, 2011). These girls are often overlooked or missed, even if they display enough ASD traits to be over the traditional diagnostic threshold (Dworzynski et al., 2012). Meanwhile, the presence of another

condition with overlapping traits may overshadow or further delay an autism diagnosis (Rosen et al., 2018).

A final factor in the diagnosis disparity involves clinical and parental bias (Bargiela et al., 2016; Kreiser & White, 2014; Rutter et al., 2003). Women who were diagnosed later have spoken about barriers to this diagnosis, such as dismissal or unawareness on the part of the clinicians when expressing concern and the refusal for any further testing (Bargiela et al., 2016; Green et al., 2019). An “expectancy bias” could affect the diagnostic patterns and instincts of physicians, causing them to believe a disorder is more common in only one gender and inducing them to adhere to stereotypical traits and cognitive profiles (Kreiser & White, 2014; Rutter et al., 2003). Goldman (2013) argued that “Clinical diagnosis is in the eyes of the beholder,” demonstrating how fickle and bias-vulnerable diagnosis can truly be. This pattern has been seen before in the scope of another diagnosis: depression. Despite independently presenting with above-threshold-level traits for clinical depression, males tend to be underdiagnosed as compared with women because of a bias among clinicians that the disorder is more common in women (Kreiser & White, 2014; Potts et al., 1991).

Because of stereotypes for young girls as quiet and shy, a study found that teachers were 13 times more likely to express concern to parents over male students’ behavior than female students’ behavior (Goldman, 2013; Hiller et al., 2015). Males may also be more likely to raise concerns because their ASD traits, such as repetitive behavior, are more external and probable to attract more attention from parents and teachers, whereas females experience more internalized symptomology which is not as

easily noticed or targeted (Hartung & Widiger, 1998; Kreiser & White, 2014). Even when parents express initial concern for their child at the same age, regardless of their child's gender, this same pattern persists of later and lesser ASD diagnosis in females (Giarelli et al., 2010).

Furthermore, girls who do receive diagnoses tend to be marked as significantly less social than their male counterparts. Holtmann and coworkers in 2007 described the “interpreting bias” as a tendency for parents to rate their daughters as more socially impaired, not because of a significant objective difference, but because they expect disproportionately high levels of social and emotional intelligence from girls compared with boys.

As more researchers look into this disparity, they are finding ways in which females experience ASD differently from males. Accounting for these new symptoms in diagnostic criteria will better serve females and balance out this inequality (Allely, 2019). Many of these symptoms are detailed in the next section.

Gender-Based Differences in Traits

The Camouflage Hypothesis: Masking and Its Toll

One of the unique differences between ASD in both genders is that girls and women with ASD may engage in “camouflaging,” also referred to as “masking” (Bargiela et al., 2016). This phenomenon can be defined as a conscious or unconscious effort at compensating in social interactions, which creates a disconnect between the individual's external and internal states (Lai et al., 2017). Some hallmarks of this

adaptive behavior include: copying others' behavior, body language, and facial expressions; making eye contact (occasionally to the point of excess); and preparing certain conversation "scripts" or dialogue to better facilitate social interactions (Lai & Baron-Cohen, 2015). These external behaviors are used to mask any social deficits or discomfort for an appearance that is more socially accepted and integrated. Though camouflaging is not unique to women, it does have the most significant repercussions for this group and is more common in females (Allely, 2019). Women increasingly feel pressure to conform to gender roles and use camouflage as an adaptive tool (Bargiela et al., 2016; Lai et al., 2017). By definition, this coping mechanism causes girls and women with ASD to present as more neurotypical and thus elude the clinicians when it comes time for ASD diagnosis. In contrast, males who utilize this camouflaging tool may still be eligible for ASD diagnosis through other traits of the diagnostic profile which favor and encompass the wide variety of male-dominant traits. A female participant from a biographical interview-based exploration describes her camouflaging efforts as follows:

"I honed something of a persona which was kind of bubbly and vivacious, and maybe a bit dim, because I had nothing to say other than adult novels. So I cultivated an image, I suppose, that I brought out to social situations . . . that was not 'me.' "

(Bargiela et al., 2016, p. 3287)

Other participants from this study described "acting neurotypical," unconsciously adopting accents to fit in, and facing confusion about who they truly were in contrast to their masking personality (Bargiela et al., 2016). Another point these women brought up

was that the act of camouflaging, in and of itself, made them more vulnerable to abuse or unhealthy relationships. The increased suggestibility and the need to conform to people's behaviors and desires can quickly become perilous when interacting with someone who may be toxic or abusive. In addition, without the deeper and nuanced understanding of social cues and intentions, it can be hard for the women to detect when they may be in an unsafe situation or with a dangerous person. A common issue with sexual or emotional abuse was that the women struggled to differentiate how they felt internally with their masking and presenting. The external facade conformed to the abuser's desire and behavior and kept the women trapped in dangerous situations. However, because masking is not always a conscious or distinct process, it was hard for the women to differentiate between the two. Even in unromantic or nonsexual relationships, it was difficult for the women to understand the nature of the relationship, often trying to decipher whether a person was a friend and what a friendship meant in terms of behavior to display (Bargiela et al., 2016).

In a 2011 study on adult women with autism, Lai and colleagues found that when self-reporting on autistic behavior through the Autism Questionnaire (AQ) tool, the subjects reported more autism symptoms than were detected by an interviewer's observational assessment using the ADOS. This disconnect in self-perception and lived experience compared with perceived external traits suggests that women have learned to mask neuroatypical behaviors but continue to internally feel the cognitive and emotional effects of their own ASD manifestation (Lai et al., 2011).

In 2017, Lai and coworkers investigated this subject using a camouflaging score (CF) integrating two factors. The first compared scoring of autistic behavior on the self-rated AQ assessment with that observed externally through the ADOS. The second factor analyzed the difference between the individual's ability to mentally understand and recognize emotions, measured by the Reading the Mind in the Eyes Test (REMT) (Baron-Cohen et al., 2001), and their external behavior (Lai et al., 2017). The researchers found that women had significantly higher CF scores than men, as shown in Figure 2. The researchers also found that there were no effects of age on CF scores (Lai et al., 2017). This suggests that once an individual begins using and developing the camouflaging mechanism, there is no substantial increase in the behavior, even with gained life experience and more time to learn social norms (Lai et al., 2017). In addition, because the researchers detected no correlation between CF and verbal IQ, the phenomenon of camouflage seems to extend deeper than verbal acuity and taps into other cognitive processes and bases (Lai et al., 2017). This idea is further supported by the researchers' observation that women with higher CF scores also had better executive function and were able to process signals quicker, which are signs of underlying cognitive differences (Lai et al., 2017; Lehnhardt et al., 2016).

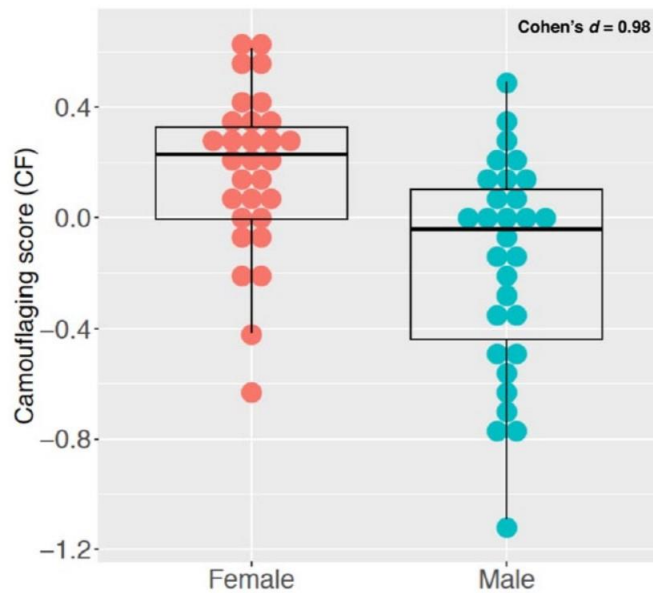


Figure 2. Use of Camouflage in Adult Females With ASD Compared With Adult Males With ASD. Women use camouflage, measured by the camouflaging score (CF), significantly more than men. This external masking of internal mentality and social deficits can provide social advantage at a superficial level but also has a toll on an individual’s mental health. ASD = autism spectrum disorder; Cohen’s d = effect size for difference between means (>0.8 represents “large” effect). For boxplot: first quartile = bar forming bottom of box; median = horizontal bar inside box; third quartile = bar forming top of box. Taken from (Lai et al., 2017).

More empirical support for this hypothesis comes from the research by Head, McGillivray, and Stokes (2014). Using equal groups of adolescent males and females, both TD and with ASD, they tested friendship and social function using the self-report friendship questionnaire (FQ) (Baron-Cohen & Wheelwright, 2003; Head et al., 2014). The results showed three main points which are depicted in Figure 3. First, females scored higher than males, regardless of ASD or TD status. Second, the average FQ scores of individuals with ASD were lower than those of TD teens, regardless of gender. Third, the FQ scores of females with ASD were similar to those of TD males *without* ASD (Head et al., 2014).

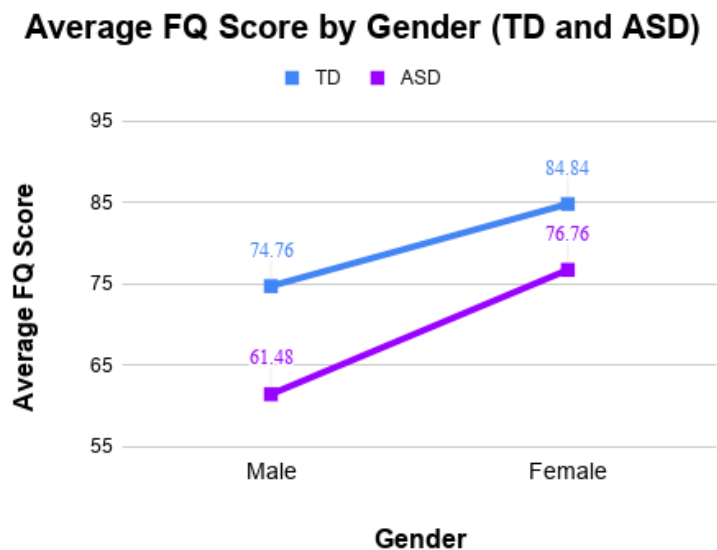


Figure 3. Average FQ Score by Gender (TD and ASD). Females, both typically developing (TD) and with ASD, scored better than their respective male counterparts on the friendship questionnaire (FQ), indicating more social skills and ability to maintain friendships. Females with ASD had scores comparable with TD males, who do not have ASD. This may indicate some underlying gender-based differences in social function. ASD = autism spectrum disorder. Adapted from (Head et al., 2014).

The effects of camouflage are most prevalent, and thus go mainly undetected, when comparing males and females with near-TD levels of cognitive function (Gillberg et al., 2006; Schaafsma & Pfaff, 2014). The women in this group are more likely to engage in masking and less likely to outwardly present any of the stereotypical autism behaviors and mannerisms (Schaafsma & Pfaff, 2014). In fact, the ratio of males-to-females with an ASD diagnosis, typically about 4:1, becomes an extraordinary 11:1 ratio at these higher levels of intellectual function (Gillberg et al., 2006; Schaafsma & Pfaff, 2014). These women with higher cognitive functioning are likely to go undetected as they appear to blend seamlessly into the social norms of interactions (Schaafsma & Pfaff, 2014).

Camouflaging is mentally and emotionally draining for the individuals who utilize it (Bargiela et al., 2016). Social interaction consists of many different social and cultural norms or habits. For neurotypicals, these interactions do not require active attention on the part of the individual (Rosqvist, 2012). However, for an ASD individual utilizing camouflage, each social interaction involves constant assessment of and deliberation on many facets: How loud should they be speaking? How close or far from the person should they stand? What is an acceptable amount of eye contact? What words or phrases should they use? How is the other person reacting to them? What is the person saying, and what do they mean by it? Understandably, the interaction can quickly become overwhelming (Bargiela et al., 2016). Many camouflage users become more vulnerable to internalized psychopathy such as anxiety or depression (Lai et al., 2011). The effort and struggle of maintaining this facade and adhering to social norms can lead individuals to seek more alone time or avoid large social gatherings (Bargiela et al., 2016).

Additional Differences in ASD Traits

In addition to the phenomenon of camouflaging, there are other gender/sex-linked differences in ASD manifestation. For example, young autistic males display more repetitive behavior and inappropriate play, both stereotypical traits used in ASD diagnosis (Hartley & Sikora, 2009; McLennan et al., 1993). By using a stop task (Enticott et al., 2009), researchers found that girls with ASD had poorer response inhibition (or “inhibitory control”) than either boys with ASD or TD girls (Lemon et al., 2011). These females also struggled disproportionately more than males with hyper-responsiveness to

sensory stimuli, a factor which has been recently added to the ASD diagnostic profile (Lai et al., 2011).

Autistic girls between 1 and 2 years of age were found to have better visual reception and nonverbal problem-solving skills, but lagged behind boys in fine and gross motor skills, as well as both receptive and expressive language (Carter et al., 2007). Language delay, however, which is an important first sign of suspected ASD diagnosis, does not manifest as frequently in females with ASD unless they have another intellectual disability that affects this development (Eriksson et al., 2012). A possible explanation is that there is an underlying gender-based difference in language learning, regardless of any diagnoses or disorders (Eriksson et al., 2012). Another explanation might be that these findings are from studies of females with both ASD and high IQs, rather than a more varied group (Halladay et al., 2015; Lai et al., 2011). Female adults with ASD who experienced a language delay in youth tended to have a lower verbal IQ in adulthood, a pattern not replicated in males (Lai et al., 2011).

Autistic girls were also found to be more successful than males in forming friendships with peers, but they had difficulty in maintaining these relationships. Males, on the other hand, struggled with both acts (Hiller et al., 2014). Furthermore, females with ASD were more successful than males in autobiographical memory (emotional and elaborate memory) retrieval and verbal skills (Goddard et al., 2014). They were also more likely than males with ASD (but less successful than TD females) to display expressive and social behavior such as engaging in dialogue, using facial expressions, and adjusting behavior in response to the context or environment (Hiller et al., 2014). These factors

may contribute to or may be caused by the greater superficial socio-communicative skills and adeptness of females at masking as compared with males (Lai et al., 2011).

In 2007, Carter and coworkers showed that female toddlers on the autism spectrum had more social deficits than their male counterparts. However, other researchers found no gender-based differences in early social communication skills (a factor that is significantly different between TD males and TD females), adaptive behavior, developmental function, and even core autism symptoms (Reinhardt et al., 2015). Diagnosis, even at this young age, is rare for females who may be similar to their autistic male peers at that time (Reinhardt et al., 2015). This is where diagnosing or observational bias, among other factors, may play a large role (Holtmann et al., 2007). Girls and boys are differently gendered, meaning they are taught and expected to fulfill different gender roles (Goldman, 2013). Because these stereotypes for girls, unlike for boys, tend to include more social-emotional intelligence, there may be another bias in the reporting and observation of their socio-communicative behaviors. The girls may be expected to be more sociable than boys, and so they could be rated as being more deficient than they are in actuality, simply for not reaching a higher-set standard (Holtmann et al., 2007).

Autism is also associated with increased risk for a number of psychiatric disorders. Comorbidity rates among the ASD populations are approximately 70%-83%, including (in order of greatest to least prevalence): attention-deficit-hyperactivity disorder (ADHD), oppositional defiant disorder, anxiety disorders, and mood disorders (Brookman-Frazer et al., 2017). Brookman-Frazer and colleagues (2017) found that

more boys than girls with ASD were also diagnosed with ADHD. However, this observation requires further scrutiny because, much like ASD, ADHD diagnosis is male-biased (Quinn, 2005). Girls were more likely to be diagnosed during adolescence with internalizing psychopathology symptoms or mood disorders (Hartley & Sikora, 2009; Solomon et al., 2012; Stadnick et al., 2017). This increase in stress, anxiety, and depression may also be due to the use of camouflage and its heavy toll (Lai et al., 2017). At a higher level of intelligence, there was little to no gender difference in either basic ASD symptoms or the occurrence of comorbid psychiatric disorders (Hofvander et al., 2009; Lai et al., 2011). This could signify that males at this level of cognitive function can attain an ASD diagnosis based on stereotyped behavioral and external ASD traits (all part of the male-biased diagnostic criteria), but females, who do not demonstrate these attributes would not necessarily get this benefit. In addition, because the core symptomology of autism may overlap the signs and symptoms of another psychiatric disorder, diagnosis of either can become a challenge (Lai et al., 2015). This is especially true with females for whom the diagnosis of another psychiatric disorder may overshadow or deter from an ASD diagnosis (Lai et al., 2015). In this case, any symptoms, even those of ASD, may be attributed to the other condition (Lai et al., 2015).

Sex-Associated Differences in Biological Bases of ASD

As work is being done to bridge the gender/sex gap in autism, researchers are focusing specifically on how biological aspects of ASD (bio-markers, genes, comorbidities, etc.) may be different in females than in males. For example, a study utilizing magnetic resonance imaging (MRI) showed that in addition to exhibiting the

same neural abnormalities as their male counterparts, young girls have age-correlated increases in the volume of cerebral white and gray matter and decreases in the volume of temporal gray matter volume (Bloss & Courchesne, 2007). Correspondingly, autistic females have a larger volume of gray matter in the parietal lobe than autistic males, opposite to the pattern found in neurotypical females and males (Beacher et al., 2012). Another biological difference lies in a region of the Y chromosome. The sex-determining region on the Y chromosome (*SRY*) gene in males directly regulates the monoamine oxidase isoform-A (*MAO-A*) gene, encoding an enzyme of the same name that breaks down catecholamines such as dopamine in the synaptic cleft. This region also controls the enzyme tyrosine hydroxylase, which is used in dopamine synthesis (Schaafsma & Pfaff, 2014). The postsynaptic dopamine D1-class receptor (D1R) and the enzyme MAO-A are specifically correlated with ASD in males (Loke et al., 2015). Figure 4 depicts both D1R and MAO-A as part of the dopaminergic signaling pathway.

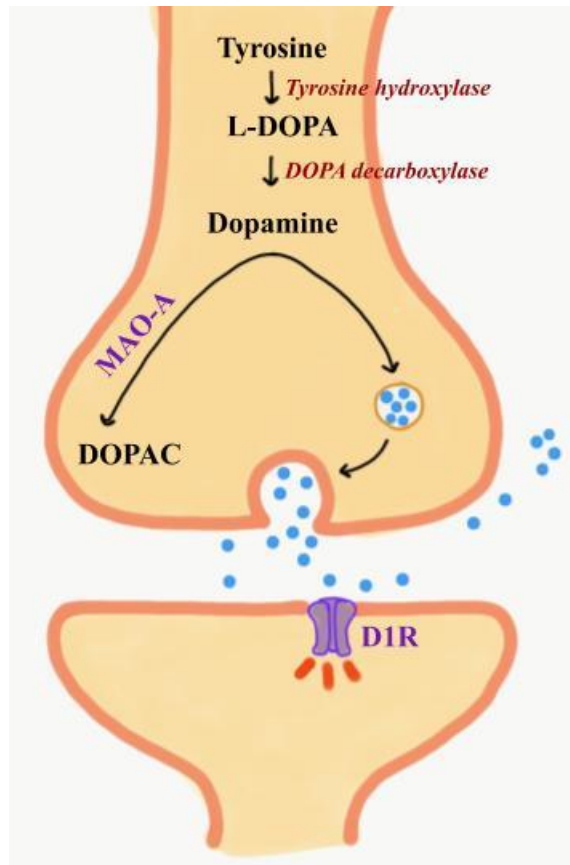


Figure 4. D1R and MAO-A in the Dopaminergic Signaling Pathway. Tyrosine is converted to L-DOPA (L-3,4-dihydroxyphenylalanine) by the enzyme tyrosine hydroxylase. L-DOPA is then converted to dopamine by DOPA decarboxylase. The generated dopamine can follow multiple trajectories. The two paths depicted in the figure are: (1) (right) Dopamine is packaged into vesicles and released from the presynaptic membrane. Dopamine then binds to appropriate receptors on the post-synaptic neuron, such as the dopamine D1-class receptor (D1R). (2) (left) Dopamine is converted into DOPAC (3,4-dihydroxyphenylacetic acid) by monoamine oxidase isoform-A (MAO-A). Both D1R and MAO-A are associated with autism in males. Adapted from (Loke et al., 2015).

Estrogen, a primarily female sex hormone, can have a “neuroprotective” effect in regulating the dopaminergic system and thus may shield females from ASD manifestation or severity (Loke et al., 2015). Another theory about a protective factor in females is due to the X-linked gene *NLGN4X*, which evades X-inactivation and continues to persist (Davies and Wilkinson, 2006; Schaafsma and Pfaff, 2014). In autistic males,

this gene is suppressed or not expressed because of mutations (Loke et al., 2015; Schaafsma and Pfaff, 2014). Finally, as seen by the increased vulnerability of females with Turner syndrome (karyotype XO rather than the typical XX) to develop autistic traits, the simple presence of a second X chromosome and the associated imprinted genes may be protective against ASD, thus causing the gender/sex imbalance in autism prevalence (Loke et al., 2015; Skuse, 2000).

Commonly Used ASD Therapies and Interventions, Detailed

There are many approaches to help individuals address their autism and gain adaptive skills, all of which show better outcomes if started early. Therapists employ various techniques with these individuals, and one of the more ubiquitous treatments is cognitive behavioral therapy (CBT) (Scarpa & Reyes, 2011). CBT uses tenets such as emotion recognition, cognitive re-framing, and practiced behaviors to address not only socio-communicative struggles faced by children with ASD but also how these individuals understand their view of themselves and the world around them (Wood et al., 2015). CBT can help with adaptive skills, emotion regulation, self-esteem, social skills, and other co-occurring disorders such as anxiety or obsessive compulsive disorder (Scarpa & Reyes, 2011; Spain et al., 2017). For example, in addressing emotion dysregulation, CBT builds a cognitive understanding of emotions (e.g., happiness, anger, anxiety, and relaxation) and introduces “emotional toolboxes” of skills and exercises to help the child not only recognize emotions but also respond to and modulate them accordingly (Scarpa & Reyes, 2011). Though CBT is typically practiced in one-on-one interactions between a therapist and a child, a 2017 study found that in a group of autistic

men with similar high cognitive function, group CBT intervention further helped alleviate feelings of anxiety and create a supportive community (Spain et al., 2017). Modified forms of CBT, specifically geared toward individuals with ASD and anxiety, have been shown to yield improvement in learned social skills and their maintenance in the long term (Maddox et al., 2017). Despite these benefits somewhat fading after the discontinuation of therapy, the levels of anxiety posttreatment are still typically lower than pretreatment (Maddox et al., 2017; White et al., 2015).

Applied behavior analysis (ABA) presents a more controversial treatment plan. Though initially rooted in procedures such as negative reinforcement, punishment, and arduous and difficult repetitive tasks for children, the therapy has shifted away from these harmful practices and become more child-friendly and helpful (Child Mind Institute, n.d.; Prizant, 2009). ABA also evokes concerns of ableist biases. In the past, the therapy created a neurotypical prototype and pushed autistic children to conform to it in ways that might actually disadvantage the child, such as preventing stimming behavior, a useful and necessary practice for many people on the spectrum (Child Mind Institute, n.d.). However, more recent forms of ABA veer away from this structure and use more individualized and flexible therapies to help children adjust and modify their behavior without trying to eradicate their neuroatypicality. These modern forms of ABA have been effective in autistic children, especially when the intervention was started at an early age. Some benefits of this treatment include: increased eye contact and communication (verbal and nonverbal) skills; fewer outbursts and more behavioral and emotional regulation; more independence and comfortability; better motor skills; fewer repetitive

and self-harming behaviors; increased use of adaptive behaviors; lower stress levels; and overall increased quality of life (McPhilemy & Dillenburger, 2013; Vietze & Lax, 2018).

Stemming from the principles of ABA, early intensive behavioral intervention (EIBI) is a more recent and thus far more effective therapy. This type of intervention, typically following the University of California, Los Angeles (UCLA) model of treatment, targets and aims to mitigate certain autistic traits, including challenges of communication, repetitive or self-harm behavior, and echolalia. The key to this treatment is its intensity and early proactive action. Children diagnosed with ASD or suspected of being on the spectrum, start EIBI by the age of 3 and work with a therapist from 20 to 40 hours a week (Matson & Konst 2013).

To assess the long-term effectiveness of EIBI therapy, a 2019 study by Smith and colleagues followed 19 children with ASD (16 of whom were male). These children all began 2 years of EIBI between 2 and 4 years of age and then continued to use ABA-based methods in early school integration (Smith et al., 2019). The researchers implemented various tests and standards to draw comparisons as the children grew older. Intelligence was measured by the following tests: IQ scores (if available); the Wechsler Intelligence Scale for Children or the modified Wechsler Abbreviated Scale of Intelligence; and as a final option if the prior tests were unsuitable or inapplicable, the Peabody Picture Vocabulary Test-IV and Expressive Vocabulary Test-II. These assessments were made at three points: when the child was first diagnosed and began EIBI, when the child finished 2 years of EIBI, and 10 years later (Smith et al., 2019).

In addition to the intelligence assessments of the Smith et al. (2019) study, adaptive behavior was measured at the same time points using the Vineland Adaptive Behavior Scales-II (Vineland-II). Adaptive behavior and function, typically lower in children with ASD and ADHD, incorporate and test skills in socialization, communication, and other “daily living skills” (Ashwood et al., 2015). The autistic profile, which is used in diagnosis, includes in part lower values in these areas in comparison with same-aged, neurotypical children, especially in the sphere of socialization (Ashwood et al., 2015).

Figure 5 shows the results from this study of long-term effectiveness of EIBI therapy (Smith et al., 2019). All of the children in this cohort, having received EIBI treatment, experienced a gain in adaptive behavior and an increase in IQ throughout their development. However, the amount of improvement varied by child. This can be attributed to many factors, including but not limited to the severity of the ASD, the educational setting (Did the child attend a special education school or a program at an unspecialized public school? Did the child have access to a teaching assistant and faculty support?), and the presence of comorbid psychiatric disorders such as obsessive compulsive disorder (OCD) (Smith et al., 2019).

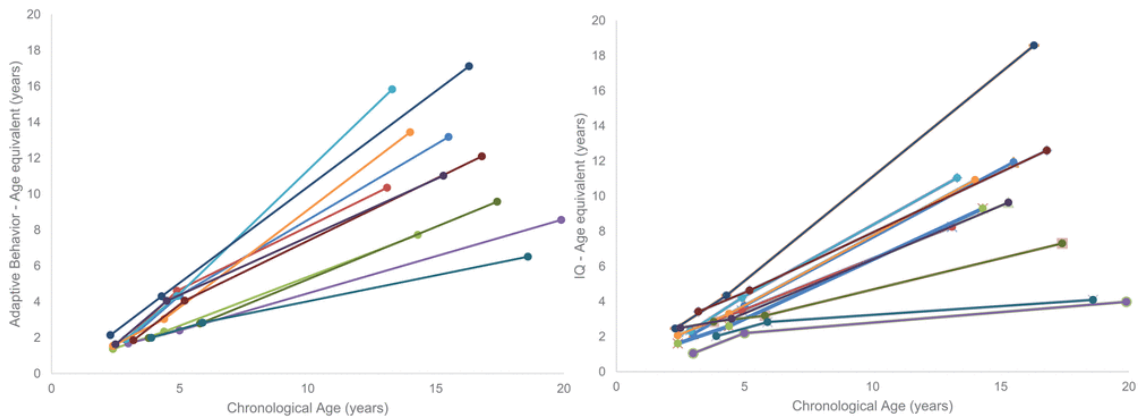


Figure 5. Changes in Adaptive Behavior and IQ Over Time in ASD Individuals After Receiving EIBI and ABA Therapies. Despite individual variability, EIBI and ABA therapies led to an increase in both adaptive behavior over time (left plot) and IQ over time (right plot). ABA = applied behavior analysis; ASD = autism spectrum disorder; EIBI = early intensive behavioral intervention; IQ = intelligence quotient. Taken from (Smith et al., 2019).

Another common ASD intervention targets speech, language, and communication (Choueiri & Zimmerman, 2017). Speech language pathologists are employed, either in the home, school, or clinic, to help the individual develop communication skills (both verbal and nonverbal) (Choueiri & Zimmerman, 2017). Social workers facilitate with societal integration by helping these individuals find resources and accessible schools and jobs. Occupational and physical therapists assist with physical movement exercises as well as motor coordination and development (Choueiri & Zimmerman, 2017). Finally, physicians work to make sure their patient is healthy by monitoring the progress of both the patient and the ASD (Rhoades et al., 2007).

Disparities in Treatment and Outcome

Research has found that behavioral interventions, such as EIBI, work best when started early. Younger children show the same gains with less intense treatment as slightly older children show with heavily intense levels (Granpeesheh et al., 2009).

Unlike older peers who begin to plateau at a certain point with this treatment, children under seven years old do not level off and instead have continuously increased rates of learning that show much greater treatment efficacy (Granpeesheh et al., 2009). This heightened potential at a young age can have significant effects on the child's development. Girls and women are often diagnosed later than boys and men (Begeer et al., 2012; Hiller, 2015; Siklos & Kerns, 2007). Less and later treatment presents a clear and unfortunate disadvantage to these females (Begeer et al., 2012; Granpeesheh et al., 2009). In a 12-year longitudinal study following a cohort of individuals with pervasive developmental disorders (one of the subcategories under the main umbrella of ASD), males exhibited more improvement and a greater decrease in symptoms and severity than females (Burd et al., 2002). These men had lower scores on the Autism Behavior Checklist and also did better than women in social and communication skills as measured by the Vineland assessment (Burd et al., 2002). These results show a discrepancy between overall adult outcomes and progress (Burd et al., 2002).

Treatment for females (referring to biological sex only) will be different from treatment for their male peers in that it must also cater to biological differences (Green et al., 2019). Women with ASD are likely to experience anxiety and depression, along with other comorbid psychiatric disorders which are also experienced by autistic males (Green et al., 2019; Owen et al., 2009). However, when prescribing pharmacological medicines, physicians remain cognizant of any harmful side effects specific to these individuals. For example, the most commonly prescribed antipsychotics cause hyperprolactinemia in women (Green et al., 2019; Owen et al., 2009). Similarly, valproic acid, used in bipolar

disorder treatment (another common ASD comorbidity), can contribute to polycystic ovary syndrome (Green et al., 2019).

Another difference in outcome for ASD individuals involves social relationships—specifically friendships (Dean et al., 2014). Because same-gender female friendships may have different expectations than same-gender male ones, young children face different challenges in the school and classroom settings (Dean et al., 2014). In a study by Dean and coworkers (2014), the researchers found that girls with ASD were typically ignored or were on the periphery of female friend groups, whereas boys with ASD were rejected and excluded more. However, other researchers noted that male friendships tended to be less language-heavy, and so autistic boys had one less challenge to face in this scope (Blatchford et al., 2003; Dean et al., 2014). Thus, the exclusion found in the Dean et al. (2014) study comes regardless of what would seem to be a facilitated benefit. More important, girls, unlike boys, typically require “reciprocal friendship” for social and emotional health (Dean et al., 2014; Rose & Rudolph, 2006). Despite what seemed to be a better status as fringe members of a group rather than outwardly rejected like many autistic boys, the autistic girls still do not benefit from their outsider social position and are negatively affected (Dean et al., 2014; Rose & Rudolph, 2006).

Though camouflaging may offer some superficial level of assimilation, this success is counteracted by its role in the prevention of ASD diagnosis in females (Allely, 2019; Hull et al., 2017). In addition, this behavior can have deleterious effects on women’s mental health, causing them to develop more internalizing psychopathology

with higher incidence of anxiety and depression. This duality can also affect how women view and understand themselves, which in turn affects their own personality, development, and relationships with others (Allely, 2019; Hull et al., 2017). This situation takes a heavy emotional and psychological toll on women throughout the years (Bargiela et al., 2016).

Overall, females with ASD, in comparison with affected males, have reported a lower quality of life in all fields except the social domain, and in this domain, mixed findings were described (Green et al., 2019; Kamio et al., 2013; Mason et al., 2018). This thesis has so far examined the many factors that may contribute to such a disparity, and in the next section, some adjustments that could address and begin to ameliorate this issue are discussed.

LOOKING TO THE FUTURE: ADVANCEMENT AND PROGRESS

At present, diagnostic criteria used by the *DSM-5* and other sources are heavily rooted in male-based external behavior and traits (Hartung & Lefler, 2019; Lai et al., 2013). However, such characteristics can be inapplicable to women because ASD manifests differently based on gender (Hartung & Lefler, 2019; Lai et al., 2013). Thus, as ASD treatment moves forward, the diagnostic tools and criteria must be updated to account for nuances and differential diagnosis of each gender (Lai et al., 2013). Some progress is being made on this front (Grzadzinski et al., 2013). The most current form of the DSM, the *DSM-5*, has already made strides compared with its predecessor. As opposed to the triad of symptoms covered by the *DSM-IV*, the newer fifth version focuses on two main areas of symptomology: socio-communicative behavior and restricted, repetitive behavior (Grzadzinski et al., 2013). A third trait, found in the *DSM-IV* but omitted in the *DSM-5*, is a language delay or lack of language development (Grzadzinski et al., 2013). This omission is especially crucial in catching and appropriately diagnosing individuals with higher IQ or cognitive function, particularly women (Grzadzinski, 2013). Because the *DSM-5* criteria are more specific, they allow for better and more accurate diagnosis of ASD in individuals (Grzadzinski, 2013). . However, though the ideology behind these changes seems logical, harmful effects of the shift were observed in an experiment comparing diagnosis based on the *DSM-IV* versus the *DSM-5* (Matson et al., 2012). The researchers found that whereas 795 toddlers were classified as autistic according to the *DSM-IV*, the newest DSM diagnosed only 415 of that group with ASD

(Matson et al., 2012). This result would hurt many families and children who, though still atypically developing, could no longer have the formal diagnosis needed to access therapies and interventions (Matson et al., 2012).

In addition, the ICD has made changes. As opposed to its predecessor, *ICD-11* accounts for individuals who have both ASD and ADHD, which is a significant comorbidity with autism (Stein et al., 2020). This iteration of the ICD also differs from the *ICD-10* in that it no longer specifies ASD onset at 3 years of age; rather, it encompasses “the developmental period,” ranging from early childhood to later manifestation (Stein et al., 2020; WHO, 2018).

Another view of future progress emphasizes cross-departmental and more holistic research in an attempt to capture not only biological and psychological nuances but also sociocultural influences (Cicchetti & Toth, 2009; Kreiser & White, 2014). This kind of multidisciplinary work would be very informative for many groups of people, all of whom could contribute to the much-needed advancement of the study (Cicchetti & Toth, 2009; Kreiser & White, 2014; Stadnick et al., 2020). Similarly, cross-country study or information sharing would not only increase the foundations in ASD knowledge but also help develop culturally sensitive and socioeconomic status (SES)-flexible solutions to better support marginalized or underserved groups (Stadnick et al., 2020). In general, focusing on these groups, whether underserved because of gender, race, socioeconomic status, or other factors, will greatly help lessen the systemic disparity in ASD diagnosis and treatment, of which gender disparity is only one small part. Some possible ways to address this issue, as discussed at a 2020 colloquium on pediatric mental health inequity,

include community outreach to spread awareness and accessibility, increased parent engagement in treatment trajectory, and adoption of more holistic views and assessments (Stadnick et al., 2020).

A further idea is to change current EBIs to make them more flexible and accessible for communities and ASD youth. Wood and colleagues (2015) described such modifications, including the “stepped-care” approach, which would work with the individual’s needs as they arise and become salient, and thus create a more personalized longitudinal plan rather than adhering to generalized theories and practices. This change could help all children on the spectrum, but especially the girls and young women (Wood et al., 2015). The new personalized approach would better cater to their unique and often gender-specific needs instead of assuming a trajectory of manifestation typical of males (Wood et al., 2015).

To more directly target the gender disparity in ASD, clinicians could add a “camouflaging measure” to current or future diagnostic tools for ASD in females, especially those with higher intelligence and cognition (Allely, 2019). Camouflage is one of the unique manifestations of ASD in females, yet it simultaneously contributes to their missed diagnosis (Allely, 2019). Diagnostic tools for women should therefore aim to recognize this trait (Allely, 2019; Hull et al., 2018). Currently, there are some qualitative and narrative examples of camouflage from women who describe their differences (Bargiela et al., 2016). This information is important, and listening to these women’s stories and concerns is the first step on this path. Then, using these self-assessments to get a better understanding of camouflage, clinicians can begin to operationalize and

codify the trait (Allely, 2019). After there is a framework in place for categorizing and evaluating camouflage, researchers can begin quantitative studies to delve further (Allely, 2019). Lai and colleagues (2017) argued for three main points of focus when researching camouflage: (1) use qualitative analysis to find what triggers and characterizes camouflage; (2) utilize psychological analysis to understand more of the personality and cognitive traits of camouflage users; and (3) perform clinical studies to evaluate the effects of camouflage on the user and the role of the phenomenon in ASD diagnosis.

Hull and coworkers (2018) worked according to these ideals and developed the Camouflaging Autistic Traits Questionnaire (CAT-Q). This online self-assessment builds on shared experiences of adults with autism who have utilized social camouflage. The basis of this test comes from qualitative data collected from interviews of adults with ASD on how they camouflage (Hull et al., 2017). Participants taking the CAT-Q rate themselves according to a Likert scale (from “Strongly Disagree” to “Strongly Agree”) on 48 items describing camouflage-identified behaviors (Hull et al., 2018). These items include using film or television to learn about body language, practicing facial expressions to appear more natural, developing a script of conversation topics to use in social situations, and repeating phrases previously heard verbatim (Hull et al., 2018). The researchers also itemized counter-indicators, denoted as “reversed,” which would not represent camouflage (Hull et al., 2018). These items include feeling that a conversation flows naturally, not paying attention to your body or face when in conversation, and feeling “free to be myself” when with others (Hull et al., 2018). Expansion on this

preliminary work could create promising solutions to better serve the female autistic community (Hull et al., 2018).

Although interventions like CBT and ABA focus on many external traits and behaviors of autistic individuals, the women within these groups also experience a myriad of internalized symptomology (Hartung & Widiger, 1998; Kreiser & White, 2014). These therapies could be better adapted to autistic women and the specific subset of traits and struggles that they face (Blainey & Spain, 2014; Jamison & Schuttler, 2017). For example, group therapy may be better suited to women's needs if the groups themselves are single sex (i.e., all women), especially if the women are struggling with similar issues (Blainey & Spain, 2014). Jamison and Schuttler (2017) proposed a program to better target autistic girls' traits, called Girls Night Out (GNO). This program, intended for use by adolescent autistic women, uses practice and discussion to help improve self-perception, social skills such as conversation, and self-care skills, and to better equip these young women for their futures (Jamison & Schuttler, 2017). The autistic individuals go through the program together, and the program directors and implementers are also female. Some other components of this intervention include interviews with parents, family, and the individual to identify strengths and areas of growth; role-play and practice with facilitators and other group members; and videos of peers engaging in and modeling conversation behavior (Jamison & Schuttler, 2017). The GNO program is designed to run a 3–4 month long course with weekly meetings of just two hours (Jamison & Schuttler, 2017). As the program progresses and the group members become more comfortable with each other, the structure can be modified to better suit the individuals, their unique

interests, and the specific challenges they face (Jamison & Schuttler, 2017). By comparing self-reported data from four different cohorts that went through the GNO program, the researchers found that the young women reported gains in social competence, self-perception, and overall quality of life (Jamison & Schuttler, 2017). Though more growth and development could be done with the GNO program, the researchers noted especial promise as these ideals and practices can easily be incorporated into existing support groups and communities and spaces for female autistic teens (Jamison & Schuttler, 2017).

Another way to better tailor treatment to females with ASD is with interventions that are more influenced by and cognizant of sociocultural factors (Green et al., 2019). Women in the current socio-political climate are still frequently expected to conform to certain gender norms which emphasize caring and caretaker roles in relationships, as well as other social and physical standards (Barrett & White, 2002; Green et al., 2019). These harmful and heavy expectations of femininity already cause worsened mental health and/or emotional toll on TD women (Barrett & White, 2002; Broderick & Korteland, 2002; Green et al., 2019). Such a strain becomes exceedingly toxic for women with ASD, who struggle more to conform to such molds and are increasingly vulnerable to abuse and victimization with less access to self-advocacy (Bargiela et al., 2016; Green et al., 2019). Researchers recommended “consciousness raising” as a way to help autistic women separate any negative self-beliefs from societal demands and pressures and eventually from their own goals, feelings, and aspirations (Green et al., 2019; Mahalik et al., 2005). In addition, treatment for women can emphasize safety and self-advocacy, especially

because these aspects are of more concern for females with ASD than for males with ASD (Green et al., 2019).

A different possible solution comes from etiological studies. As researchers learn more about the biological bases and markers of ASD in females, they may be able to reliably use this information for diagnostic criteria or for part of the ASD profile in women (Milner et al., 2019; Torres et al., 2013). Some progress in better researching females with ASD has been made; for example, Gockley et al. (2015) conducted a genome-based study on only females (TD and with ASD). Other researchers carried out an experiment on motor function and decision time, looking for differences specific to females with ASD compared with TD females (Torres et al., 2013). The researchers emphasized that they chose to search for biomarkers that make females with ASD distinct from neurotypical female counterparts, rather than comparing with males with ASD. This approach provides two advantages (Torres et al., 2013). First, ASD is a broad spectrum of conditions with variable traits and penetrance. To try to compare females with ASD and males with ASD becomes difficult when such a large range exists. This difficulty is further exacerbated when considering that much of the currently known range of traits is still male-biased and that the corresponding information for females is not yet readily accessible. Second, this technique accounts for any underlying biological or cognitive difference between the two genders (Torres et al., 2013). For example, it was previously discussed that females may, implicitly have better social skills (to a certain extent), which may contribute to different symptomology in girls with ASD (Head et al., 2014). Thus,

when establishing a baseline and possible divergence, comparing these patterns with boys is much less informative than comparing them with TD girls (Torres et al., 2013).

Finally, as with most fields of healthcare, it is important for physicians and clinicians to listen to their patients' concerns and to take them seriously (Bargiela et al., 2016). Self-diagnosing has become a necessary and final option for many (Lewis, 2016). This is especially true for women with autism who are simply unable to attain a formal diagnosis despite demonstrating ASD traits (Bargiela et al., 2016; Lewis, 2016). Women (and minorities) often express concerns in medical settings, yet they are not taken seriously or are frequently dismissed by physicians (Bargiela et al., 2016; Green et al., 2019; Hagiwara et al., 2013; Kreiser & White, 2014; Rutter et al., 2003). Thus, educating clinicians and making them more aware of their own personal biases would increasingly benefit a great many patients (Bargiela et al., 2016; Kreiser & White, 2014).

OTHER SOURCES OF DISPARITY

Though the purpose of this thesis is to specifically investigate gender disparity and its effects on individuals with ASD, other forms of inequality may also play a role in people's lives and journeys with ASD. This section addresses a few of the more significant factors that contribute to these unequal treatments and experiences. None of these factors exist separately; rather, they are intertwined in many ways and often contribute to or perpetuate each other intrinsically (Sambamoorthi & McAlpine, 2003).

Race

A large source of disparity in many different areas of medicine and life is race. Racism is ubiquitous in today's world—whether through institutional and structural biases or through stigmas and societal norms. In the United States, healthcare is frequently and deeply biased, and minorities such as people of color are consistently under- or misdiagnosed and inadequately treated (Feagin & Bennefield, 2014). Such inequality affects the ASD community (Jo et al., 2015). There is no evidence to support that the incidence of ASD is disproportionately greater in one race over another (Jo et al., 2015). However, despite any distinction in epidemiology, many other factors play a role in disadvantaging individuals of color with ASD and presenting challenges to their diagnosis, treatment, and future outcomes. Together, these factors comprise a significant and harmful racial disparity (Jo et al., 2015).

One such component lies in the individual's age of diagnosis. By analyzing Philadelphia Medicaid records for a six-year span, investigators found that white children

were typically diagnosed with ASD at an average age of 6.3 years, whereas their black counterparts went undiagnosed until 7.9 years and their Latinx peers waited longer until 8.8 years (Mandell et al., 2002). As previously mentioned, early intervention is key to autism treatment, and these first few years of life are critical periods of change and development. The 1- to 4-year-delay in diagnosis for children of color confers a large disadvantage with many ramifications (Mandell et al., 2002). This delay not only affects how quickly the child and parents can start medical and behavioral intervention but also plays a role in the child's formal education and in the family as a whole (Mandell et al., 2002).

The work by Mandell and coworkers (2002) also found that some other contributors to this setback in the diagnosis timeline include the delay on the part of the pediatrician in listening to and recognizing parental concerns and the irregularity in pediatric care because of issues with health insurance (Mandell et al., 2002). These ideas show two forms of racial bias. The first is internalized and personal bias by the pediatrician for not taking seriously a minority parent's concerns, and the second is institutional bias that hinders people of color, immigrants, and other minorities from access to consistent and constructive healthcare (Mandell et al., 2002). Finally, interactions between clinicians and families are also skewed by race and the effects of any such prejudices (Feagin & Bennefield, 2014; Lapp, 1995). There is a history of medical racism that includes segregation, exclusion from higher/medical education, and catastrophic events such as the 1932-initiated Tuskegee syphilis study, the 1939 Negro Project sterilization of African-American women, the Henrietta Lacks controversy, and

the 1950s unethical birth control experimentation on Puerto Rican women (Feagin & Bennefield, 2014; Lapp, 1995). Such injustices have created a sense of distrust among people of color for medical communities, and this distrust contributes to healthcare and diagnosis disparity (Feagin & Bennefield, 2014; Lapp, 1995).

Another study to analyze racial disparity concerning ASD focused on Latinx communities in which individuals are diagnosed even later than African Americans (Zuckerman et al., 2014). In 2014, Zuckerman and colleagues, using a cohort of 24 families, delved deeper into the subject by using focus groups and interviews (thematic findings shown in Figure 6). Most of these parents, born in Latinx countries and cultures, mentioned struggling with understanding their child's ASD diagnosis because this topic was not known or talked about in those countries (Zuckerman et al., 2014). This lack of awareness, caused by a cultural gap, occurs for people from many different nations and cultures (Zuckerman et al., 2014).

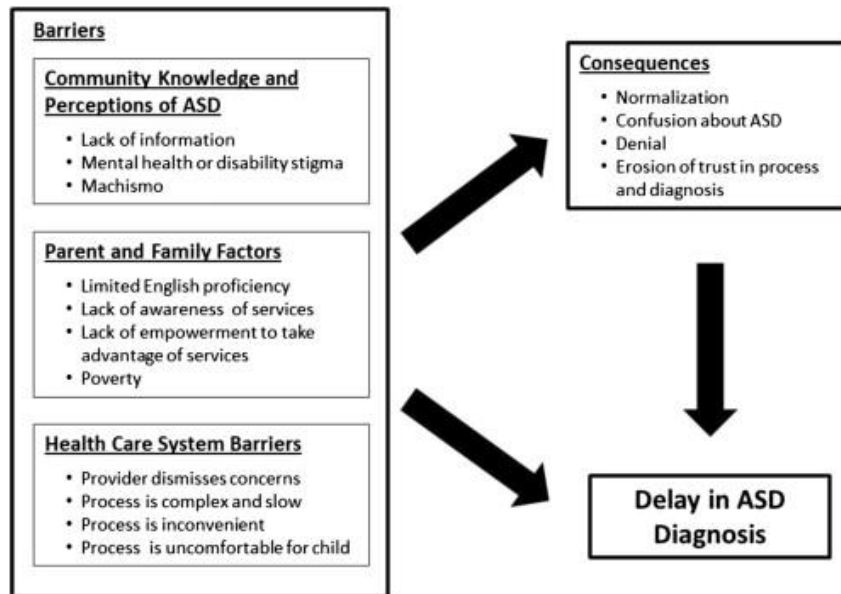


Figure 6. Interplay of Various Factors That Lead to Late ASD Diagnosis in Latinx Communities. Many factors contribute to the later diagnosis of Latinx children with ASD. These influences include a lack of awareness or information for families to identify the problem, systemic barriers such as access to healthcare, and societal barriers such as mental health stigma. The consequences of these factors impeding a child’s diagnosis lead to a delay in helpful and important early interventions. Public health professionals, community workers, and clinicians, who work to address this disparity by targeting these different issues, hope to improve conditions and foster earlier diagnosis. ASD = autism spectrum disorder. Taken from (Zuckerman et al., 2014).

Being an immigrant or new to this country can also present other hurdles (Giacco et al., 2014; Yingling & Bell, 2019; Zuckerman et al., 2014). Immigration status itself can affect access to healthcare through insurance, financial strains, and the availability or accessibility of local and well-funded clinics (Giacco et al., 2014). A language barrier may hinder effective communication with healthcare workers or learning about possible interventions and solutions (Yingling & Bell, 2019). In fact, a recent study found that although Hispanic parents are less likely than their white counterparts to initially enroll in EIBI treatment programs, participation levels increase with time, suggesting an improvement in physician-parent communication (Yingling & Bell, 2019). However, the

same study showed that the involvement of Hispanic groups in EIBI treatment, even after initiation, continues to be lower than their white or Asian counterparts (Yingling & Bell, 2019).

Because an ASD diagnosis often requires multiple medical specialists in addition to a general physician or pediatrician, these struggles can be magnified at each step of the process. These many factors, as well as others detailed in Figure 6, can lead to denial and frustration on the part of the family, thus delaying any ASD diagnosis and intervention and, unfortunately, disadvantaging the child (Zuckerman et al., 2014

Mental Health Stigma

Another reason families may be less able to access or thrive with ASD diagnosis and treatment is a cultural or social stigma against the disorder itself. Many cultures in different regions and communities of the world have a deep and dangerous stigma against any kind of mental or cognitive divergence (Ng, 1997; Rüsçh et al., 2005; Zuckerman et al., 2014). Even outside of a particular culture, this kind of mindset can pervade in various parts of society (Ng, 1997; Rüsçh et al., 2005). Unfortunately, this mentality disadvantages any individual who identifies as neuroatypical (Ng, 1997; Rüsçh et al., 2005; Zuckerman et al., 2014).

The 2014 study by Zuckerman and coworkers showed that a stigma against mental health (coupled specifically with “machismo” in Latinx cultures) plays a large role in barring families from seeking, accepting, and treating ASD (Zuckerman et al., 2014). Such a stigma exists especially in many minority communities but is not limited to solely these groups (Rüsçh et al., 2005).

This bias may prevent an individual from asking for help or recognizing personal struggles, and it may also preclude family and friends from accepting a diagnosis (Zuckerman et al., 2014). In the case of young children with ASD, the hesitation to accept a diagnosis or to even discuss any possible issues with a physician for fear of receiving one further delays the child's opportunity for interventions and therapies (Zuckerman et al., 2014).

Socioeconomic Status

Socioeconomic status (SES) is a dynamic measure that takes into account factors such as income, education, employment, and other living conditions (Williams et al., 2016). This measure can also be tied to race, ethnicity, immigrant or refugee status, and a number of other identities and factors that contribute to how one moves in the modern world and society (Williams et al., 2014). Categorizations such as "upper or lower class" fall under SES as well (Williams et al., 2014). These distinctions and experiences shape an individual's access to many resources, one of the most important being healthcare (Williams et al., 2014). As a result, SES creates disparity for the autistic and neuro-atypical community at large, as well as inequity regarding general healthcare access and resources (Stadnick et al., 2020; Williams et al., 2016). . For example, up to 75% of young individuals struggling with a psychological disorder of any kind in low- or middle-income nations do not receive appropriate treatment (Stadnick et al., 2020). This lack of treatment disproportionately affects certain communities and groups and has very dire consequences (Williams et al., 2016).

Though socioeconomic-based disparity in autism diagnosis has improved somewhat, over the last few decades, inequality still persists (Fountain et al., 2011). A study of 10 different birth cohorts found that the more educated a child's parents are, especially the mother, the younger the child is when diagnosed with ASD, an association that has become stronger over the years (Fountain et al., 2011). An earlier age of diagnosis proves to be more beneficial for the individual's long-term outcomes; therefore, children from higher SES backgrounds who are able to attain this diagnosis have this added benefit (Giarelli et al., 2010; Granpeesheh et al., 2009). Figure 7 shows the approximate calculated ages of diagnosis for children from high and low SES groups (Fountain et al., 2011).

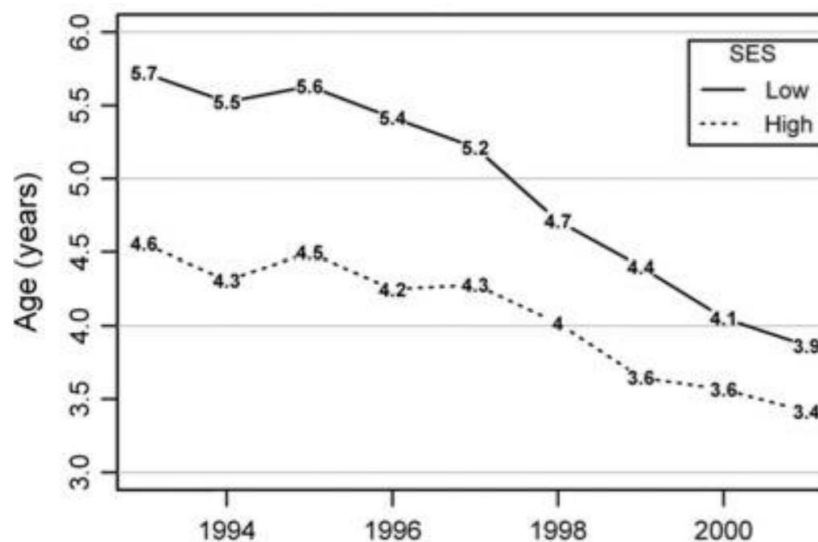


Figure 7. Predicted Age of Diagnosis for High and Low SES children on the Autism Spectrum. Though age of diagnosis for both groups has been steadily decreasing over the years, the difference between high and low socioeconomic status (SES) is still evident. The most recent extrapolation from these predictions estimates that on average, children from high SES families (designated in this study as higher parental education from variables including race, parental age, and wealth) are diagnosed at an earlier age than those from low SES families. The earlier diagnosis provides an advantage to these children who can more rapidly begin intervention and therapies. Taken from (Fountain et al., 2011).

At a more basic level, a greater number of individuals are able to attain an ASD diagnosis when coming from higher educated (higher SES) families (Durkin et al., 2017). There is no empirical support to suggest that incidence of autism varies significantly between the groups, even though diagnosis varies (Durkin et al., 2017). Figure 8 shows this trend, exploring how prevalence of (diagnosed) ASD among 8-year-old children (regardless of gender) varies by parental educational attainment (EA).

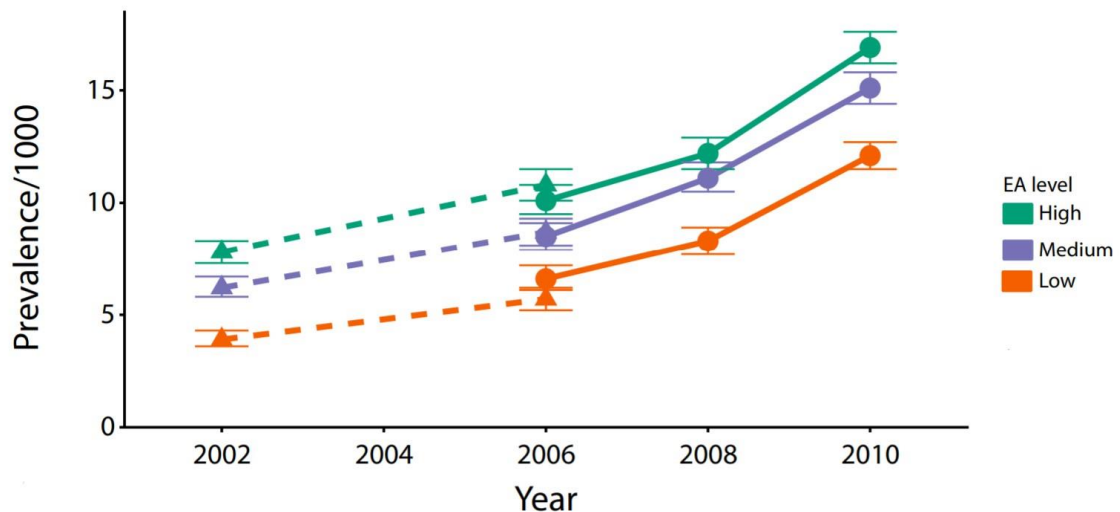


Figure 8. Prevalence of Diagnosed Autism Varies According to Parental Educational Attainment. Parental educational attainment (EA) is measured as the percentage of adults older than 25 years of age with at least a bachelor’s degree. A higher EA is indicative of a higher SES. This study found that in cohorts of 8-year-old children diagnosed with ASD, more individuals came from families of higher EA/SES. This result does not indicate a difference in incidence of the disorder; rather, there seems to be a disparity in diagnosis which disproportionately affects children from lower SES backgrounds. ASD = autism spectrum disorder; SES = socioeconomic status. For plot: bars = 95% confidence interval for point; dashed line = based on 2000 United States Census data; solid line = based on 2006-2010 American Community Survey data. Taken from (Durkin et al., 2017).

Another signifier of SES is the affluence level (or poverty level) of a neighborhood or area (Yingling et al., 2019). One study found that autistic individuals from less affluent neighborhoods tend to engage in less therapies, specifically enrolling in

fewer hours of EIBI intervention (Yingling et al., 2019). Generally, poverty and SES play large roles in an individual's healthcare, especially in a country like the United States where universal healthcare policies are not in place (Yingling et al., 2019). Some factors that contribute to this situation include the inability to recruit and retain healthcare providers in these areas as well as the inconsistent and unequal access to healthcare services, particularly specialists (Auchincloss et al., 2001; Kirby & Kaneda, 2005; Yingling et al., 2019).

DISCUSSION

Autism manifests differently in girls, especially when comparing individuals with higher levels of IQ or cognitive function. These differences, not just in underlying biological bases but also in behavior and mentality, contribute to what can be a very different experience for females on the autism spectrum as opposed to their male counterparts. An important fact to recognize is that girls experience more internalized symptoms of autism which are not equally classified in diagnostic criteria compared with the more external traits and behaviors of boys (Hartung & Widiger, 1998; Kreiser & White, 2014).

A remarkable symptom is the phenomenon of camouflage or masking, which allows many autistic girls to appear more neurotypical during social interactions but also prevents them from being externally observed for any diagnosable social deficits (Allely, 2019; Lai et al., 2017). By using camouflage to cope or compensate and thus mask any ASD-related deficits, these girls may become, at least phenotypically, very similar to their TD peers. This invisible impairment could easily go unnoticed by clinicians, especially those searching specifically for male-stereotypical social anomaly/external behavior. In this way, the camouflage theory may contribute to and account for some of the gender disparity in ASD diagnosis. Ultimately, although camouflage is an innovative, though not always successful, way to gain social acceptance, it comes at a great cost to the individual. Thus, it is an important factor to consider and address for the individual's therapy and treatment plan.

Although females may experience biological protective factors, this etiological imbalance of the genders is much lower than what diagnosis disparity currently indicates (the present male-to-female ratio of about 4:1 should be closer to 2:1). This comparison shows that there is a great deal of work to be done in improving these inconsistencies. Perhaps one day when these issues are addressed, etiological studies can be used to better identify ASD biomarkers in both genders for reliable use in the diagnostic profile of autism. Paradoxically, the greatest barrier to this objective is gender disparity in autism diagnosis. It is important to emphasize the pervasive effects of gender-skewed diagnosis on biological research. Because most current diagnosis is rooted in male-biased behavioral criteria, less females are initially diagnosed with ASD. This means that when researchers are recruiting subjects for their biological and genetic studies, there is a smaller pool of females with known ASD to use for the research. This pool can be more biased because the women who are able to attain an ASD diagnosis may disproportionately have more severe symptoms than the pool of men. The overall result is a further lack of information on ASD origins in females, making it harder for physicians and scientists alike to understand and gain awareness. Progress in this scope would heavily rely on better and more equal diagnosis of females so that researchers have a wider and more representative population with whom to conduct their studies. One possible way to combat the frequent misdiagnosis and missed diagnosis of autistic females, without waiting for larger and necessary systemic changes, would be to include self-diagnosed females in these studies in addition to formally diagnosed ones (Milner et al., 2019). Finally, as this research and technology advances, interventions and treatments

at the biological level will also differ between the sexes and thus provide more targeted and personalized approaches for autistic individuals.

With many of the studies analyzed in this thesis, there are inherent limitations. For one, in studies assessing effectiveness of treatment, there cannot ethically be control groups of children with ASD who do not receive any therapy or intervention. In addition, there is no way to truly randomize group selection—individuals either do or do not display and experience ASD traits. These issues are significant but unavoidable limitations. However, some flaws that may in the future be preventable include gender, clinician, and reporter biases in categorizing and diagnosing individuals with ASD. A large component of current ASD diagnosis relies on parental/clinical accounts and ratings, such as the ADI-R assessment. Although this assessment is especially necessary in young children and individuals who are nonverbal or at a younger mental age, it is a subjective system and particularly vulnerable to biases. Thus, such diagnostic tools are not infallible alone and should aim to be bolstered by other more objective diagnostic assessments.

The presence of comorbid psychiatric disorders also plays a large role in ASD diagnosis. Again there are gender biases in the diagnoses: ADHD is more likely to be diagnosed in boys, whereas depression is more commonly recognized in girls. However, the presence of another psychiatric disorder can both bolster and prevent ASD diagnosis in women. On one hand, many women only receive an ASD diagnosis after presenting with symptoms of the co-occurring psychiatric disorder. On the other hand, because clinicians may not consider autism as a likely diagnosis in their female patients (as

opposed to males), the psychiatric condition may overshadow the ASD diagnosis, and the subtler or internalized autism symptoms may be attributed to other disorders.

Interestingly, Polyak and colleagues (2015) hypothesized that this situation could also work the other way around and cause overdiagnosis of ASD for individuals who may actually be exhibiting a different intellectual disability or disorder altogether. Both scenarios emphasize how imperative it is for the diagnosing clinician to be aware of this confounding possibility to avoid misdiagnosis in either direction.

In recent years, more work has been done to investigate this gender disparity in ASD, and the results should hopefully contribute to meaningful and significant progress in the field. Researchers and clinicians are modifying current diagnostic tools and treatments, as well as developing new ones, to better cater to ASD manifestation in females. Clinicians are watching and must continue to watch for older girls and women who may have missed diagnosis as children but are still experiencing and demonstrating autistic traits. Finally, the most important part of fighting this disparity is to raise awareness in physicians, clinicians, and parents. As researchers learn more about autism in females, physicians and clinicians must also learn more about these different traits and behaviors and work to overcome any previous internal biases regarding gender in autism. Parents must also learn more so that they know what to look for, understand how autism may manifest in their daughters, and become comfortable in voicing concerns and advocating for their affected children. Together, these actions could help diagnose girls earlier and easier with autism, lessen the gender disparity, and better support their long-term outcomes.

APPENDIX

A Note: Gender as Nonbinary

This analysis primarily considers and references binary gender, specifically in terms of biological sex—male or female. Most autism research and study is done in very young children (Lai et al., 2015). At this age, individuals generally do not yet understand the difference between genders or have the autonomy in their own gender performance to actively identify as a certain (or neither) gender (Lai et al., 2015). Thus, these children are so young that the two concepts of sex and gender are indistinguishable (Lai et al., 2015). However, this male-female dichotomy is a limited and narrow view of gender. Gender and sex are not equivalent; rather, gender identity can be fluid, multifaceted, and nonbinary (Liszewski et al., 2018).

Making this distinction is especially necessary because studies have shown that the prevalence of autistic traits is six times higher in individuals with gender dysphoria than in the general population (Heylens et al., 2018). This experience of gender dysphoria, much more common in individuals with ASD than in the population at large, creates nuance in the topics discussed throughout this thesis (Heylens et al., 2018; Strang et al., 2014).

At present, one possible correlation has identified that individuals with high birthweight, which is considered a risk-associated factor for ASD, are more likely to be gender nonconforming, in addition to displaying autistic traits (VanderLaan et al., 2015). Another current theory is that because of their challenges with social settings and cues,

autistic individuals may not be able to grasp gender roles and norms as easily. This means they may not develop a binary gender performance and instead display traits stereotypically considered “male” and others considered “female” (Strang et al., 2014). Such a theory reinforces the concept of gender identity as a social construct rather than something innate or inherent and further validates untraditional gender expression.

Though the terms gender and sex are used interchangeably throughout this thesis that sameness, importantly, does not extend to the societies of the world (Liszewski et al., 2018).

LIST OF JOURNAL ABBREVIATIONS

BJPsych Open	British Journal of Psychiatry Open
BMC Medicine	BioMed Central Medicine
BMC Proceedings	BioMed Central Proceedings
BMC Psychiatry	BioMed Central Psychiatry
MMWR	Morbidity and Mortality Weekly Review
PLOS Biology	Public Library of Science Biology
PLOS ONE	Public Library of Science ONE

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