Relationship between social networks and mental health in individuals with ASD



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Relationship between social networks and mental health in individuals with ASD

Have you ever been unable to communicate with someone in a social setting? Do you have trouble recognizing someone else's or maybe your own emotions? These are just some of the obstacles that a person with autism spectrum disorder (ASD) may experience every day. According to the Centers for Disease Control and Prevention (2016), 1 in every 54 children in the United States is diagnosed with autism. Autism is a lifelong developmental disorder, meaning it is normally diagnosed in childhood and extends into adulthood. Individuals with ASD are more susceptible to mental health disorders. Around the world, millions of people suffer from a mental health disorder that can have numerous effects on their life. Some of these individuals may also suffer from a comorbid disorder: when one is affected by more than one mental disorder at the same time. An example of this includes someone diagnosed with both autism spectrum disorder and depression. When two disorders interact with each other this can sometimes cause the symptoms of both or one of the disorders to become intensified. In the case of autism and a comorbid depression or anxiety disorder, ASD symptoms can sometimes be worsened or masked (Chandrasekhar & Sikich, 2015). An example would include the repetition of behaviors or interests becoming more frequent in the individual's life, or these specific interests becoming less common in someone's life (Chandrasekhar & Sikich, 2015; Nadeau, 2011).

Recent studies have observed differences in several brain areas that may explain why individuals with ASD exhibit some behaviors. Some of these brain areas include the frontal, prefrontal or temporal cortices, the occipital gyrus, or amygdala (Clements et al., 2018; Liu et al., 2019 & Sato et al., 2017). Many of these areas are involved in processes associated with social interaction, such as perceiving social cues (e.g., facial expressions, tone of voice, body

language). There are some similarities within the neuroanatomy of anxiety, depression, and ASD that could be associated with the high prevalence of comorbid disorders within this population specifically. Individuals with ASD have a comorbidity rate of 23% for depression and 27% for anxiety, while the general population has rates of 1-12% for these two disorders (Hollock et al., 2017). There are many aspects of our lives that may influence how someone is dealing with their disorders on a daily basis. For example, social networks (friends, family, coworkers, group members, etc.) can be very beneficial in helping someone cope with their symptoms in a positive way. When someone lacks the tools necessary to develop social relationships, this can affect their moods and how they may view their life. An individual's social motivation and skills are associated with their ability to develop lasting and pleasurable relationships that can be useful for their mental health (Han et al., 2019; Hedley et al., 2019; Neahaus et al., 2019; Pouw et al., 2013; Turcotte et al., 2016). This review will describe research investigating the relationship between social networks and the presence of comorbid depression and anxiety in individuals with autism spectrum disorder. This paper will also look into the neurophysiological, neuroanatomical, and psychological characteristics of ASD, and how these may explain the most common comorbidities.

Autism spectrum disorder (ASD) is a developmental disability that impacts social interaction and communication, altering how someone may perceive and socialize with others (National Institute of Mental Health [NIMH], 2013). The official diagnostic criteria for ASD within the Diagnostic and Statistical Manual of Mental Disorders includes: (a) persistent deficits in social communication and social interaction across multiple contexts; (b) restricted, repetitive patterns of behavior, interests, or activities; (c) symptoms must be present in the early development period; (d) symptoms cause clinically significant impairment in social,

occupational, and other important areas of current functioning; (e) these disturbances are not better explained by intellectual disability or global developmental delay (American Psychiatric Association [APA], 2013). ASD is a lifelong disorder where symptoms do not go away, and since there is early onset, this disorder represents a major health concern. People with ASD want to form lasting relationships and make connections, but they struggle with the social skills necessary to have these types of interactions (Asselt-Goverts et al., 2015).

Current study

This review will explore previous research conducted about anxiety, depression, ASD, social networks, and their relationships with each other. The questions this review will try to answer include: Are there neuroanatomical findings that may help explain the overlap of symptoms in ASD, anxiety, and/or depression? What are the differences in rates of comorbid mood and anxiety disorders in ASD? What are the psychological explanations for increased comorbidity in the ASD population? Are social networks beneficial to individuals with ASD and a comorbid disorder? How does rurality affect the resources available for individuals with ASD and a possible comorbidity? In chapter 1 I will focus on neuroanatomical research for ASD, depression, and anxiety and then comparisons between each will be made. Chapter 2 will look at the comorbidity of depression and anxiety in ASD, specifically focusing on the rates within literature and psychological explanations. Chapter 3 will narrow in on the use of social networks in ASD and how they could correlate with comorbid mood and anxiety disorders. The focus of chapter 4 will be the issues present in rural communities and how this might affect resources available to individuals with ASD and comorbidities. Chapter 5 will be a discussion on all the presented information, tying all of the research together, and will end with a conclusion of the

review. The review will then aim to determine where the literature is lacking and identify what areas future research should focus.

Chapter 1: Can neuroanatomical findings help explain comorbidities in ASD?

As stated previously, Autism Spectrum Disorder (ASD) is categorized as a developmental disorder, with symptoms appearing generally within the first two years of life (NIMH, 2013). The origin of the symptoms is currently unknown to the world of neurobiology, but researchers have started to make advances toward our understanding. There are many theories as to what is occurring within various regions of the brains in individuals with ASD that may explain the symptomatology. Many of these theories are inconsistent in the literature and there are many disagreements about potential brain differences in individuals with ASD. This chapter will cover the neurobiology of ASD, depression, and anxiety as well as compare similarities between the three disorders that may account for the increased comorbidity rates in ASD populations.

Neurobiology of ASD

One theory regarding the social deficits characteristic of ASD includes the social motivation hypothesis that argues ASD symptoms might stem from a diminished social motivation (Clements et al., 2018). This occurs because those with ASD find social stimuli less rewarding compared to typically developed (TD) people. This hypothesis provides a developmental suggestion for how reward processing may demonstrate social deficits in those with ASD. This means the children with ASD may focus less on social information (nonverbal cues) leading to less social learning and worsened social skills. Clements et al. (2018) conducted a meta-analysis of 13 different studies that used functional magnetic resonance imaging (fMRI) to observe the areas of the brain involved in the social motivation hypothesis . The fMRI results of samples of ASD were compared to TD control groups. The participants within the various studies were given different tasks including incentive delays for money gain or smiling face, money loss or sad face, social reward or punishment for auditory task performance, viewing

pictures of others' or own interests passively, gain or loss of domino chips in game (Clements et al., 2018). The caudate, accumbens, and anterior cingulate gyrus showed the strongest hypoactivation (less activation than normal) for social rewards in ASD groups. The caudate nucleus is involved with movement, learning, emission, reward, and motivation. The nucleus accumbens helps process and analyze rewarding and reinforcing stimuli. The anterior cingulate gyrus has connections to emotions, this helps to regulate and control or avoid emotions. All three of these brain areas could help an individual with ASD process social stimuli, understand whether it is rewarding, and then regulate or avoid emotions within interactions. Lessened activity within these areas could help explain why an individual with ASD may find social situations as less rewarding than the TD control groups. Less activation in the anterior cingulate gyrus would also help identify the emotional dysregulation in individuals with ASD, where they may struggle with using typical emotional responses in social interactions (Neuhaus et al., 2019).

Two areas of the brain that have been observed to have deficiencies in those with ASD compared to TD are the frontal and temporal lobes (Liu et al., 2019; Pagnozzi et al., 2018). Pagnozzi et al. (2018), conducted a review to summarize the structural connections of ASD and identify features (biomarkers) that may approximate impairment. The analysis consisted of research since 2007 that used 3T magnetic resonance imaging (MRI) providing improved resolution. There was an observation of increased cortical thickness in frontal and temporal lobes that has been consistent across literature (Pagnozzi et al., 2018). The frontal lobe has a role in movement, language, and executive functions such as controlling responses. The temporal lobe also plays roles in language, and processing emotions. The increase in cortical thickness may be associated with poorer ASD severity measure outcomes. This means that the increase in

thickness in the frontal or temporal lobe may lead to worsened social communication with language as well as issues with emotional processing (Pagnozzi et al., 2018).

Liu et al. (2019) conducted a review of ASD studies using functional near-infrared spectroscopy (fNIRS) to look at the brains of infants and children. fNIRS is a noninvasive brain imaging technique that can be used for studying functional activation in participants while having little physical constraints, making it useful for developmental imaging for young participants. Liu et al. (2019) looked at a collection of data varying across areas of research using fNIRS including: non-social deficits, atypical connectivity, and social deficiencies. In infants, atypical connectivity and dysfunctions between the fronto-temporal cortex may be one aspect of ASD (Liu et al., 2019). Results looking at the communication of infants with ASD symptoms suggest that prefrontal cortex dysfunction may be associated with social deficits.The prefrontal cortex works to help with decision making, social behavior, planning, and personality expression (Liu et al., 2019). Deficits in this area could lead to the lack of social skills and communication that individuals with ASD experience.

Emotional and social behaviors that are characteristic of ASD have been linked to the role of the amygdala (Pagnozzi et al., 2018). The amygdala plays a role in emotion and behavior, meaning that affects to this area could be associated with the social deficits and emotional dysregulation experienced by those with ASD. Differences in the volume of the amygdala have been observed within the brains of individuals with ASD, though this is not consistently found (Pagnozzi et al., 2018). Schumann et al. (2009) aimed to measure the amygdala volume in toddlers at risk for ASD with TD children of the same age. MRI scans of 89 toddlers between the ages of 1-5 years were taken to analyze differences in amygdala volume within the two groups. Both male and female participants had significantly larger left and right amygdala compared to

the control groups. The enlargement of the amygdala was associated with the severity of social and communication deficits in males, but not with females (Schumann et al., 2009). Avino et al. (2018) evaluated neuron numbers in the amygdala throughout development in TD and ASD individuals. Children with ASD have significantly more neurons within their amygdala than the TD children (Avino et al., 2018). The number of neurons within the amygdala of individuals with ASD decreased 17% from childhood to adulthood in a sample of 28 individuals with ASD, mean age 17.46 years (Avino et al., 2018). In TD individuals, the number of neurons within the amygdala increased from childhood to adulthood by 11% in a sample of 24 TD subjects with a mean age of 20.17 years (Avino et al., 2018). TD adults had significantly more neurons in their amygdala than adults with ASD. This would mean that the amygdala within ASD individuals starts out larger than TD individuals and then decreases during development and becomes smaller in adulthood (Avino et al., 2018; Schumann et al., 2009). There is some agreement across literature that the size of the amygdala is linked to increased social and communication impairments in individuals with ASD.

Another theory includes functional changes to specific subregions of the middle temporal gyrus (MTG) across the lifespan (Xu et al., 2019). As noted previously, increased cortical thickness in the temporal lobe has been associated with increased ASD symptom severity (Pagnozzi et al., 2018). The middle temporal gyrus is a gyrus in the temporal lobe that is involved with language processes and integrating information from different senses. Since the MTG is part of the temporal lobe one may speculate that issues within this region may also be associated with worsened ASD symptoms. Xu et al. (2019) used fMRI scans to observe MTG changes in children and adults with ASD, hypothesizing specific MTG subregion changes to be associated with ASD. During the fMRI scans participants were instructed to relax, keep their

head still, and eyes open while fixating on a black cross on a white screen (Xu et al., 2019). Xu et al. (2019) also compared their results to previous studies where participants may have been asked to mentalize social interactions or complete response naming tasks. Hypoconnectivity (less connectivity than normal) was observed in the posterior MTG specifically, and this was associated with social context tasks and eye-gazing, meaning this area may contribute to social communicative deficits. When considering previous research, a larger temporal cortex with less connectivity within the cortex could be associated with the altered social skills observed in ASD (Pagnozzi et al., 2018; Xu et al., 2019).

Individuals with ASD may use executive functioning (flexible thinking, self-control, working memory) to compensate for social deficits (Walsh et al., 2019). Walsh et al., (2019) observed social behavior within ASD and control groups and the relationship to executive function with behavioral and neural indications. The Social Responsiveness Scale-2 (SRS-2) was administered to all participants to measure social behavior associated with ASD (Walsh et al., 2019). The Tower of London (ToL) total moves is a behavioral measure that evaluates the planning aspects of executive function (Walsh et al., 2019). Resting-state fMRI and 3-T MRI scans were complete for 85 men with and without ASD. These scans were used to observe connectivity of the resting-state EN to assess neural executive functioning (Walsh et al., 2019). The executive network includes varying areas of the brain such as the dorsolateral prefrontal cortex (dlPFC) and posterior parietal cortex, which are believed to mediate executive controls (Walsh et al., 2019). Within older men with ASD, there were decreased executive function performance that was related to increased social cognition difficulties. Older men with ASD had more reduction in prefrontal EN connectivity than NT men (Walsh et al., 2019). This reduction in connectivity could be associated with the decreased executive function noted and also

correlate to social deficits in ASD individuals. Although this study was only on men, one could speculate that similar findings may be observed with any gender that has ASD, although similar studies should be conducted to observe the brains of females with ASD.

Sato et al. (2017) used structural MRI data to analyze gray matter, mainly neuronal cell bodies and unmyelinated axons, volume in 36 adults with ASD and no comorbidities and 36 TD adults. Sato et al. (2017) found reduced gray matter in several areas associated with the social brain networks, such as the occipital gyrus, amygdala, orbitofrontal cortex, and inferior frontal gyrus. These results are consistent with the literature on neural activation where reduced activity in the social brain networks is observed during social stimuli processing (Clements et al., 2018). Pagnozzi et al., (2018) reported an increase in cortical thickness of the frontal lobe. The cortex is mainly made of gray matter, so if there is an increase in thickness of this area one may speculate there would be more gray matter (cell bodies), but these two studies are contradictory (Pagnozzi et al., 2018; Sato et al., 2017). Differences in something as simple as volume of brain structures may help shed a light on the need for more neuroanatomical research on ASD.

Barnea-Goraly et al. (2003) used diffusion tensor imaging to investigate the structural integrity of white matter tracts in individuals with ASD and correlate abnormal morphology to social cognition deficits. The participants included 16 male children (mean age of 14.6 years) and adolescents with ASD and 9 TD children (mean age of 13.4 years). The white matter, containing myelinated axons, between brain regions involved in social cognition are observed to have disrupted structure within ASD groups (Barnea-Goraly et al., 2003). These regions include the fusiform gyrus, superior temporal sulcus, amygdala, ventromedial PFC, and anterior cingulate (Barnea-Goraly et al., 2003). Altered white matter would mean that there are reductions in the amounts of myelinated axons in these areas, causing decreased activity and

slower processing, leading to issues with connectivity within the region. Impairments in these regions could correlate to disruption of neural connectivity in ASD, associating the deficits with social skills in this population (Barnea-Goraly et al., 2003). This is consistent with previous research that noted atypical connectivity and dysfunctions within the fronto-temporal cortex (Liu et al., 2019). There has been research reporting decreased size of the amygdala in adults with ASD when compared to TD adults, and if the white matter is altered this could be associated with the smaller size (Avino et al., 2018) This study did use children instead of adults, but the results could be applied to this different population as well. The regions included are important for face and gaze processing as well as mental and emotional awareness and processing, aspects that are impaired in ASD.

The neuroanatomy of anxiety and depression has similarities to the neuroanatomy of ASD (Canteras et al., 2009; Etlin, 2009; Grady & Keightley, 2002 Koenigs & Grafman, 2009; Walsh et al., 2019). Individuals with ASD that are higher functioning may have less social skill impact, and their awareness could lead to the development of depression or anxiety (Chandrasekhar & Sikich, 2015; Matson & Nebel-Schwalm, 2007; Sterling et al., 2008; Wijnhoven, 2019). Similar to ASD, some of the findings are inconsistent across literature and may vary within the research.

Neurobiology of anxiety and depression

Studies have investigated the areas of the brain that may be activated during anxiety or depression (Canteras et al., 2009; Etkin, 2009; Grady & Keightley, 2002; Koenighs & Grafman, 2009; Walsh et al., 2019). Canteras et al., 2009 reviewed brain systems associated with fear and anxiety. Etkin (2009) explored the neural basis of anxiety by reviewing functional neuroimaging research of emotion. Within anxiety, increases in the activity of the amygdala have been noted

when an individual is processing negative or fearful stimuli in ASD (Canteras et al., 2009; Etkin, 2009; Schmidt et al., 2018). The PFC has also been found to have decreased activity when identifying stimuli as threatening, with increases in activity when the stimuli is interpreted as less threatening (Canteras et al., 2009). The dorsomedial (dm) PFC may be linked to monitoring and accessing importance of emotions, which can be linked to anxiety (Etkin, 2009). Various neural actions exhibited during anxiety involve the mediation of the prefrontal-amygdala pathway (Canteras et al., 2019). The amygdala and prefrontal cortex play a role in emotions, behaviors, and attention. If there are increases in the amygdala activity this could be associated with increased emotional processing, in terms of anxiety if the individuals is constantly processing fearful or negative emotions this would account for the increase in amygdala activity. If there is decreased PFC activity during anxiety this would mean that there is an increase in processing stimuli as threatening. There are also decreases in PFC activity observed in ASD, showing possible links to the development of comorbid anxiety (Walsh et al., 2019)

The dorsolateral (dl) and ventromedial (vm) PFC are two areas that play important roles within depression only participants. Koenigs and Grafman (2009) reviewed research indicating subregions of the prefrontal cortex as playing roles in the development of depression. Damage to the vmPFC of either hemisphere was associated with blunted responses to pictures that elicit emotional arousal (Koenigs & Grafman, 2009). This area may be linked to reduction in certain symptoms of depression such as feeling guilt or shame, as well as self-awareness or reflection. Another neural area possibly linked with depression is the dlPFC. The dlPFC has been activated during regulation of negative emotions as a strategy for reappraisal and suppression of these emotions (Koenigs & Grafman, 2009). Grady and Keightley (2002) reviewed fMRI research to examine psychiatric disorders and social cognition. When in remission of depression, there are

increases to the activity of the dlPFC (Grady & Keightley, 2002). The dlPFC is associated with the executive network, assisting with social cognition control within ASD (Walsh et al., 2019). Decreased activity of the dlPFC could cause increased social cognition difficulties as well as increased negative emotions linked to depression (Koenigs & Grafman, 2009; Walsh et al., 2019). The tendency to ruminate about negative memories is linked to the increase in amygdala activity (Grady & Keighley, 2002).

Heerington et al. (2017) used 53 children with ASD and 37 TD children to distinguish the comorbidity of anxiety in ASD and ASD alone using amygdala morphology. In young participants with ASD, there was decreased amygdala volume associated with the presence of any anxiety disorder (Herrington et al., 2017). As discussed previously, the size of the amygdala in ASD individuals as compared to TD, starts off larger in volume with the possibility of decreasing over time and resulting in a smaller amygdala in adulthood (Avino et al., 2018; Schumann et al., 2009). Decreased amount of white matter within the amygdala has been reported within children around 14.6 years, so one may speculate that the amygdala starts off larger in infancy and then decreases in size during childhood and into adulthood (Avino et al., 2018; Barnea-Goraly et al., 2003; Herrington et al., 2017; Schumann et al., 2009). Although this study was conducted using children (mean age 11.9 years), one could speculate that similar observations may be noted within an adult sample. The presence of decreased amygdala volume in ASD individuals with comorbid anxiety is beneficial in understanding the impacts of the disorder. The amygdala is a part of the social cognitive network that has effects on the social abilities of an individual with ASD (Grady & Keightley, 2002). Variations in the size and activity of the amygdala have been noted across both literature about anxiety and ASD.

Similarities within the PFC activity are observed when looking at literature within depression, anxiety, and ASD. Decreases to various areas of the PFC (dl, dm, vm) are all noted within all three disorders (Canteras et al., 2009; Etkin, 2009; Grady & Keightley, 2002; Koenigs & Grafman, 2009; Walsh et al., 2019). The similarities between the sizes and activities of these brain areas could be another reason why individuals with ASD are more susceptible than TD to developing a comorbid depression or anxiety disorder (Hollocks et al., 2017; van Steensel & Heeman, 2017). The social cognitive network is made up of 10 different brain regions including: amygdala, prefrontal cortex, fusiform gyrus, and superior temporal sulcus (Grady & Keightley, 2002). Within Autism patients, there are widespread deficits within this network (Grady & Keightley, 2002; Gyawali & Patra, 2019; Pagnozzi et al., 2018; Walsh et al., 2019).

In general, the neuroanatomical research within the area of ASD is limited in some aspects and requires further exploration. The neuroanatomy of ASD is conflicting, with some consistencies and contradictions throughout the research. The size of the amygdala has been reported to be larger in infants with ASD as compared to TD infants, and then as development continues the amygdala volume may decrease and result in adults with ASD having smaller amygdala's than TD adults (Avino et al., 2018; Barnea-Goraly et al., 2003; Herrington et al., 2017; Schumann et al., 2009). This could also be associated with the diagnostic criteria including the requirement of ASD symptoms to be present in early developmental periods (APA, 2013). Enlarged amygdala in infants was associated with severe social and communication deficits, motivating abnormal behaviors and this could possibly help predict diagnosis in young children (Schumann et al., 2009). An increase in cortical thickness of the frontal lobe is noted, but a decrease in gray matter within the frontal gyrus was observed (Pagnozzi et al., 2018; Sato et al., 2017). Disrupted white matter structures were observed in the amygdala and the ventromedial

PFC, consistent with decreases in amygdala and dysfunction with connectivity in the fronto-temporal cortex (Avino et al., 2018; Barnea & Goraly et al., 2003; Liu et al., 2019). Anxiety and depression also have some variation within the neuroanatomy described within the literature. As I noted, there may be some similarities within the neuroanatomy of anxiety, depression, and ASD. An example includes the decrease to the prefrontal cortex (dorsolateral, dorsomedial, and ventromedial) in all three disorders (Canteras et al., 2009; Etlin, 2009; Grady & Keightley, 2002; Koenigs & Grafman, 2009; Walsh et al., 2019). Increased social cognition difficulties and negative emotions may be linked to decreased activity within the dorsolateral PFC (Koenigs & Grafman, 2009; Walsh et al, 2019). Similarities in the neuroanatomy and/or neurophysiology within these disorders could be one of the reasons that individuals with ASD are more susceptible to a comorbid mood or anxiety disorder. The issue of a lack of consistency within the literature is similar across other areas of ASD research, such as rates of comorbid anxiety or depression, as we will move onto the various rates of comorbidity within this population next.

Chapter 2: Rates and psychological symptoms of comorbid mood and anxiety disorders in ASD

This chapter will identify comorbidity rates of depression and anxiety in Autism Spectrum Disorder (ASD), the psychological symptoms of these comorbidities, and will explore possible explanations for why these comorbidities are prevalent in the ASD population.

Rates of mood and anxiety disorders in ASD

Individuals with ASD are more susceptible to developing a comorbid disorder such as depression or anxiety (Hollocks et al., 2017; van Steensel & Heeman, 2017). Hollocks et al. (2017) conducted a meta analysis including 35 studies to determine a more accurate rate of comorbid depression or anxiety in adults with ASD. For any current anxiety or depression disorder, the meta-analytic pooling estimates were 27% and 23% both of which far exceed the prevalence of these disorders in the TD population. Specifically, the rate of social anxiety was estimated for current prevalence to be around 29% and 20% for lifetime prevalence (Hollocks et al., 2017). For obsessive compulsive disorder, current rates were around 24% and lifetime were around 22% (Hollocks et al., 2017). Generalized anxiety disorder had a prevalence of 18% and 26% for current and lifetime rates (Hollocks et al., 2017). Social anxiety disorder, obsessive disorder, and generalized anxiety were the three anxiety disorders with the highest prevalence rates reported within the review conducted by Hollocks et al. (2017).

The rates of comorbidity for these two disorders within the ASD populations fluctuates across literature, while sharing the fact that the prevalence is higher than in the typical population. Buck et al. (2014) used 129 caregiver-reports as well as the mini Psychiatric Assessment Schedule for Adults with Developmental Disability (PAS-ADD) to determine the comorbidity of psychiatric disorder in adults with ASD and compare the association between the

two reports. The rates of anxiety reported were 40% and the lifetime rates were 53% by the mini PAS-ADD while caregiver reports were around 11% (Buck et al., 2014). Obsessive compulsive disorder (OCD) had lifetime rates of 36% and current rates of 33% in the mini PAS-ADD and caregivers reported only 9% (Buck et al., 2014). Lifetime rates of depression were similar between the two reports to be around 12-13% (Buck et al., 2014). This shows the inconsistencies between clinician reports and care-giver reports.

Maddox and White (2015) investigated the prevalence of social anxiety disorder (SAD) in adults with ASD. A sample of 79 individuals between the ages of 16 and 45 years old were used, 28 with ASD, 26 with SAD, and 25 control participants (Maddox & White, 2015). Maddox and White (2015) used the social responsiveness scale, second edition adult (SRS-2-A) for self report of ASD related social impairments. Four different scales and one interview were used to asses the social anxiety symptoms of the participants: Anxiety Disorder Interview for DSM-IV: Social Phobia module (ADIS-IV), Brief Fear of Negative Evaluation scale (BFNE), social Interaction Anxiety Scale (SIAS), Social Anxiety Scale for People with ASD (SASPA), and the Depression Anxiety Stress Scale (DASS-21) was used. Around 50% of the participants with ASD met the diagnostic criteria for SAD, which has some similarities in symptoms to ASD such as impaired social functioning (Maddox & White, 2015). ASD individuals with co-occurring SAD had significantly higher scores on the BFNE, SIAS, and SASPA in comparison to the ASD only group. The ASD+SAD group also reported higher levels on the SRS-2A measure. This means that a high percentage of individuals with ASD may also have comorbid social anxiety, along with more social impairments.

Leyfer et al. (2006) set out to develop a reliable and accurate diagnostic tool to accurately identify comorbid psychiatric disorders in children with ASD. A modified version of the Kiddie

Schedule for Affective Disorders and Schizophrenia for Autism was created and renamed Autism Comorbidity Interview-present and lifetime (ACI-PL). Their sample consisted of 109 children, between the ages of 5-17 years old, with ASD. Leyfer et al. (2006) identified rates of depression and various anxiety disorders to be around 10-12% of children in their sample. The instrument used had good criterion validity and inter-rater reliability with major depression, ADHD, and OCD meaning that there may still be work to improve the quality of the tool (Leyfer et al., 2006). Although the tool is for children, the development of a high quality diagnostic measure for any age could help push the creation of a more accurate tool for adults with ASD. This study helps to confirm the comorbidity of psychiatric disorders and ASD, even as early as during childhood.

Wijnhoven et al. used both self-report and parent-reports to examine the prevalence of suicidal ideation and depression in children with ASD. Ninety three children between the ages of 8-15 years old participated in the study. The diagnostic tool used was the children's depression inventory 2 (CDI-2). Rates of depression were around 52% for females and 30% for males with ASD (Wijnhoven et al., 2019). In TD adults rates around 5.5% in women and 3.2% in men were noted (Albert, 2015). Around 32% of children in the sample had thoughts of killing themselves but would not do it and 2% had intentions (Wijnhoven et al., 2019). This shows the high prevalence of depression and suicide in the ASD population, even though the sample were only children one may speculate that these depression rates could continue into later childhood and adulthood.

The presence of a comorbid depression or anxiety disorder has a wide range from 10-52% within the ASD population (Buck et al., 2014; Hollocks et al., 2017; Leyfer et al., 2006; Maddox & White, 2015; Wijnhoven et al., 2019). While all of these studies report varying

percentages of participants with ASD meeting diagnostic criteria for anxiety or depression, the most accurate estimate to use would be around 27% and 23% since this was a meta-analysis that collected data from numerous studies and created on overall statistic (Hollocks et al., 2017). This would be because the meta-analysis includes multiple studies that also had varying percentages, and then a pooled estimate was calculated (Hollocks et al., 2017). This variation across the literature shows the lack of consistent diagnostic criteria for comorbid psychiatric disorders within this specific population of ASD.

When compared to the general population, whose estimates are around 1-12% for a depression or anxiety diagnosis, those with ASD are clearly a more vulnerable population, despite the varying percentages observed throughout the literature and lack of consistency in measures used (Chandrasekhar & Sikich, 2015; Hollocks et al., 2017). There are consistent diagnostic measures used for the TD population for multiple disorders, including depression and anxiety. These measures however cannot be applied to the ASD population because the symptoms that are present are not always the same. This is why the need for diagnostic measures, with reliability and validity, are needed to help create more accurate estimates. Even though both TD and ASD individuals may be diagnosed with depression or anxiety, the symptoms experienced by both groups may be different when compared to each other.

Psychological symptoms

In a typically developed individual, depression and anxiety symptoms include: excessive uncontrollable worry, tiredness, irritability, muscle aches, diminished interest, depressed feelings most of time, and feeling worthless (APA, 2013. These symptoms can cause varying levels of social distress or impairment within the individual's life (APA, 2013). Depression and anxiety can exacerbate ASD symptoms such as reduced communication, aggression, increased ritualistic

and obsessive behaviors, and social withdrawal (Murray et al., 2019; Magnuson & Constantino, 2011; Sterling et al., 2008). Some of the similarities include difficulty sleeping, changes in appetite, and social withdrawal (Chandrasekhar & Sikich, 2015). Although there are some similarities in symptoms, the diagnosis of depression in an individual with ASD is still more difficult to accurately determine. Individuals with ASD may not experience similar symptoms to the TD individuals such as having no feelings of worthlessness, sadness, or low self-esteem (Chandrasekhar & Sikich, 2015), but there are some similarities in the symptoms one in either group could experience. Individuals with ASD might already be emotionally withdrawn, showing little to no emotion at baseline, making determining changes in emotions due to a comorbid disorder difficult.

Reasons for inconsistent rates

The prevalence rate for depression or anxiety in those with ASD is not exactly certain, this is mainly because many individuals are never tested for depression and anxiety, since the symptoms between the general public and ASD population are different. Since depression and anxiety symptoms sometimes interact with ASD symptoms, studies stress the importance of understanding the individual's baseline ASD symptoms to observe how they may have changed (Chandrasekhar & Sikich, 2015). ASD symptoms could either become more intense, or less often when an individual develops depression or anxiety (Chandrasekhar & Sikich, 2015). Observing and diligently watching for changes from baseline, either more or less frequent, could help lead to determining if an individual with ASD has developed a comorbidity. The chances of an individual developing depression or anxiety will be determined by several factors. For example individuals that have less severe ASD symptoms and therefore more social functioning as well as higher cognitive functioning are more susceptible to experiencing depression and anxiety

symptoms than an individual further on the spectrum (Chandrasekhar & Sikich, 2015; Matson & Nebel-Schwalm, 2007; Sterling et al., 2008; Wijnhoven, 2019). The chances of an individual with ASD developing depression or anxiety have been shown to be higher than those within the TD population, but the reasons for the ASD population being at a higher risk are less known.

The rates of comorbid disorders for those with ASD that a study reports may not always be accurate, due to an overshadowing phenomenon where the symptoms of ASD may overlap with the symptoms of another disorder and because the symptoms may present differently than in the TD population (Hollocks et al., 2017). Geurts et al. (2016) used a sample of 114 adults between 60-90 years old that were diagnosed with depression to test for ASD characteristics. Around 31% of the depression sample scored above the ASD cut off, while only 6% of the control group had elevated ASD traits (Geurts et al., 2016). This research helps to show that the rates of not only comorbidities but ASD in general are not accurate within literature (Geurts et al., 2016). The participants in this study were older adults, so when they were children ASD was associated with low intellectual functioning and a childhood disorder, today we know that ASD persists into adulthood and can be present in varying intellectual levels.

Another reason for inconsistency is that studies observing comorbid disorders in individuals with ASD often use different diagnostic measures. Some of the measures used include the Beck's Anxiety Inventory (Geurts et al., 2016), Inventory of Depressive Symptomatology Self-Report (Geurts et al., 2016), and the Patient Health Questionnaire-9 (Hedley et al., 2017). Other studies have used structured/semi-structured interview measures instead such as the Mini PAS-ADD (Buck et al., 2014), family history- research diagnostic criteria (Sterling et al., 2008), ADIS-IV (Maddox & White, 2015), ACI-PL (Leyfer, et al., 2006). The variability in methods of diagnosing is because there has not been a unified diagnostic

measure or interview created for this specific population, meaning researchers often need to create their own measurement for diagnosing, such as the Autism Comorbidity Interview (Leyfer et al., 2006). Also, some studies may use parent or caretaker reports while others utilize self-report from the child with ASD (Han et al., 2019; Pouw et al., 2013; Wijnhoven et al., 2019). If individuals with ASD also have low intellectual functioning, then the use of self-report may not be appropriate, but if the individuals are higher functioning then they may provide valid and reliable reports (Pouw et al., 2013). The use of the parent report is also not accurate, as higher rates of depression were reported by parents (75%) in comparison to self-report (35%) (Wijnhoven et al., 2019). Whether someone may be able to self-report or not would be determined based on where they fall on the spectrum. The accuracy of self-report would depend on whether the individual is able to evaluate their emotions. The use of either self- or parent-report and a lack of consistent diagnostic tests used across the literature all contribute to inconsistent rates of comorbidities across literature.

Reasons for development of comorbidities

The reasons why someone may develop depression and anxiety can be similar for both TD and ASD individuals. Similar to TD individuals, those with ASD can develop depression and anxiety based on family history (Chandrasekhar & Sikich, 2015). Family history is a leading factor for susceptibility of a mental disorder, but this is not the sole factor and there are many other aspects that could influence whether someone will develop a mental disorder (Mayo Clinic, 2019). Negative life events (significant losses, transitions in caregivers, pandemic) or changes in routine could also lead to any individual developing depression (Chandrasekhar & Sikich, 2015), which may also be able to be projected to anxiety as well. Having a chronic medical condition (e.g., Cystic fibrosis) could also increase an individual's risk of developing a mental disorder (Mayo

Clinic, 2019). If one is exposed to various environmental stressors or drugs while in the womb this could also be linked to the development of mental illness (Mayo Clinic, 2019).

Another factor that could lead to the development of depression in those with ASD involves lack of social networks and social support. Limited social interactions or little social support can leave an individual, either ASD or TD, vulnerable to depression (Harandi et al., 2017). Pouw et al. explored the relationship between self-reported emotional and social functioning and depression in 63 boys (mean age 11.7) with ASD. The child depression inventory was used to measure the symptoms of depression self-reported by the participants, with the suicide item removed. Individuals with ASD have more symptoms of depression and score higher on victimization (bullying) and negative friendship interactions compared to TD individuals (Pouw et al., 2013). Less severe depression symptoms were related to finding a solution or social support in relation to a stressful event (Pouw et al., 2013). If someone with ASD is used to having negative relationships with peers, then this may lead them to avoid the development of relationships and possibly social interactions altogether. The avoidance of social situations could affect an individual's relationships with others, therefore increasing the likelihood they develop a depression or anxiety disorder.

Research observing the prevalence of a comorbid mood or anxiety disorder within the ASD population has been improving. There are more studies reporting on this specific population but the rate of comorbidities is still fluctuating throughout research. What is consistent in the literature however is that those with ASD experience a comorbid mood or anxiety disorder at a higher rate than the TD population. There is a lack of research on possible factors that may be influential in the development of these comorbidities, or protective factors against these comorbidities. One factor that could affect the development of these mood and

anxiety disorders are the social networks and support an individual may have available to them within their life. This is the focus of the next chapter.

Chapter 3: The use of social networks in individuals with ASD and comorbid mood and anxiety disorders

When discussing protective factors against comorbid mood or anxiety disorders in those with Autism Spectrum Disorder (ASD), we mean conditions or circumstances within an individual's life that may help reduce the effects of stress or trauma (Substance abuse and mental health services administration [SAMSA]). Protective factors can also help reduce the possibility of an individual developing a mental health disorder. Protective factors can be beneficial for everyone, including individuals with ASD. Examples of protective factors for anyone include social support systems, religion, coping skills, or being a caregiver (SAMSA). The general definition used for a social support system within this review is: anyone an individual has interactions or a personal relationship with. By this definition, social media could lead to someone having online networks as well, where they may never meet these people face-to-face. Social networks include friends, family, coworkers, or group members. This chapter will identify the social network characteristics of individuals with ASD and their possible role in the development of comorbid depression or anxiety.

Social motivation and network size

As previously stated, individuals with ASD struggle to form relationships with people due to deficits in social functioning (APA, 2013; Mazurek, 2014). Neuhaus et al. (2019) investigated the emotional and social functioning in 2,079 children and adolescents with an average age of around 10 years with ASD. These participants were chosen from the Simons Simplex Collection (SSC), a collection of behavioral, medical, and genetic data around the US. Social motivation and skill were taken from the SSC data, along with aspects of emotional dysregulation (Neuhaus et al., 2019). An individual’s social motivation and skills are associated

with emotion dysregulation (Neuhaus et al., 2019). Emotion dysregulation refers to the poor ability to maintain typical emotional responses or keeping them within acceptable ranges. The presence of emotional irregularities within an individual with ASD may correspond to less motivation and poorer skills (Neuhaus et al., 2019). If someone is not motivated to interact with others socially then this could lead to few relationships and less social support networks. The possession of social skills does not matter if the individual is not first motivated to interact with other people socially, so the lack of both motivation and skill is an even worse combination. As observed in the TD population, having more social support networks and people you could lean on if need be, can help an individual with their mental disorder (Harandi et al., 2017). This same theory has been applied to ASD, but the present issue is the lack of those networks available to this population specifically.

There are differences in the size of social networks between people with ASD or TD. Asseselt-Goverts et al. (2015) investigated social network characteristics along with satisfaction and wishes in individuals with ASD, Intellectual Disability (ID), or TD. The sample included 33 people with ID, 30 with ASD, and 42 TD people. Individuals with ASD had significantly smaller network members (the people that make up their social network), mean of 11.27 members, compared to TD individuals, mean of 17.86 members on an ecogram (Asselt-Goverts et al., 2015). The report of smaller social networks within those with ASD and compared to a TD group may not be surprising, since those with ASD do not have the same social functioning. The issue is not only the size of these individuals' social networks but also the satisfaction they have with these networks.

Comorbidities and satisfaction of networks

Chang et al. (2012) observed anxiety, specifically social anxiety, effects on the social functioning of 53 children with ASD between the ages of 7-11 years. Maddox and White (2015) reported around 50% of participants with ASD also met the diagnostic criteria for social anxiety disorder (SAD). Lower social functioning predicted by parents was associated with more severe social anxiety in children with both ASD and an anxiety disorder (Chang et al., 2012). Trembath et al. (2012) explored the effects of self-reported anxiety on everyday life for individuals with ASD. The sample included 11 adults with ASD between the ages 18 and 35 (Trembath et al., 2012). Key sources of anxiety identified by participants included social interactions and performance anxiety (Trembath et al., 2012). This sample also identified the symptoms of anxiety they experience including nausea, sweating, frustration, withdrawn, depressed, and fast heartbeats (Trembath et al., 2012). Social situations can oftentimes cause individuals with Autism to have worsened anxiety symptoms (Chang et al., 2012; Trembath et al., 2012). If an individual may be aware of their differences, they could become nervous when they have to interact with others. This is not saying that having social relationships may worsen anxiety symptoms, instead it is overall social situations. This can include school, work, or even general everyday tasks such as going to the store. The presence of social anxiety could stem from the already present limitations in their social functioning (Chang et al., 2012). Some with ASD are aware of their altered social skills and may fixate on these when interacting with others, causing them to worry about future interactions.

When asked to evaluate their relationships individuals with ASD may realize they are unhappy with their current networks (Asselt-Govets et al., 2015). Han et al., (2019) examined the loneliness and depressive symptoms along with social and non-social pleasure. The sample

consisted of 49 adults with ASD, 30 TD adults with a depressive disorder, and 28 TD adults with no history of ASD or depression (Han et al., 2019). Increased Autism symptoms were associated with decreased social and non-social pleasure. Decreased abilities of social pleasure were associated with higher levels of loneliness (Han et al., 2019). Hedley et al. (2019) aimed to observe the relationships between depression, suicidal ideation, and social support in adults with ASD. Seventy six adults with ASD between the ages of 17-56 participated in the study (Hedley et al., 2019). Around 25% of participants reported scores within the clinical range for depression and 20% reported suicidal ideation. Around 37% of the sample reported being diagnosed with depression at some point in their life, and 40% reported anxiety (Hedley et al., 2019). Increased support did not reduce suicidality risks, but it could have a positive effect on depression (Hedley et al, 2019). Mazurek (2014) aimed to observe the associations between loneliness, friendship, and well- being in adults with ASD. Participants included 108 individuals with ASD between the ages of 18-62 (Mazurek, 2014). Feelings of loneliness were correlated with increased depression and anxiety as well as decreased life satisfaction and self-esteem in adults with ASD (Mazurek, 2014). Decreased loneliness was associated with the presence of friendships in this sample Mazurek, 2014). This supports the use of social networks as a possible protective factor for depression and anxiety in adults with ASD. Robertson et al. (2018) conducted an analysis exploring the experiences of anxiety in adults with ASD and the impacts on their daily lives . There were three main themes: contributing and mitigating factors to anxiety, consequences of anxiety, and management of anxiety (Robertson et al., 2018).

The realization of unhappiness could lead to loneliness and possibly depression or anxiety symptoms (Han et al., 2019; Hedley et al., 2019; Mazurek, 2014). When rated, individuals with ASD more often felt neutral or dissatisfied with their social network and are

satisfied less often when compared to a TD group (Asselt-Govets et al., 2015). This shows that both the quality and quantity of social networks and relationships appears to be lower in individuals with ASD as compared to a TD group. Perceptions of having fewer people who support you and being less satisfied with these people may lead to an individual with ASD feeling lonelier than an individual that is satisfied with their social networks. Individuals who report lower levels of social pleasure also report having higher levels of loneliness no matter what their Autism severity is (Han et al., 2019). This means that individuals that may not have any Autism symptoms are also experiencing increased loneliness when they are not satisfied with social networks. Loneliness has also been reported to be a strong predictor for depression, in any individual, so decreasing rates of loneliness could also lead to the possibility of depression being developed to drop (Han et al., 2019). Increasing the amount of social support available to an individual with ASD could lead to decreased levels of loneliness and fewer symptoms of depression and anxiety (Hedley et al., 2019; Mazurek, 2014). Loneliness significantly contributes to decreased life satisfaction and self-esteem and both increased anxiety and depression in ASD (Hedley et al., 2019; Mazurek, 2014; Robertson et al., 2018).

There may be numerous ways to help improve the interactions between individuals with ASD and their social network members. The use of family-based cognitive behaviour therapy resulted in a decrease in parent-reports anxiety in children with ASD (Nadeua et al., 2011). Even though this was an adolescent study, there is still the possibility that increasing family support in this manner could also be effective for adults. An individual's family unit is a small section of their social network and if therapy in this area could help lessen anxiety symptoms that could be a useful tool for prevention of anxiety and possibly depression Since individuals with ASD have fewer members within their social network, working on improving the quality of these

relationships will be crucial (Asselt-Govets et al., 2015). Therapy could be utilized to help improve the quality of certain relationships, for example families (Nadeua et al., 2011). Therapy could also be used to help an individual learn how they may communicate with friends or other members in their social networks that they are not satisfied with their relationship.

Service needs and possible resources

Turcotte et al. (2016) report the service needs of adolescents and adults with ASD, reported by caregivers. This study was conducted using 3,269 caregivers that are Pennsylvania residents, with 32% of the sample residing in rural areas, 20% in urban, and 48% in suburban. Adults with ASD receive significantly less social skills training, and this could help them learn how to improve their current relationships and possibly even create new ones (Turcotte et al., 2016). Layous et al. (2014) reviewed previous research to propose how happiness-increasing strategies may be used as protective factors against mental health disorders. Increased social support is associated with greater well-being and can help decrease risk factors (Layous et al., 2014). When interviewing practitioners that work or worked with adults with ASD and anxiety, continued support during and after therapy were often needed for anxiety management (Ainsworth et al., 2020). Since it is thought that there is a need for support during therapy for the ASD population, the presence of these support systems could be thought of as protection factors to keep someone from developing a comorbid anxiety disorder. The use of social skills training can help individuals with ASD develop more satisfactory relationships that last longer and provide them with increased support, possibly associating with greater well-being (Ainsworth et al., 2020; Layous et al., 2014; Turcotte et al., 2016).

The presence of various resources can be beneficial for individuals with ASD, for example social media. This would provide people with the chance to interact with others in a

safe and controlled environment while also feeling supported. Many individuals with ASD utilize social media for engagement and connection with others (Mazurek, 2014.) When interviewing adults with ASD and anxiety, many discussed fears of social interactions and would use social networking sites to talk with others (Trembath et al., 2012; Robertson et al., 2018). This shows that individuals with ASD still want that social interaction, but the fear of these situations may be a factor that could create or worsen anxiety in face-to-face interactions. Social media provides individuals with the opportunity to create relationships without the burden or fear of interacting in a social situation in person. By having a constant support system that they feel comfortable with, this may work to lessen the anxiety symptoms present or help prevent symptoms developing. We know that individuals with ASD desire an expanded network of social members along with increased contact with these members (Asselt-Goverts et al., 2015). If someone is feeling socially isolated, they may want more opportunities to meet new people and have the opportunity to develop successful relationships (Sosnowy et al., 2019). One could speculate that social media could provide people with the opportunity to join new groups and meet new people without feeling out of their comfort zone. Also, if someone is feeling particularly down one day and does not want to interact with others face-to-face, social media could be used as an alternative. Even though there may be many options, oftentimes when someone with ASD is able to develop relationships, these relationships may still have negative aspects in terms of quality.

Increasing an individual's pleasure in their social relationships may correlate with decreased feelings of loneliness while also decreasing depression and anxiety symptoms. The ladder of socialization starts with the motivation to socialize, then processing social relationships, observing and identifying pleasurable vs. non pleasurable networks, and

understanding social support (Asselt-Govets et al., 2015; Clements et al., 2018; Hedley et al., 2017). Research looking into how differences between the quality of social relationships as well as the quantity may correlate with the amount of depression and anxiety symptoms is currently not known for the ASD population. From the research on social support in a typical population, however, one may predict that increased quality and perhaps quantity of social networks may correlate with less symptoms of comorbid disorders in individuals with ASD.

Chapter 4: The role of rurality in resources for people with ASD

Around 2010, about 19% of the United States population lived in a rural population, a figure which represents almost 60 million people (United States Census Bureau, 2010). The definition of "rural" differs across the literature. Population size and density or economic factors are the most common basis for the definitions of rural used (Smalley & Warren, 2012). The United States Census Bureau (2010) states that any territory, population, or housing that is Anxiety within an urban area is defined as rural. Urban areas may have a population of 50,000 or more, and urban clusters have a population of at least 2,500 and less than 50,000 (United States Census Bureau, 2010). The 2013 US Department of Agriculture's Rural-Urban Continuum Codes categorize counties according to population size and adjacency to a metro area. This chapter will explore the issues with mental health present in rural populations and how a lack of resources may affect individuals with ASD and possibly lead to increased comorbidities. It is important to note that not all of the information presented may be generalizable to all rural areas, and may be more of a concern in some rural areas as compared to other rural areas.

Individuals with ASD that live in rural areas face more difficulties receiving care than their counterparts living in urban areas (Henning-Smith et al., 2018; Smalley & Warren, 2012) . This is because anyone that lives in a rural area faces a triple threat to receiving mental health resources: accessibility (transportation, issues with payment), acceptability (negative stigma), and availability (shortages in professionals) that will affect their rates of entering care (Smalley & Warren, 2012). Increased substance abuse, suicide, and loneliness/isolation may be just three issues that are present within rural populations (Smalley & Warren, 2012). Ziller et al. (2010) investigated the rural-urban differences in the use and out-of-pocket payment of mental health services. The study classified counties as urban, rural but adjacent to an urban county, or rural

and not adjacent. The 2003 and 2004 Medical Expenditure Panel Survey (MEPS) was used to gather information on health insurance, mental health service use and expenditures, and other socioeconomic information from US residents between 18-64 years old (Ziller et al., 2010). The sample within this study consisted of 82% urban residents and 16% rural residents.

The triple threat to mental health in rural areas

The poverty rate within rural communities is higher than that in urban communities (Smalley & Warren, 2012; Ziller et al., 2010). The poverty rates for rural versus urban areas, respectively, for varying race/ethnicities include: White (14% vs. 10%), Black (31.6% vs. 21.6%), Hispanic (13.2% vs. 18.5%) ("Rural Poverty", 2020). This higher poverty rate leads to more individuals being unable to pay for mental health services, leaving them more likely to set their health aside. Another issue is the lack of transportation individuals within rural areas have access to (Henning-Smith et al., 2018; Smalley & Warren, 2012). Since rural communities are spread out across wider areas, their resources for mental health may be distanced from some individuals and public transportation may not reach them (Henning-Smith et al., 2018). Since those living in rural areas have lower socioeconomic status they may not be able to afford multiple cars, or even one car, for individual or family member's use. Lack of ability to purchase a vehicle leaves the need to use public transportation or walking to access services. Individuals within rural areas may also not have anyone to help transport them to access varying services (Herring-Smith et al., 2018). Accessibility also includes an individual not knowing when and where to receive mental health services within their community. Not knowing when and where to receive mental health services ties into health literacy. Individuals within rural areas have less mental health literacy, meaning they may need increased education within the topic of mental health as a whole (El-Amin et al., 2018).

The acceptance of mental health care is lower in rural areas due to increased negative stigma and the lack of anonymity (Henning-Smith et al., 2018; Smalley & Warren, 2012). The lack of mental health literacy described above may correlate to why the amount of stigma towards mental health is increased in rural areas (Smalley & Warren, 2012). Larger amounts of stigma are observed in smaller communities, showing an inverse relationship between stigma and population size (Smalley & Warren, 2012). Individuals in rural communities typically have closer relationships with one another, making anonymity of mental health services more difficult to maintain (Smalley & Warren, 2012). The location of a mental health professionals office may lead to community members easily knowing when someone is seeking services (Smalley & Warren, 2012). The lack of anonymity mixed with increased stigma may lead to rural residents becoming less likely to seek mental health care. The issues present in rural communities are harmful to the entire mental health community, but those with ASD and comorbid disorders could be at an even higher loss.

Mental health resources have limited availability to those that live in rural areas. Rural residents with fair or poor mental health had less than half the odds of receiving any mental health treatment compared to their urban counterparts (Ziller et al., 2010). This could be due to the lack of mental health professionals within these regions (Smalley & Warren, 2012; Ziller et al., 2010). Practitioners in rural areas face decreased salaries, increased chance of ethical dilemmas, and smaller social/cultural resources (Smalley & Warren, 2012). Not only is there a lack in the quantity of professionals, the quality of their training for the needs of rural populations specifically may be limited (Smalley & Warren, 2012). Limited access to mental health services within rural areas leads more individuals to utilize their primary care provider (PCP) for access to medications and other mental health care needs. The use of PCP's as mental

health providers may also lead to more prescription use, where 17% of rural residents used psychotherapeutic medication in comparison to 14% in urban residents (Ziller et al., 2010). There may be a lack of competency within rural mental health providers since they cannot be trained for every aspect of mental health, but they may be the only option for residents within the rural area.

Effects of rurality on ASD

The prevalence of individuals with ASD within urban and rural areas differs within research. Muhammed et al. (2016) reported almost equal rates of ASD within urban and rural areas . Lai et al. (2012) reported higher rates of ASD in urban areas than in rural areas. Since there are fewer professionals within rural areas, this could account for the potentially lower rates of ASD diagnoses. This inconsistency in diagnoses may be higher for individuals that have higher functioning and do not have a co-occuring intellectual disability (Antezana et al., 2017), because symptoms of ASD may be harder to recognize in these two populations. The difficulty in diagnosing in rural areas stems from a lack of awareness and screening for ASD in infants (Antezana et al., 2017). If an individual is not diagnosed, then this may delay treatment and reduce the amount of resources available to them.

Residents of rural areas have higher levels of mental health disorders compared to urban residents, such as depression or anxiety (Smalley & Warren, 2012). Ziller et al. (2010) reported in a sample consisting of 16% of participants living in rural areas, self-reports of fair or poor mental health were 8% for rural residents and 6% urban. An important aspect of this study is that 82% of the participants reported to live in an urban area, and there were still only 6% reporting fair or poor mental health (Ziller et al., 2010). If an individual with ASD is living within a rural population this means that they are even more susceptible to depression or anxiety. The ASD

population is already at a higher risk of developing a comorbid disorder, add in living in a rural area, and this rural ASD population is at an even greater increased risk (Hollocks et al., 2017; van Steensel & Heeman, 2017). The risk of an individual being misdiagnosed or not diagnosed with ASD at all within rural areas is another factor that increases the possibility of an individual developing a comorbid disorder (Antezana et al., 2017). They may feel out of place and or have feelings of an outsider within their community.

Other factors affecting mental health

Previously stated, loneliness is one of the increased issues within rural communities (Smalley & Warren, 2012). Despite having the close connections across residents, there is still a feeling of isolation that many individuals experience (Smalley & Warren, 2012). Loneliness is a risk factor for depression and anxiety, meaning that the increased presence of feelings of loneliness could lead to the development of depression or anxiety symptoms (Han et al., 2019; Mazurek, 2014). Social isolation also leads to increased risks of depression, anxiety, substance abuse, among other disorders (Henning-Smith et al., 2018). One reason an individual may feel lonely in rural areas is because of the increased stigma regarding mental health (Henning-Smith et al., 2018). If an individual does seek mental health services, then they may feel disconnected or isolated from their communities or judged (Smalley & Warren, 2012). These feelings may leave someone with decreased self worth or sense of meaning, since they are not contributing to their community (Henning-Smith et al., , 2018). The issue of transportation within rural communities could be another factor that leaves residents feeling less connected (Henning-Smith et al., 2018).

The use of technology for rural communities may lead to increased feelings of loneliness, due to issues with limitations with internet connection (Henning-Smith et al., 2018). We know

social media can be used to feel connected with others and increase social networks (Mazurek, 2014). Technology could lead to individuals connecting less with people in person (Henning-Smith et al., 2018). When access to others is available to people in the comfort of their home, this could lead them to have diminished interest in face to face interactions. Within rural areas, there may be issues with constant access to the Internet since signals are often lost in less populated areas (Henning-Smith, 2018). This could leave someone feeling disconnected from others and increase their feelings of loneliness. There may also be shifts between generations, where older adults may not use technology as often for social outlets (Henning-Smith, 2018; Reed et al., 2014).

Improvements for rural mental health

Even though there are many difficulties individuals within rural areas face when needing to access mental health care, there are ways to work around them. If a practitioner's office is within a building that has other agencies this will help with anonymity (Smalley & Warren, 2012). The mental health provider could also work with PCPs to provide care at their office, instead of having the client come to a separate office solely for mental health services. Understanding this specific population and learning the specific concerns will help with the availability of adequate care (Smalley & Warren, 2012). The use of tele-health services could be a way to combat numerous concerns with transportation, anonymity, and lack of providers (Reed et al., 2014). When using tele-health services an individual would be able to contact a mental health professional from a different area of the country, unless they have a lack of Internet access. If services were also able to work with local bus companies to improve the access of transportation within the areas this could help provide more people with better access (Henning-Smith et al., 2018). The Mental Health First Aid (MHFA) program helps increase

mental health literacy within these populations and will increase awareness and recognition of mental health in rural areas (El-Amin et al., 2018). This program cannot address the other issues within rural areas regarding mental health, but it can help teach people more about the topic. Some mental health services may also be able to work with community partners on collaboration to increase involvement of the members (Henning-Smith et al., 2018). Programs could also be created across organizations in rural settings to increase the community inclusivity within multiple people (Henning-Smith et al., 2018). These would help lessen social isolation across age groups and possibly decrease feelings of loneliness.

Rural residents have less access to mental health services, decreased health literacy, worsened feelings of self isolation and loneliness compared to urban residents (El-Amin et al., 2018; Henning-Smith et al., 2018; Smalley & Warren, 2012; Ziller et al., 2010). There are multiple limitations within rural communities that are not present in urban areas, but these issues can be addressed by varying organizations. Working together as a community may help bridge the gap between services for residents of rural communities. There are also issues with the rates of diagnoses for ASD within rural communities, due to decreased screening in infancy (Antezana et al., 2017). Since individuals with ASD are more susceptible to worsened mental health and possibly comorbid depression or anxiety disorder, this would leave people with ASD in rural settings even more at risk for developing a comorbid disorder (Hollocks et al., 2017; Smalley & Warren, 2012; van Steensel & Heeman, 2017; Ziller et al., 2010). Overall, residents living within rural areas are more likely to develop mental health disorders and have less access to the necessary care and resources than urban counterparts (Smalley & Warren, 2012; Ziller et al., 2010). The awareness of mental health in rural settings needs to be improved in order to start learning how to help this population and possibly move into prevention strategies.

Chapter 5: Discussion and conclusion

This review aimed to explore the research investigating the relationship between social networks and the presence of comorbid depression and anxiety in individuals with Autism Spectrum Disorder. The questions this review aimed to answer include: Are there neuroanatomical or neurophysiological findings that may help explain the overlap of symptoms in ASD, anxiety, and/or depression? What are the psychological explanations for increased comorbidity in the ASD population? Are social networks beneficial to individuals with ASD and a comorbid disorder? How does rurality affect the resources available for individuals with ASD and a possible comorbidity?

Anxiety and depression are highly prevalent comorbid disorders in individuals with ASD, with rates between 10-52% depending on what source you consult (Buck et al., 2014; Hollocks et al., 2017; Leyfer et al., 2006; Maddox & White, 2015; Wijnhoven et al., 2019). Estimates of around 27% and 23% for participants with ASD who meet diagnostic criteria for anxiety or depression were reported in a recent meta-analysis conducted by Hollocks et al. (2017). Though these rates are around 4 years old, they may be the most accurate report to be used since the analysis included 35 studies. In comparison the rates of anxiety and depression in the TD population range from 1-12% (Chandrasekhar & Sikich, 2015; Hollocks et al., 2017). The ASD population is more susceptible to comorbid disorders than the TD population. This may be because of similarities in neuroanatomy or the affects of ASD symptoms on overall life. The rates of comorbid depression and anxiety may be due to an overshadowing phenomenon where ASD symptoms overlap with symptoms of another disorder, causing altered rates of diagnosis (Hollocks et al., 2017).

When looking at the neuroanatomy of ASD, depression, and anxiety all three have inconsistencies within the literature. However, there are also some similarities within the neuroanatomy of an individual with ASD, depression, or anxiety. Decreases to varying areas of the prefrontal cortex (dorsolateral, dorsomedial, and ventromedial) were present in the brains of an individual with any of the three disorders (Canteras et al., 2009; Etlin, 2009; Grady & Keightley, 2002; Koenigs & Grafman, 2009; Walsh et al., 2019). Another area of the brain that may be affected by ASD and anxiety is the amygdala. There are variations in the size and activity of the amygdala in research on anxiety as well as ASD. Since the amygdala is part of the social cognitive network, it has effects on the social abilities for someone with ASD (Grady & Keightley 2002). This is an important structure within the brain to pay attention to within research. Similarities in the amygdala or prefrontal cortex of those with anxiety, depression, and ASD could help explain why someone with ASD may be more susceptible to developing a comorbid anxiety disorder.

Depression and anxiety may cause worsened ASD symptoms such as increased social withdrawal ritualistic/obsessive behaviors, and aggression or reduced communication (Murray et al., 2019; Magnuson & Constantino, 2011; Sterling et al., 2008). TD individuals may have feelings of worthlessness, sadness, or low self-esteem, whereas in ASD individuals these feelings may not be experienced (Chandrasekhar & Sikich, 2015), indicating that depression may present differently in these two populations. Since depression and anxiety can affect ASD symptoms, understanding an individual's baseline feelings is crucial for diagnosis of a comorbid disorder (Chandrasekhar & Sikich, 2015). Symptoms of depression and anxiety are not always the same in ASD as TD individuals, this is why more accurate diagnostic measures are needed.

The quantity and quality of social networks for individuals with ASD is significantly smaller than that of the TD population (Asselt-Govert et al., 2015). This could be due to the lack of social skills or motivation, as well as the poor ability to maintain typical emotional responses that the ASD population may experience (Neuhaus et al., 2019). The lack of motivation to participate in social interactions could be caused by the presence of anxiety symptoms, with social anxiety disorder reported to be around 50% in participants (Chang et al., 2012; Maddox & White, 2015; Neuhaus et al., 2019; Trembath et al., 2012). Although limited social abilities are a symptom of ASD, there is also little training provided to this population specifically focused on improving social skills (APA, 2013; Neuhaus et al., 2019; Turcotte et al., 2016). Those with ASD also feel dissatisfied with their social networks leading to feelings of unhappiness (Asselt-Govert et al., 2015). Once one realizes they are unhappy this can lead to loneliness, decreased life satisfaction, and eventually depression or anxiety (Han et al., 2019; Hedley et al., 2019; Mazurek, 2014; Robertson et al., 2018). To combat this, programs would need to be created to help individuals with ASD learn how to form these lasting and beneficial social connections. The use of social media could also provide individuals with ASD an opportunity to form these relationships without interacting in an in-person social situation.

Living in a rural area increases an individual's chance to develop a mental disorder (Smalley & Warren, 2012). Issues with receiving care such as reduced transportation, increased negative stigma, fewer professionals, lower health literacy, and increased poverty in rural versus urban areas could play into this increased risk for mental disorders (El-Amin et al., 2018; Henning-Smith et al., 2018; Smalley & Warren, 2012). Though the rates of ASD within rural and urban areas seems to be around the same, the resources for those living in rural areas is far more limited, leaving them to perhaps be even more susceptible to depression or anxiety than their

urban counterparts (Antezana et al., 2017; Lai et al., 2012; Muhammed et al., 2016; Smalley & Warren, 2012). There is a need for future research to investigate the rates of ASD and comorbid rates in rural areas as well as the resources available to these populations. The increased levels of loneliness and isolation in rural areas is another factor that could leave the ASD population more at risk of comorbid mood or anxiety disorders (Smalley & Warren, 2012). The use of social media for individuals in rural areas can be both beneficial and harmful. Social media can be used to feel more connected with others and to increase social networks, but for individuals in rural areas their connections to the Internet can be limited, leaving them feelings more isolated and lonely (Henning-Smith et al., 2018; Mazurek, 2014).

Future studies should look into the use of social media by the ASD population within rural communities to observe how this may be an alternative to in-person interactions. Gaining knowledge on the usage of social media by this specific population could help rural areas understand and create better programs and resources for those with ASD. Since this is a very vulnerable population that is susceptible to the development of a comorbid depression or anxiety disorder, understanding what may increase or decrease symptoms would be beneficial. Understanding how social media may help with feelings of loneliness or possibly worsen these feelings is needed to learn whether social media could represent a protective or risk factor for mental disorders in the ASD population. Research should also look further into the neuroanatomy and neurophysiology of individuals with ASD and comorbid anxiety or depression to compare with the TD population to better understand the differences between these groups. Future research should also focus on determining how to create more accurate and consistent rates of comorbid disorders within the ASD population.

This review has contributed an analysis of the current literature on the relationships between ASD, anxiety, and depression. The study included aspects of social networks and rural life in the ASD population as potential protective or risk factors for comorbidities. To our knowledge, this is the first time this type information has been brought together in a single, cohesive paper. This paper also addresses the needs for future research and the current complications that are present throughout the literature, and where there is a lack of information.

Conclusion

Overall, the research within autism spectrum disorder is limited in many respects (e.g., neuroanatomical research and comorbidity rates) and suffers from many inconsistencies. There are some similarities between the brains of individuals with ASD, depression, and anxiety which could help explain the high rates of comorbidity of these two psychiatric disorders in the ASD population. But much more research is needed in this area to explore possible brain-based explanations for ASD. To help protect individuals with ASD from developing depression or anxiety symptoms, the benefits of large and quality social networks should be further evaluated. The lack of mental health resources and social interactions within rural areas could leave the ASD population even more susceptible to developing a comorbid disorder than their urban counterparts. Research describing the unique challenges faced by rural populations and possible routes for improving access to mental health resources could go a long way to benefiting the ASD population.

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