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Factor Invariance of Anxiety and Depression Measures in Autism

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Abstract

This study examined factorial invariance of three self-report measures of psychiatric symptoms—the World Health Organization Adult ADHD Self-Report Scale (ASRS; Kessler et al., 2005), the Center for Epidemiologic Studies Depression Scale-Revised (CESD-R; Eaton, Smith, Ybarra, Muntaner, & Tien, 2004), and the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995)—using a convenience sample of 434 adults surveyed though Amazon Mechanical Turk. Participants were sorted into two groups based on their score on the Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). Of 423 participants included in the final sample, 203 were included in the *low ASD traits* group and 220 were included in the *high ASD traits* group. Results indicated that the CESD-R did not demonstrate configural invariance, such that the same latent constructs did not emerge across both the *low ASD traits* and *high ASD traits* groups. Further, the CESD-R did not possess the same factor model specifications as previously established in general and clinical adult populations. The DASS-21 demonstrated evidence of scalar invariance, indicating cross-group equality in factor loadings and factor intercepts. The ASRS demonstrated evidence of metric invariance in the current sample, indicating that the established latent factors were represented in the data but that the levels and relations among those factors differed across groups. Findings from this study demonstrate that the DASS-21 and the CESD-R are not fully invariant across those with and without a high level of ASD traits, such that scores on these measures may not be valid when assessing symptoms of depression and anxiety in the ASD population.

Keywords: autism spectrum disorder, factorial invariance, anxiety, depression

FACTOR INVARIANCE OF ANXIETY AND DEPRESSION MEASURES IN AUTISM

by

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Elizabeth P. McKernan

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder marked by deficits in social communication and social interaction, as well as the presence of repeated, restricted patterns of behavior, interests, or activities (American Psychiatric Association, 2013). Impairment in social communication and interaction may include deficits in social-emotional reciprocity, nonverbal communicative behaviors used for social interaction, or understanding and establishing social relationships. As its name implies, ASD is a heterogeneous construct that is thought to exist on a continuum, such that the phenotype can be conceptualized as a set of continuous traits that exist in the general population (Sucksmith, Roth, & Hoekstra, 2011), with people with a diagnosis of ASD scoring at the extreme end of this distribution (Baron-Cohen, 2010). Previous research has indicated that the component traits of the autism spectrum are distributed across the population and potentially have distinct etiologies (Robinson et al., 2016; Bralten et al., 2017).

In 2014, the overall prevalence of ASD was 16.8 per 1,000 (one in 59) children aged 8 years, with males four times more likely than females to be identified with ASD (Autism and Developmental Disabilities Monitoring [ADDM] Network, 2018). ASD prevalence estimates increased from 6.7 to 16.8 per 1,000 children aged 8 years, an increase of approximately 150 percent, from 2000 to 2014 (ADDM Network, 2018). It remains unclear whether this increase is reflective of a true increase in prevalence or increased awareness of ASD and changes in diagnostic practices (Maenner et al., 2014). Regardless of which factors are driving this increase in prevalence, it remains the case that increasing numbers of children will be diagnosed with ASD, and that more individuals with ASD are entering the educational, medical, and community systems than ever before. This increase in the number of individuals entering these systems

warrants research into effective and evidence-based practices in each of these settings. Heretofore, common measures of adult outcome, including educational attainment, employment status, physical and mental health status, and quality of life have been poor for the population of individuals with ASD (Billstedt, Gillberg, & Gillberg, 2011; Farley, Cottle, Bilder, Viskochil, Coon, & McMahon, 2018; Howlin & Moss, 2012; Howlin, 2000). As a result, individuals with ASD may be underestimated, despite their skills and capabilities (Courchesne, Meilleur, Poulin-Lord, Dawson, & Soulieres, 2015).

The Stakeholder Perspective

In 2015, federal and private foundation funding for autism research in the United States exceeded $342 million (Office of Autism Research Coordination, National Institute of Mental Health, on behalf of the Interagency Autism Coordinating Committee, 2017). Recent research has indicated that this funding often does not match the needs and priorities of the autism community itself (Pellicano, Dinsmore, & Charman, 2014). Gotham et al. (2015) used online survey data from a large sample of adults with ASD and their legal guardians to investigate outcomes across a variety of contexts, as well as stakeholders' priorities for future research. Areas of poorest adult outcome were associated with co-occurring physical and mental health conditions, vocational engagement, and low levels of adaptive behavior. In fitting with these outcomes, stakeholders indicated a need for more ASD research focused on life skills, treatments, co-occurring mental and emotional health conditions, and vocational and educational opportunities. Similarly, stakeholders and members of the ASD community based in the United Kingdom identified research focused on effective public services and evidence-based interventions as a priority (Pellicano, Dinsmore, & Charman, 2014).

Co-occurring mental health conditions pose particular concern, given that traditional diagnostic measures have largely not been tested for validity and reliability in ASD populations (Leyfer et al., 2006). In keeping with the aforementioned ASD stakeholder priorities for research, the present study seeks to examine anxiety and depression in ASD, with particular focus on whether these constructs are measured reliably and validly in this population using common self-report instruments originally normed in the general population. Anxiety and depression may be difficult to assess in individuals with ASD, given that their presentation may be atypical or complicated by the social and communicative impairments inherent to autism (Stewart, Barnard, Pearson, Hasan, & O'Brien, 2006). The phenotypic overlap between these conditions and ASD, as well as the tendency for ASD symptomatology to mask anxiety and depression symptoms (Magnuson & Constantino, 2011), makes the psychometric examination of existing self-report measures in individuals with ASD an empirical question of importance.

Comorbidity in ASD

ASD commonly co-occurs with other developmental, neurological, psychiatric, and genetic diagnoses (Gurney, McPheeters, & Davis, 2006; Matson & Nebel-Schwalm, 2007). In a population-based cohort of 2,568 eight-year-old children meeting surveillance case criteria for ASD, the co-occurrence of one or more non-ASD developmental diagnoses was 83 percent, and the co-occurrence of one or more psychiatric diagnoses was 10 percent (Levy et al., 2010). Children with ASD have been found to have significantly higher levels of psychopathology as compared to children with intellectual disability (Brereton, Tonge, & Einfeld, 2006). Still, age and intellectual functioning may be important factors to consider with regard to comorbidity in the population of adults with ASD. In a study of adults with ASD and intellectual disability, Totsika, Felce, Kerr, and Hastings (2010) found that psychiatric disorders were less frequent in

older adults with ASD and those with an intellectual disability compared to younger adults with co-occurring ASD and intellectual disability. Conversely, Roy, Prox-Vagedes, Ohlmeier, and Dillo (2015) found co-occurring psychiatric disorders to be more common in older adults with ASD without intellectual disability as compared to younger adults. On the other hand, a long-term follow-up study of 58 adults with autism found that informant ratings of poor mental health were not associated with child or adult IQ or age (Moss, Howlin, Savage, Bolton, & Rutter, 2015). These inconclusive findings point to the need for further research into potential mediators and moderators of the occurrence of psychiatric comorbidity in this population.

Several studies have found high rates of depression and anxiety in individuals with ASD (Buck et al., 2014; Cassidy et al., 2014; Hofvander et al., 2009; Lugnegard, Hallerback, & Gillberg, 2011), with rates that are greater than that seen in the general population (Croen et al., 2015; Joshi et al., 2013; Wigham, Barton, Parr, & Rodgers, 2017). Estimates taken from systematic reviews suggest that up to 60 percent of adults with ASD meet criteria for an anxiety disorder (Croen et al., 2015; Joshi et al., 2013; Uljarevic et al., 2018), rates which exceed those found in Down syndrome (Evans, Canavera, Klinepeter, Taga, & Maccubbin, 2005), specific language impairment (Gillott, Furniss, & Walter, 2001), and Williams syndrome (Rodgers, Riby, Janes, Connolly, & McConachie, 2012). Similarly, rates of depression in adults with ASD have been estimated to be as high as 50 to 70 percent (Lugnegard, Hallerback, & Gillberg, 2011; Wigham et al., 2017). A recent meta-analysis of the prevalence of depressive disorders in children, adolescents, and adults with ASD by Hudson, Hall, and Harkness (2018) found that the pooled lifetime prevalence rate was 14.4 percent and the pooled current prevalence rate was 12.3 percent. Further, results indicated that individuals with ASD are four times more likely to experience depression in their lifetime compared to typically developing individuals (Hudson,

Hall, & Harkness, 2018). Overall, the extant literature demonstrates that a majority of adults with ASD meet diagnostic criteria for at least one psychiatric condition, with anxiety and depression being the most commonly co-occurring psychiatric disorders in adults with ASD after attention-deficit/hyperactivity disorder (Lever & Geurts, 2016).

Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder defined by age-inappropriate inattention, impulsivity, and hyperactivity (American Psychiatric Association, 2013). For a diagnosis of ADHD to be made, significant symptoms must have onset prior to age 12, be currently manifested in two or more settings, and reduce the individual's functioning. Alternative explanations for ADHD symptoms, including the presence of anxiety or mood disorders, must be excluded for the diagnosis to be given (Adler, Faraone, Sarocco, Atkins, & Khachatryan, 2019). Importantly, between 25 and 35 percent of children with ADHD are also likely to meet criteria for major depression or an anxiety disorder (Biederman et al., 2008; Carlson, Tamm, & Gaub, 1997; Pliszka, 2007). Adult ADHD is one of the most commonly occurring disorders in the general population, with an estimated point prevalence of 4.4 percent, and is highly comorbid with other psychiatric disorders (Kessler et al., 2005).

ADHD and ASD show a high degree of comorbidity, with 22 to 83 percent of children with ASD having symptoms that satisfy criteria for ADHD (Ronald et al., 2008; Matson et al., 2013), and an estimated 30 to 65 percent of children with ADHD having clinically significant symptoms of ASD (Clark et al., 1999; Ronald et al., 2008). Despite this high comorbidity, previous studies have indicated that children with ASD can be distinguished from children with ADHD based upon symptom profiles (Luteijn et al., 2000; Hattori, Ogino, Abiru, Nakano, Oka, & Ohtsuka, 2006; Mayes, Calhoun, Mayes, & Molitoris, 2012), with meaningful behavioral

differences between groups in terms of nonverbal communication, sensory interests, repetitive movements, and preoccupations.

Comorbidity of Depression and Anxiety

Depression and anxiety are known to be highly co-occurring conditions in the general population (Mineka et al., 1998; Moffit et al., 2007). Moreover, research has consistently found high correlations between depression and anxiety when measured on a continuum (Cannon & Weems, 2006; Morgan, Wiederman, & Magnus, 1998). Subsequently, some have suggested that the two may be merely differing expressions of the same underlying phenomenology (Burns & Eidelson, 1998; Feldman, 1993). Specifically, it has been posited that depression and anxiety may share the same diathesis (Barlow & Campbell, 2000; Clark & Watson, 1991). Notwithstanding these high correlations, depression and anxiety can be reliably distinguished from one another, with unique diagnostic aspects for each disorder (Beesdo, Pine, Lieb, & Wittchen, 2010). For instance, the tripartite model, a common theory that seeks to explain the common factors underlying anxiety and depression (Clark & Watson, 1991), posits that both anxiety and depression share elements related to negative affect; however, anhedonia is unique to depression, whereas physiologic arousal is unique to anxiety. Therefore, although both share elements of internalizing behavior, depression and anxiety can be measured as unique constructs.

Anxiety

Anxiety disorders are the most common mental health diagnosis in the United States, affecting nearly one in five American adults age 18 and older (US Department of Health and Human Services, 2016). Based on diagnostic interview data from the National Comorbidity Study Replication (NCS-R), an estimated 19.1 percent of adults in the United States had any anxiety disorder in the past year, and 31.1 percent experience any anxiety disorder at some point

in their lives (Harvard Medical School, 2007). Anxiety disorders are characterized by features of excessive anxiety and related behavioral disturbances, which cause clinically significant distress in social, academic, occupational, or other areas of functioning (American Psychiatric Association, 2013). High prevalence of anxiety disorders has been linked to low levels of education, low income, and unemployment (Michael, Zetsche, & Margraf, 2007). Anxiety also has a considerable impact on society in terms of decreased work productivity and increased health care utilization (Wittchen, 2002). The annual cost of anxiety disorders was estimated at $42 to $47 billion in the United States in 1990 (Greenberg et al., 1999; Rice & Miller, 1998). Consequently, anxiety disorders can have a measurable impact, both in a personal and in a societal sense.

Depression

The World Health Organization has recognized depression as the leading cause of disability worldwide, ranking as the single largest contributor to non-fatal health loss (World Health Organization [WHO], 2017). The 2016 National Survey on Drug Use and Health (NSDUH; Center for Behavioral Health Statistics and Quality, 2017) indicated that an estimated 16.2 million adults in the United States had at least one major depressive episode, representing 6.7 percent of all adults in the United States. Depressive disorders are characterized by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, and poor concentration (American Psychiatric Association, 2013). Depression can be long lasting or recurrent, and thus can substantially impair an individual's ability to function in daily life (WHO, 2017). Depression is associated with higher rates of chronic disease and increased health care utilization (Katon, 2003; Wells et al., 1989). Most individuals with major depressive disorder report some sort of role impairment associated with their depression, including impairment in

home, work, relationship, and social domains (Kessler et al., 2003). Depression may have an adverse effect on health habits such as smoking, diet, overeating, and having a sedentary lifestyle, thus contributing to the incidence of additional medical conditions (Goodman & Whittaker, 2002; Rosal et al., 2001). Indeed, evidence suggests that both depressive symptoms and major depression may be associated with increased morbidity and mortality from illnesses such as diabetes and heart disease (Katon, 2003).

Depression is also one of the largest contributors to suicide (Arsenault-Lapierre, Kim, & Turecki, 2004; Bradvik, Mattisson, Bogren, & Nettelbladt, 2010; Lonnqvist, 2000). Suicide was the tenth leading cause of death overall in the United States in 2016, claiming the lives of nearly 45,000 people (National Center for Injury Prevention and Control, 2016). Given the high burden of disease inherent to depression, the US Preventive Services Task Force has recommended screening for depression in the general adult population, given that systems are in place to ensure accurate diagnosis, treatment, and follow-up (Siu et al., 2016). As follows from these recommendations, it is imperative that these systems are effective and available; however, the extant literature indicates that substantial gaps persist in the treatment of depression, with a majority of United States adults who screened positive for depression not having received treatment (Olfson, Blanco, & Marcus, 2016).

Anxiety and Depression in ASD

Several symptoms of ASD may share features with symptoms of depression and anxiety disorders. For instance, social avoidance and withdrawal, commonly seen in individuals with anxiety, may also be an expression of the social communication impairments that are common to ASD (Uljarevic et al., 2018). Similarly, common symptoms of depression, such as reduced eye contact and decreased communication of affect through facial expression or intonation, may be

masked by existing symptoms of ASD (Stewart, Barnard, Pearson, Hasan, & O'Brien, 2006). It is also possible that the converse is true, in that social affect-related symptoms of depression may mask underlying symptoms of ASD, though this hypothesis remains untested. These similarities in clinical presentation may make anxiety and depression more difficult to detect in this population. Ghaziuddin, Ghaziuddin, and Greden (2002) point out that diagnosing depression can be particularly difficult in individuals with severe cognitive or communication impairments, given that the diagnosis of depression often relies on the ability to recognize one's own emotional state and to verbally express that emotional state. Recognition and expression of one's emotional state poses challenges for many individuals with autism, some of whom may have difficulty inferring the mental or emotional states of others or even themselves (Baron-Cohen, 1991; Mazefsky & Oswald, 2007). Because assessment of anxiety and depression is often reliant on self-report, this may present additional complications in those with limited insight or verbal aptitude. In such cases, attention to behavioral changes or informant reports may be helpful. For instance, increased aggression, self-injurious behavior, and irritability, as well as decreased self-care, sleep difficulties, or weight changes have been noted in the onset of depression in individuals with ASD (Magnuson & Constantino, 2011). Similarly, an increase in repetitive or compulsive behaviors or reactions to sensory stimuli may be associated with anxiety disorders in those with ASD (Rodgers et al., 2016). Nonetheless, it remains largely unknown to what extent these behaviors are a direct result of the underlying mood or anxiety disorder.

On the other hand, symptoms of ASD may contribute to the incidence of depression and anxiety. For instance, the social difficulties inherent to ASD may result in elevated loneliness and social isolation (Bauminger & Kasari, 2000; White & Roberson-Nay, 2009), both of which have been shown to predict depression among typically developing adults (Cacioppo, Hughes,

Waite, Hawkley, & Thisted, 2006). This relationship is not specific to typical development, as other research has supported the link between negative affect and the poor quality of social relationships in ASD (Whitehouse, Durkin, Jaquet, & Ziatas, 2009). Similarly, it is possible that associated characteristics of ASD, such as social skill deficits or sensory sensitivities, contribute or predispose to anxiety in this population (Bejerot, Eriksson, & Mortberg, 2014; Ben-Sasson et al., 2008; Farrugia & Hudson, 2006). Indeed, in his original description of autism, Leo Kanner (1943) hypothesized that the restricted and repetitive behavior of the children could be driven by anxiety. Others have suggested that ASD may increase vulnerability to anxiety as a result of the increased life stressors experienced by those with ASD (Gillott & Standen, 2007), as well as difficulties regulating emotion and arousal that are common in this population (Bellini, 2006). Importantly, however, it remains unknown to what extent anxiety results from ASD symptomatology, accompanies it, or arises from an alternate pathway (Kerns & Kendall, 2012).

Kerns et al. (2014) assessed traditional and atypical presentations of anxiety in youth with ASD. With regard to atypical anxiety, individuals with ASD may exhibit anxiety that is associated with the characteristic features of ASD, such as excessive worry about circumscribed topics, including changes in schedule or the environment, or fears focused on perseverative or restricted behaviors, such as keeping sleeves rolled down or eating food of only one color (Kerns et al., 2014). Traditional anxiety disorders were found in 17 percent of their sample, whereas atypical anxiety was found in 15 percent of the sample; 31 percent of the sample presented with both traditional and atypical anxiety. The authors' findings confirm the idea that anxiety is a true comorbidity among individuals with ASD, in that many co-occurring anxiety symptoms appeared to be distinct from associated features of ASD such as compulsions and social avoidance, thus providing support for the idea that some of these symptoms may reflect a distinct

manifestation of anxiety in ASD. However, Kerns et al. (2014) note that a definitive answer regarding the co-occurrence of anxiety and ASD is not possible, as there is a lack of validated diagnostic instruments with which to make these conclusions.

Validity and Reliability of Measurement Instruments

Research on the validity and reliability of standardized measures of anxiety and depression within the ASD population is limited, with few studies undertaking analyses of these constructs in a non-neurotypical sample. One cannot assume to measure a phenomenon of interest in a particular group accurately if measures have not been normed using members of that group, as this may pose a threat to validity and thus hinder the utility of that assessment (Hays & Wood, 2017).

Validity refers to the degree to which an instrument measures the construct it purports to measure (Mokkink et al., 2010b). Validity can be further delineated into content validity, construct validity, and criterion validity. Content validity refers to the degree to which the items of the instrument adequately reflect the construct to be measured (Scholtes, Terwee, & Poolman, 2011). Construct validity estimates the degree to which scores on an instrument are consistent with hypotheses, such as those regarding the relationships to other instruments of similar constructs (convergent validity) or instruments of dissimilar constructs (discriminant validity), as well as differences between relevant groups (Mokkink et al., 2010b). Finally, criterion validity refers to the strength of the relationship between measures intended to predict an ultimate criterion of interest and the criterion measure itself (Salkind, 2010). Relatedly, reliability can be defined as the degree to which an instrument is free from measurement error, or the consistency of scores from one assessment to another (Scholtes, Terwee, & Poolman, 2011). In this manner, reliability is a necessary, although not sufficient, component of validity, in that an instrument

that does not yield reliable scores cannot yield valid interpretations (Cook & Beckman, 2006). Internal consistency is a specific type of reliability, which assesses the degree of interrelatedness amongst individual items (Mokkink et al., 2010b). Subsequently, internal consistency assumes that items are part of one underlying construct (Scholtes, Terwee, & Poolman, 2011). In other words, internal consistency can be defined as the extent to which all the items of an instrument measure the same construct (Tang, Cui, & Babkeno, 2014).

Measurement of Anxiety and Depression in Individuals with ASD

There is a need to examine whether and to what degree common measures of anxiety and depression are able to assess these same constructs in individuals with ASD, in order to establish the reliability and validity of these measures in the ASD population. Several studies have examined the psychometric properties of such measures in children with ASD, with relatively fewer studies examining these constructs in adults with ASD.

Sterling et al. (2015) examined the Revised Children's Anxiety and Depression Scale (RCDAS; Chorpita et al., 2005) in a sample of 67 youth with autism spectrum disorders ranging in age from 11 to 15 years who also met criteria for an anxiety disorder. In addition to the RCDAS, other standardized measures of anxiety and depression, including the Anxiety Disorders Interview Schedule (ADIS-IV-C/P; Silverman & Albano, 1996), Child Behavior Checklist (CBCL; Achenbach, 2001), Multidimensional Anxiety Scale for Children—Parent (MASC-P; March, 1997), and the Pediatric Anxiety Rating Scale (PARS; Research Units on Pediatric Psychopharmacology Anxiety Study Group, 2002), were examined. Internal consistency of the RCADS was acceptable, with Cronbach's alpha ranging from .72 to .93. To measure concurrent validity of the RCADS Total Anxiety and Total Internalizing scores, correlations were conducted with total scores on the ADIS, CBCL, MASC-P, and the PARS.

Total scores on the RCADS correlated with PARS total scores and with the CBCL Anxiety/Depression scale, indicating that the RCADS could potentially be a useful tool for self-report of anxiety and depression among youth with ASD. To examine divergent validity, correlations were examined between RCADS Total scores and subscales of the CBCL and the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2002) that were not expected to be related. None of the relationships was significant, with the exception of the Attention Problems subscale of the CBCL, which had significant correlations with both the RCADS Total Anxiety and Total Internalizing scores, which the authors posit may be a result of the role of attention in regulating emotional impulses. Overall, results of Sterling et al. (2015) indicate that the RCADS may be useful in detecting depression and anxiety in youth with ASD; however, more convincing evidence, such as that produced by factor analysis, is needed.

A small body of literature has examined the invariance of self-report measures in individuals with ASD using factor analytic methods. Factorial invariance refers to the consistency of a factor model across different groups (Dimitrov, 2010). Establishing factorial invariance involves a hierarchy of nested levels that include tests of configural, metric (weak factorial invariance), scalar (strong factorial invariance), and strict factorial invariance (Meredith & Teresi, 2006). Configural invariance tests whether the pattern of free and fixed model parameters is the same across groups (Dimitrov, 2010). At the level of metric invariance, equal factor loadings are required across groups (Dimitrov, 2010). Scalar invariance tests whether there are equal item intercepts across groups (Dimitrov, 2010). Finally, strict factorial invariance establishes that equal item error variances and covariances exist across groups, such that group differences on any item are due only to differences on the common factors (Dimitrov, 2010).

White et al. (2015) examined the factor equivalence of anxiety as measured by the Multidimensional Anxiety Scale for Children (MASC; March, 1997) in youth with ASD and co-occurring anxiety disorders and a gender-matched comparison group of typically developing children with anxiety disorders. The authors examined both the parent report (MASC-P) and the child self-report (MASC-C) versions for factor invariance. White et al. (2015) hypothesized that the MASC-P would demonstrate metric invariance but that the MASC-C data would not. Confirmatory factor analysis using structural equation modeling was conducted on the MASC-P and the MASC-C in the combined sample to ensure sufficient fit to test invariance. Evidence was found for metric invariance of the MASC-C across the two groups, suggesting that the original factor structure was replicable in both groups at a broad level, with the same latent factors emerging. However, scalar invariance was not supported across the two groups, indicating that the factors do not relate to each other in the same way as they do in typically developing youth. White et al. (2015) concluded that the MASC-C may not be an appropriate tool for assessment of anxiety in youth with ASD and cautioned against its use with such populations.

Uljarevic et al. (2018) examined the psychometric properties of the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) in a sample of 151 adolescents and young adults with ASD. The HADS is a norm-referenced questionnaire used to assess anxiety and depression in community and non-psychiatric populations. Uljarevic and colleagues examined the HADS for latent components using principal components analysis with direct oblimin rotation. Two factors—interpretable as Anxiety and Depression—emerged, accounting for 43.77 percent of variance. All items loaded in the same way as originally designed by Zigmond and Snaith (1983). Internal consistency was good for the HADS-Anxiety scale (alpha = .83) and acceptable (alpha = .65) for the HADS-Depression scale. The authors also examined convergent

validity by comparing the HADS to the Strengths and Difficulties Questionnaire (Goodman, Meltzer, & Bailey, 1998), the Warwick-Edinburgh Mental Well-being Scale (Clarke et al., 2011), the DSM-5 Dimensional Anxiety Scales (LeBeau et al., 2012), and the Patient Health Questionnaire-9 (PHQ-9; Kroenke & Spitzer, 2002). There were medium to large negative associations between the HADS-Anxiety and HADS-Depression scales with the Warwick-Edinburgh Mental Well-being Scale (r = -.45 and r = -.60, respectively), as well as medium to large positive correlations between the HADS-Anxiety and HADS-Depression scales and the emotional scale of the Strengths and Difficulties Questionnaire (r = .80 and r = .29. respectively). Additionally, there was a large positive correlation between the HADS-Anxiety scale and the DSM-5-Dimensional Anxiety Scale (r = .71) and a medium correlation between the HADS-Depression scale and the PHQ-9 (r = .56). Divergent validity of the HADS was also acceptable, as demonstrated by non-significant correlations with chronological age and ASD severity as measured by the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005) and the abridged Autism-Spectrum Quotient (AQ-Short; Hoekstra et al., 2011). Taken together, the results of Uljarevic et al. (2018) suggest that the HADS provides a reliable and valid assessment of anxiety and depression in older adolescents and adults with ASD.

Gotham, Unruh, and Lord (2015) examined response patterns and associations between scores on common measures of depressive symptoms in a sample of 50 verbally fluent adolescents and adults with ASD, ranging from age 16 to 31 years. Participants completed the BDI-II (Beck, Steer, & Brown, 1996), a self-report questionnaire that measures emotions related to depression, somatic symptoms, and lifestyle changes; the Self-Report Depression Questionnaire (SRDQ; Reynolds & Baker, 1988), a questionnaire designed to measure physical, cognitive, and behavioral aspects of depression in adults with mild to moderate intellectual

disability; and the Adult Self-Report (ASR; Achenbach & Rescorla, 2003), a measure that assesses a variety of symptoms, which contribute to Internalizing and Externalizing scales. Parents of participants completed the Children's Depression Rating Scale (CDRS; Poznanski & Mokros, 1996), the CDI—Parent-Rated Version (CDI-P; Kovacs, 1992), and the Adult Behavior Checklist (ABCL; Achenbach & Rescorla, 2003). Scores on the various depression measures were not associated with chronological age or verbal IQ, which ranged from 72-140 in their sample. Internal consistency was acceptable to strong for the BDI-II (alpha = .97), CDI-P (alpha = .73), and the CDRS (alpha = .85). The authors indicated that their results provide support for the use of self-report measures for depression within verbally fluent individuals with ASD.

Cassidy, Bradley, Bowen, Wigham, and Rodgers (2018) undertook a systematic review of the literature surrounding tools used to assess depression in adults with and without ASD. The authors first searched the literature for all available studies that utilized a tool to assess depression frequently (at least twice) with evidence of validity in adults with ASD without intellectual disability and adults from the general population without co-morbid conditions. Six tools were identified based on the above criteria and were considered further: the Hamilton Rating Scale for Depression (HRSD; Hamilton, 1960); Montgomery Asberg Depression Rating Scale (MADRS; Montgomery & Asberg, 1979); Beck Depression Inventory-Second Edition (BDI-II; Beck, Steer, & Brown, 1996); Center for Epidemiological Studies Depression Scale-Revised (CESD-R; Eaton, Smith, Ybarra, Muntaner, & Tien, 2004); Patient Health Questionnaire (PHQ-9; Kroenke & Spitzer, 2002); and the Zung Self Rating Depression Scale (ZDS; Zung, 1965). In comparison to the general population, there were few studies that used validated tools to assess depression in adults with ASD, and none that used a tool validated specifically for ASD.

Cassidy et al. (2018) used The Consensus Based Standards for the Selection of Health Measurement Instruments (COSMIN; Mokkink et al., 2010a), a checklist that assesses the evidence for the appropriateness and measurement properties of an instrument. COSMIN rates the evidence in support of nine measurement properties (internal consistency; reliability; measurement error; content validity; structural validity; hypothesis testing; criterion validity; responsiveness to change; and cross-cultural validity) on a 4-point scale. The BDI-II and the PHQ-9 were identified as having robust evidence for a range of these properties in general population adults; only one study explored the psychometric properties of a validated depression tool (BDI-II) in adults with ASD (Gotham, Unruh, & Lord, 2015), finding it to possess strong internal reliability in a sample of adolescents and adults with ASD. Cassidy et al. (2018) highlight the need for future research studies to explore the validity of depression measures in adults with ASD to ensure that items relate to the relevant construct to be measured.

Goals of the Study

The present study seeks to determine whether the psychometric properties and factor structure of two self-report measures of internalizing symptoms—the Depression Anxiety Stress Scales-21 (DASS-21; Lovibond & Lovibond, 1995) and the Center for Epidemiologic Studies Depression Scale, Revised (CESD-R; Eaton et al., 2004)—are equivalent in adults with high and low levels of autistic traits. Previous research has indicated that the autism spectrum is a heterogeneous construct, with its component traits distributed across the population (Rai et al., 2018); therefore, these traits can be measured on a continuum and used to categorize individuals into groups. The CESD-R is one of the most widely used instruments in the field of psychiatric epidemiology, particularly with regard to depression research (Eaton & Kessler, 1981; Murphy, 2002). It possesses excellent psychometric properties within the general population (Van Dam &

Earleywine, 2011), but has never been investigated in the population of adults with autism. Like the CESD-R, the DASS measures depression, but it also examines the constructs of anxiety and stress, providing a broader assessment of internalizing symptoms. Nah, Brewer, Young, and Flower (2018) used the DASS as a screening measure for anxiety and depression in a sample of 155 adults with autism; however, its psychometric properties were not examined in this sample nor in previous research. In addition, the World Health Organization (WHO) Adult ADHD Self-Report Scale (ASRS; Kessler et al., 2005) will be examined as a measure of divergent validity. As the ASRS, CESD-R, and DASS are all self-report instruments, they use respondents' own perceptions as the source of data. In addition, because the ASRS, CESD-R, and DASS are in the public domain, they can be completed quickly and do not pose a significant cost to users. Consequently, the current study will investigate the factorial invariance of these measures in a large sample of adults.

Factorial Invariance

Measurement invariance refers to "whether or not, under different conditions of observing and studying phenomena, measurement operations yield measures of the same attribute" (Horn & McArdle, 1992, p. 117). Measurement invariance is a prerequisite to establishing factorial invariance (Ollendick & White, 2012). Relatedly, factorial invariance refers to whether the same construct is being measured across groups or across time. One can consider factorial invariance to have four levels, each of which adds additional constraints to the preceding level: configural invariance, metric (weak factorial) invariance, scalar (strong factorial) invariance, and strict factorial invariance (Meredith, 1993). Configural invariance refers to whether the same factor model specification holds across groups; metric invariance requires cross-group equality in factor loadings; scalar invariance requires cross-group equality

in factor loadings and intercepts; and strict factorial invariance requires cross-group equality in factor loadings, intercepts, and residual variances (Wu, Li, & Zumbo, 2007). In this manner, configural invariance assesses whether there are similar latent factors across groups, whereas strict factorial invariance assesses whether there is an identical item structure in both groups (White et al., 2015).

Study Hypotheses

The current study examines the factorial invariance of the ASRS (Kessler et al., 2005), CESD-R (Eaton et al., 2004) and DASS-21 (Lovibond & Lovibond, 1995) across two groups of adults: those with a) high levels and b) low levels of autistic traits, as measured by the Autism Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), a well validated self-report instrument which quantifies autistic traits in adults. It is hypothesized that neither the CESD-R nor the DASS-21 will demonstrate metric invariance across groups. Metric invariance suggests that the same latent constructs are being measured across groups, with any differences in covariances of observed items able to be attributed to latent factors (White et al., 2015). The hypothesis that metric invariance will not hold for the DASS-21 and the CESD-R follows from the idea that traditional measures of anxiety and depression may not capture the presentation of these constructs in individuals with ASD, whether this is due to diagnostic overshadowing, difficulty interpreting and reporting emotions, or another pathway (Cassidy et al., 2018; Mazzone, Ruta, & Reale, 2012).

In the group of adults with high levels of autistic traits, it is hypothesized that data from the CESD-R and the DASS-21 will not possess the same factor model specifications as established in general (Eaton, Smith, Ybarra, Muntaner, & Tien, 2004; Lovibond & Lovibond, 1995; Van Dam & Earleywine, 2011) and clinical (Antony, Bieling, Cox, Enns, & Swinson,

1998; Brown, Chorpita, Korotitsch, & Barlow, 1997) adult populations. In addition, it is hypothesized that convergent validity will be demonstrated between the CESD-R and the Depression scale of the DASS-21, as evidenced by significant correlation coefficients.

Third, it is hypothesized that ADHD symptoms as measured by the ASRS will be divergent from depression and anxiety symptoms, as measured by the CESD-R and the DASS-21, given the different constructs assessed within the ASRS (i.e., inattention and hyperactivity-impulsivity) as opposed to the other two self-report measures.

Finally, it is hypothesized that anxiety will be divergent from depression both within and between self-report measures among the group of adults with low levels of autistic traits, but not within the group of adults with high autistic traits, given the potential for greater diagnostic overshadowing within ASD populations.

Method

Participants

Approval from the Institutional Review Board of Syracuse University was attained before commencement of the study. Electronic informed consent was obtained from all study participants. Participants were required to enter the date on which they completed the survey to formalize their agreement to participate in the study. This was a convenience sample of participants who responded to a survey posted on Amazon Mechanical Turk, an online labor market. All participants were recruited through Human Intelligence Tasks ("HITs") posted on Amazon Mechanical Turk titled "Answer a survey about your mood, emotions, and behavior." The description of the survey was listed as "Answer questions designed to understand how people think, feel, and behave in everyday life." Accompanying keywords were "survey," "research," and "psychology."

Participants were adults located within the United States who were of at least 18 years of age. Individuals located outside the United States were restricted from participation given that study measures were normed using data collected within the United States, and all study materials were in English. Additionally, the constructs of depression and anxiety might differ cross-culturally, in a way that may not be captured adequately by the CESD-R and the DASS-21 (Byrne & Campbell, 1999; Byrne & van de Vijver, 2010; Chen, 2008). In addition to completion of the psychological measures, participants completed questions about demographic information including age, gender, and race/ethnicity.

Measures

World Health Organization Adult ADHD Self-Report Scale

The World Health Organization (WHO) Adult ADHD Self-Report Scale (ASRS; Kessler et al., 2005) is a self-report screening scale of adult attention-deficit/hyperactivity disorder that was developed in conjunction with the revision of the WHO Composite International Diagnostic Interview. The ASRS consists of 18 questions regarding the frequency of *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV-TR;* American Psychiatric Association, 2000) symptoms of ADHD. Respondents are asked to use a 5-item Likert scale to indicate the frequency of occurrence of symptoms over the last six months, with answer categories of "never," "rarely," "sometimes," "often," and "very often." The ASRS consists of two subscales, Inattention and Hyperactivity-Impulsivity, each consisting of 9 items. The total sum of the ASRS ranges from 0 to 72.

The ASRS has demonstrated good reliability and validity in both clinical and population samples (Adler et al., 2006; Silverstein et al., 2018; van de Glind et al., 2013; Vildalen et al., 2016). In previous studies, the ASRS has been shown to have moderate sensitivity, high

specificity, and high total classification accuracy, with values of .56, .98, and .96, respectively (Kessler et al., 2005).

In the normative sample, the ASRS possessed good internal consistency, with a Cronbach's alpha value of 0.88 in a sample of 60 adults evaluated for ADHD. In an independent analysis, Vildalen et al. (2019) reported Cronbach's alpha values of .93 for inattention and .91 for hyperactivity/impulsivity, with almost identical values for females (.93 and .91) and males (.92 and .91), in a sample of 1,564 adult participants. In addition, ASRS scores have been shown to be stable cross-culturally with Hungarian (Farcas et al., 2018), Israeli (Zohar & Konfortes, 2010), Korean (Kim, Lee, & Joung, 2013), and Taiwanese (Yeh et al., 2008) samples.

Autism-Spectrum Quotient

The Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) is a self-administered questionnaire that assesses the degree to which an individual without intellectual disability possesses traits associated with the autism spectrum. The AQ consists of 50 items assessing personal preferences and habits, divided into five subscales of 10 items each: social skill; communication; imagination; attention to detail; and attention switching. Individuals are asked to rate to what extent they agree or disagree with the statements (e.g., "I notice patterns in things all the time"; "I find social situations easy") on a 4-point Likert scale, with answer categories of "definitely agree," "slightly agree," "slightly disagree," and "definitely disagree." Approximately half of items are worded to produce an 'agree' response, and half a 'disagree' response, in order to avoid response bias. Each item is scored one point if the respondent endorses the behavior associated with ASD (i.e., poor social skill, poor communication skill, poor imagination, exceptional attention to detail, poor attention-switching/strong focus of attention).

The AQ has demonstrated utility in distinguishing individuals who have clinically significant levels of autistic traits, and AQ sum scores are normally distributed in the general population (Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007). An AQ total score of 32 is the recommended cutoff for use in the general population, as 79.3 percent of a group of adults with Asperger syndrome or high-functioning autism scored at this level compared to 2 percent of controls (Baron-Cohen et al., 2001). Although not a diagnostic instrument, the AQ has demonstrated diagnostic validity, with good discriminative validity and screening properties using a threshold score of 26 (Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005).

With regard to internal consistency, Cronbach's alpha coefficients were moderate to acceptable for all domains (Communication = .65; Social skill = .77; Imagination = .65; Attention to detail = .63; Attention switching =.67). In an independent analysis, Austin (2005) reported similar findings (Communication = .61; Social skill = .75; Imagination = .65; Attention to detail = .66; Attention switching = .58), as well as a coefficient alpha of .82 for the total AQ score. Test-retest coefficients were $r = .7$ in a sample of 17 university students who completed a second AQ two weeks after a first administration (Baron-Cohen et al., 2001). In addition, AQ scores have been shown to be stable cross-culturally with Japanese (Kurita, Koyama, & Osada, 2005; Wakabayashi, Baron-Cohen, Wheelwright, & Tojo, 2006) and Dutch samples (Hoekstra, Bartels, Cath, & Boomsma, 2008).

Center for Epidemiologic Studies Depression Scale-Revised

The Center for Epidemiologic Studies Depression Scale-Revised (CESD-R; Eaton, Smith, Ybarra, Muntaner, & Tien, 2004) is a self-report scale used to assess symptoms of depression in the general population. The CESD-R is an updated version of the Center for

Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), which was originally composed of four factors: depressed affect, absence of positive affect, somatic activity/inactivity, and interpersonal difficulties. The CES-D was revised to reflect the primary symptoms of a major depressive episode according to criteria from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV-TR;* American Psychiatric Association, 2000). In comparison to the CES-D, the CESD-R includes an extra response category (nearly every day for two weeks), as well as additional items reflecting anhedonia, psychomotor retardation/agitation, and suicidal ideation. The CESD-R consists of 20 items, which correspond to the nine cardinal symptoms of major depressive disorder as conceptualized by the *DSM*: sadness (dysphoria); loss of interest (anhedonia); appetite; sleep; thinking/concentration; guilt (worthlessness); tired (fatigue); movement (agitation); and suicidal ideation. Respondents are asked to select how often they have felt this way during the past week, with five response options: "not at all or less than 1 day"; "1-2 days"; "3-4 days"; "5-7 days"; or "nearly every day for 2 weeks." The total CESD-R score is calculated as the sum of responses to all 20 questions. Total CESD-R scores range between zero (for those who respond "not at all or less than 1 day" to all questions) and 60 (for those who respond "5-7 days" or "nearly every day for 2 weeks" to all questions). Scores greater than or equal to 16 indicate that the respondent is at risk for clinical depression (Radloff, 1977).

The CESD-R has been validated in several samples (Eaton et al., 2004; Van Dam & Earleywine, 2011). The CESD-R possessed excellent internal consistency across these studies, with alpha ranging from .90 to .93. Item-total correlations ranged from .32 to .75 in a sample of nurse assistants (Eaton et al., 2004). The overall correlation between the original CESD and the CESD-R in this sample was .88, which suggests that the two scales are measuring the same construct. The CESD-R also demonstrated theoretically consistent convergent and divergent

validity with anxiety, schizotypy, and positive and negative affect (Van Dam & Earleywine, 2011). Van Dam and Earleywine (2011) performed both exploratory and confirmatory factor analyses, finding that a two-factor model fit the data significantly better than a one-factor solution in two samples; however, the inter-factor correlation was .941 in sample 1 and .975 in sample 2, suggesting factor redundancy.

Depression Anxiety Stress Scales

The Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995) are a set of self-report scales designed to measure the magnitude of three negative emotional states: depression, anxiety, and stress. Two versions, one with 42 items and one with 21 items, of the DASS are offered, with the DASS-21 (Lovibond & Lovibond, 1995) consisting of a subset of items from the DASS. Each of the three scales consists of either 14 or 7 items, divided into subscales of similar content. The Depression scale assesses dysphoria, hopelessness, devaluation of life, lack of interest/involvement, anhedonia, inertia, and self-deprecation. The Anxiety scale assesses autonomic arousal, skeletal musculature effects, situational anxiety, and the subjective experience of anxious affect. The Stress scale assesses difficulty relaxing, nervous arousal, being easily agitated, easily irritable, or impatient. The individual is asked to use a 4-point scale to rate the extent to which they have experienced each symptom over the past week.

Internal consistencies for each scale for the DASS normative sample were good to excellent, with a coefficient alpha of .91 for Depression, .84 for Anxiety, and .90 for Stress (Lovibond & Lovibond, 1993). Norton (2007) assessed the psychometric properties of the DASS-21 among different racial groups, finding it to possess adequate internal consistency (coefficient alphas ranging from .78 to .87) across groups. Similarly, the DASS-21 has evidence

of good convergent and discriminant validity when compared to other measures of depression and anxiety (Henry & Crawford, 2005).

The DASS has also been examined in outpatient samples of individuals presenting for assessment and treatment of anxiety and mood disorders. Test-retest reliability was assessed in a group of 20 patients who were re-administered the DASS two weeks after their initial evaluation. All three scales of the DASS evidenced temporal stability, with test-retest coefficients of .713, .785, and .813 for Depression, Anxiety, and Stress, respectively (Brown, Chorpita, Korotitsch, & Barlow, 1997). In addition, exploratory factor analysis with principal components extraction suggested a three-factor solution (Antony, Bieling, Cox, Enns, & Swinson, 1998), in fitting with Lovibond and Lovibond (1995). Studies that have directly compared the full DASS and the DASS-21 in clinical populations suggest that the DASS-21 is associated with a cleaner factor structure relative to the DASS-42 (Antony et al., 1998; Clara, Cox, & Enns, 2001). Taken together, these results provide support for the validity of the DASS in clinical populations.

Procedure

Participants used Amazon's Mechanical Turk (MTurk; http://www.mturk.com/) to complete the survey. MTurk is an online labor market created by Amazon designed to assist "requesters" in hiring and paying "workers" for the completion of computer-based tasks, referred to as "Human Intelligence Tasks" or "HITs." Workers are paid by requesters upon successful completion of HITs (Paolacci & Chandler, 2014). All MTurk workers are required to sign a participation agreement electronically confirming that they are at least 18 years of age in order to use the platform. Research has generally indicated that MTurk workers provide high-quality data, as evidenced by equivalence to other data collection methods with regard to internal consistency and test-retest reliability (Shapiro, Chandler, & Mueller, 2013).

After accepting the HIT on MTurk, participants were redirected to a Qualtrics survey, in which they completed demographic information questions, the ASRS, the AQ, the CESD-R, and the DASS-21. Within the Qualtrics survey, each of the aforementioned survey elements was randomly presented using block randomization, with each element presented roughly an equal number of times across all respondents. To protect participants' anonymity, all survey responses were collected through Qualtrics. Specifically, Amazon has access to workers' personal identifiable information and survey responses (Mason & Suri, 2011) and automatically collects Internet Protocol (IP) addresses for all participants, increasing the risk that data may be identifiable. Upon completion of the survey, participants received a completion code, identical for all participants, which was used for the purposes of compensation on the MTurk platform.

Participants were compensated $1.50 for completing the full survey consisting of demographic questions, the ASRS, the AQ, the CESD-R, and the DASS-21. In order to achieve an optimal number of participants across both the *low ASD traits* and *high ASD traits* groups, all participants were screened using the AQ. Upon reaching 230 participants in the *low ASD traits* group, survey respondents with an AQ score less than 26 were routed to the end of the survey, and survey respondents with an AQ score greater than or equal to 26 were routed to complete all study measures. Participants who were routed to complete only the AQ were paid $0.30, whereas those who were routed to complete all study measures were paid $1.50.

Data for the present study were collected from April 2019 to October 2019 on MTurk. During this period, 17 HITs were posted to MTurk consisting of 20 (5.9% of total HITs), 50 (76.5% of total HITs), or 100 assignments (17.6% of total HITs) per HIT. Each HIT reached its total number of assignments in a minimum of 2 days and a maximum of 7 days. In total, 997 responses were collected. Of those 997 responses, 434 (43.5%) were included in the final

sample. The 563 responses that were not included in the final sample comprised participants who completed the AQ and then were routed to the end of the survey or who failed four out of four attention checks (n = 3).

Power Analysis

The power of a test is its "sensitivity or ability to detect what is present" (Maxwell & Delaney, 2004, p. 24). In other words, power is the probability of rejecting the null hypothesis when it is false. A power analysis can provide further information regarding the likelihood that a given experimental design will detect an effect of a particular size in a population (Maxwell & Delaney, 2004). In this manner, one can use a power analysis to determine the sample size necessary to provide an experiment with adequate power.

The minimum sample size required to achieve a power of .80 was calculated using the statistical program R (R Core Team, 2018), with syntax generated from Preacher and Coffman (2006). The program generated the minimum sample size needed to use the Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980) to assess goodness of model fit within structural equation modeling (MacCallum, Browne, & Sugawara, 1996). Alpha was set at .05, with 190 degrees of freedom, corresponding to the number of potentially estimable parameters of interest when conducting structural equation modeling on the CESD-R. A null RMSEA value of .05 was specified as achieving adequate model fit, with an alternative RMSEA value of .08 signifying a poor model fit. In this sense, effect size in this approach is defined in terms of the difference in overall fit of the two models, as indexed by the specified RMSEA values (MacCallum, Browne, & Cai, 2006). The above analysis yielded a minimum of 87 participants per group in order to achieve a power of .80.

Importantly, however, the power analysis above does not take both groups (high and low levels of autistic traits) into account, as it is unknown how many individuals with high autistic traits exist in the population. Therefore, 87 participants per group can be considered a minimum estimate of the number of participants needed for the proposed study. Sample size has a considerable impact on both reliability and validity in the context of factor analysis (Kyriazos, 2018). Several guidelines have been suggested with regard to achieving adequate sample size for use in a confirmatory factor analysis, including an *N* greater than 200 (Comrey, 1988); a ratio of 10 participants per indicator variable (Wang & Wang, 2012); or a ratio of 20 participants for every parameter estimated (Jackson, 2003). Given that large samples are crucial for models with accurate parameter estimates, particularly when normality assumptions are not met (MacCallum et al., 1996), the present study adopted a more conservative sample size. Consequently, the present study used quota sampling in an attempt to include a minimum sample size of 210 participants in each group (high and low levels of autistic traits) to align with the 21-item version of the DASS, in fitting with the ratio of 10 participants for every indicator variable (Wang & Wang, 2012). Consequently, participant data was split into two groups: those who have a high level of autistic traits (total AQ score greater than or equal to 26) and those who have a low level of autistic traits (total AQ score less than 26). This cut-off is in accordance with previous research by Woodbury-Smith et al. (2005) as mentioned above, which indicated that the AQ correctly identified 83 percent of patients in a referred clinical sample using a cut-off score of 26.

Data Analysis Strategy

Confirmatory factor analysis, using structural equation modeling in Mplus Version 8.4 (Muthen & Muthen, 2017), employing the standard CESD-R, DASS, and ASRS factor structure was conducted in the combined sample for each measure to ensure sufficient fit to test

invariance. The same confirmatory factor analysis was then run on the *low ASD traits* and *high ASD traits* groups in multigroup invariance analyses. In all invariance models, the *low ASD traits* group served as the reference group and the *high ASD traits* group served as the alternative group.

Analyses began with the test of configural invariance, in which latent factor means were constrained to be 0 and factor variance was fixed to 1 for identification within each group. All other parameters were freely estimated. This tested whether the same pattern or factor structure existed in both groups.

Next, the test for metric (weak factorial) invariance was conducted by constraining loadings of observed items onto latent factors to be equal across both groups. Specifically, factor variance was fixed to 1 in the *low ASD traits* group but was freely estimated in the *high ASD traits* group, and factor means were fixed to 0 in both groups. Intercepts and residual variances were permitted to vary across groups.

In addition to the constraints imposed by the test of metric invariance, the test of scalar (strong factorial) invariance specified item intercepts to be equal across groups. Specifically, factor means and variances were fixed to 0 and 1, respectively, for identification within the *low ASD traits* group; factor means and variances were then estimated in the *high ASD traits* group. Factor loadings and item intercepts were constrained to be equal across groups. Residual variances were permitted to differ across groups.

Finally, the test of strict invariance constrained residual variances to be equal across groups, in addition to the constraints imposed in the previous models. In particular, factor means and variances were fixed to 0 and 1, respectively, for identification in the *low ASD traits* group;

factor means and variances were estimated in the *high ASD traits* group. All factor loadings, item intercepts, and residual variances were constrained to be equal across groups.

Results

Descriptive Statistics

Descriptive statistics were analyzed using JASP Version 0.9.01 (JASP Team, 2019), R (R Core Team, 2017), and IBM SPSS Statistics for Windows Version 25.0 (IBM, 2017). The *low ASD traits* group was compared to the *high ASD traits* group to assess differences on basic demographic factors using univariate ANOVAs for continuous variables and χ^2 tests for categorical variables. Descriptive statistics for study variables and demographic factors are presented in Table 1. There were no significant differences between groups with regard to age, gender, native language, and race/ethnicity. Total scores on all study measures, including the ASRS, AQ, CESD-R, and DASS, were significantly higher in the *high ASD traits* group.

Missing Data

Missing values were examined to determine patterns of missingness and the necessity of subsequent analytical adjustments. Missing data analyses revealed a maximum level of missingness at 2.99% (23 items), with all other items at < 2.8% missingness ($M_{missing}$ = 1.6%; $SD_{missing}$ = 1.2%) and a minimum level of missingness of 0.23% (5 items). Little's test indicated that data were not missing completely at random [MCAR], χ^2 (277) = 590.5, $p < .001$. Consequently, the missingness pattern was explicitly examined in order to diagnose the missing data mechanism. Investigation of the missingness pattern suggested that for items with the greatest percent missing data (i.e., ≥ 2.5%), the pattern could be attributable to sample differences given that data were missing by design. Specifically, in order to achieve an optimal number of participants across both the *low ASD traits* and *high ASD traits* groups, all participants were

screened using the AQ. Upon reaching 230 participants in the *low ASD traits* group, survey respondents with an AQ score less than 26 were routed to the end of the survey, and survey respondents with an AQ score greater than or equal to 26 were routed to complete all study measures. Consequently, because the data that were missing by design could be said to be missing at random [MAR], no model adjustments were made in subsequent factorial invariance analyses.

Bivariate Correlations Within Study Measures

Correlation coefficients were calculated for all three self-report measures across both the *low ASD traits* and *high ASD traits* groups as a measure of shared variance. Bivariate correlations among study variables are presented in Tables 2-7. Importantly, most of the items of the DASS-21 and all the items of the CESD-R demonstrated high skewness and kurtosis, indicating a non-normal distribution for these data. Skewness and kurtosis values for all study measures in the combined sample are presented in Table 8.

Inter-Item Correlations

Average inter-item correlation was calculated for each of the three measures as an indicator of item redundancy. The overall CESD-R total score demonstrated medium to large inter-item correlations in the *low ASD traits* (M_{IIC} = .52) and *high ASD traits* (M_{IIC} = .46) groups. For the ASRS, inter-item correlations were medium to large for both the *low ASD traits* (Inattention M_{IIC} = .55; Hyperactivity-Impulsivity M_{IIC} =.43) and *high ASD traits* (Inattention M_{IIC} = .42; Hyperactivity-Impulsivity M_{IIC} =.33) groups. Similarly, for the DASS-21, inter-item correlations were large in both the *low ASD traits* (Depression M_{IIC} = .69; Anxiety M_{IIC} =.57; Stress M_{IIC} =.60) and *high ASD traits* (Depression M_{IIC} = .60; Anxiety M_{IIC} =.54; Stress M_{IIC} =.50) groups.

Bivariate Correlations Between Study Measures

All correlations between total scores and subscale scores for all measures were significant. Bivariate correlations between subscale scores for the *low ASD traits* and *high ASD traits* groups are presented in Table 9. Correlations between raw total scores for the CESD-R and each of the DASS-21 subscales were strong for the overall sample ($DASS_{Depression}$: r = .86; $DASS_{Anxiety}$: r = .73; $DASS_{Stress}$ = .81). Correlations between raw total scores for the CESD-R and the two subdomains of the ASRS were moderate to strong for the overall sample ($ASRS_{Inattention}$: r = .59; $ASRS_{Hyperactivity\text{-}Impulsivity}$: r = .63). Correlations between raw total scores for the ASRS and each of the DASS-21 subscales were moderate to strong for the overall sample ($ASRS_{Inattention}$-$DASS_{Depression}$: r = .60; $ASRS_{Inattention}$-$DASS_{Anxiety}$ = .51; $ASRS_{Inattention}$-$DASS_{Stress}$ = .61; $ASRS_{Hyperactivity\text{-}Impulsivity}$ $DASS_{Depression}$: r = .60; $ASRS_{Hyperactivity\text{-}Impulsivity}$-$DASS_{Anxiety}$: r=.65; $ASRS_{Hyperactivity\text{-}Impulsivity}$-$DASS_{Stress:}$ r = .69).

Internal Consistency

As a measure of internal consistency, Cronbach's alpha (Cronbach, 1951) was calculated for each factor and the overall scale for each of the study measures using the formula $\alpha = (N*\bar{c}) / \bar{v} + (N - 1) * \bar{c}$, where N is equal to the number of items, $\bar{c}$ is the average inter-item covariance among item pairs, and $\bar{v}$ is the average variance. Cronbach's alpha estimates for each scale are presented in Table 10.

Model Estimation

Because study variables could not be assumed to be normally distributed, full information maximum likelihood estimation with robust standard errors was used. In addition, maximum likelihood estimation is an optimal method for the treatment of missing data in a confirmatory

factor analysis, as it is robust to missing completely at random and missing at random data (Arbuckle, 1996).

Baseline Models

CESD-R

The baseline model demonstrated acceptable fit in the combined sample (χ^2 [170] = 591.124, $p < .001$; RMSEA = .076 [90% CI: .07 - .083]; CFI = .853; TLI = .836; SRMR = .06), thus providing sufficient evidence to proceed with multigroup factorial invariance testing.

DASS-21

The baseline model demonstrated good fit in the combined sample (χ^2 [266] = 591.57, $p < .001$; RMSEA = .054 [90% CI: .048 - .060]; CFI = .918; TLI = .910; SRMR = .043), thus providing sufficient evidence to conduct multigroup factorial invariance testing.

ASRS

The baseline model demonstrated acceptable fit in the combined sample (χ^2 [201] = 559.67, $p < .001$; RMSEA = .065 [90% CI: .059 - .072]; CFI = .868; TLI = .852; SRMR = .054), thus providing sufficient evidence to conduct multigroup factorial invariance testing.

Multifactorial Invariance Analyses

CESD-R

Unstandardized parameter estimates for the test of configural invariance across the *low ASD traits* and *high ASD traits* groups are presented in Figure 1a. Model fit indices for the test of configural invariance are presented in Table 11.

Metric invariance. Unstandardized parameter estimates for the test of metric invariance of the CESD-R across both the *low ASD traits* and *high ASD traits* groups are presented in Figure 1b. Model fit indices for the test of metric invariance are presented in Table 11.

DASS-21

Unstandardized parameter estimates for the test of configural invariance across the *low ASD traits* and *high ASD traits* groups are presented in Figure 2a. Model fit indices for the test of configural invariance are presented in Table 11.

Metric invariance. Unstandardized parameter estimates for the test of metric invariance of the DASS-21 across the *low ASD traits* and *high ASD traits* groups are presented in Figure 2b. Model fit indices for the test of metric invariance are presented in Table 11.

Scalar invariance. Unstandardized parameter estimates for the test of scalar invariance of the DASS-21 across the *low ASD traits* and *high ASD traits* groups are presented in Figure 2c. Model fit indices for the test of scalar invariance are presented in Table 11.

Strict invariance. Unstandardized parameter estimates for the test of strict invariance of the DASS-21 across the *low ASD traits* and *high ASD traits* groups are presented in Figure 2d. Model fit indices for the test of strict invariance of the DASS-21 are presented in Table 11.

ASRS

Unstandardized parameter estimates for the test of configural invariance across the *low ASD traits* and *high ASD traits* groups are presented in Figure 3a. Model fit indices for the test of configural invariance for the ASRS are presented in Table 11.

Metric invariance. Unstandardized parameter estimates for the test of metric invariance of the ASRS across both the *low ASD traits* and *high ASD traits* groups are presented in Figure 3b. Model fit indices for the test of metric invariance are presented in Table 11.

Scalar invariance. Unstandardized parameter estimates for the test of scalar invariance of the ASRS across the *low ASD traits* and *high ASD traits* groups are presented in Figure 3c. Model fit indices for the test of scalar invariance for the ASRS are presented in Table 11.

Strict invariance. Unstandardized parameter estimates for the test of strict invariance of the ASRS across the *low ASD traits* and *high ASD traits* groups are presented in Figure 3d. Model fit indices for the test of strict invariance of the ASRS are presented in Table 11.

Model Comparisons

Because all models were nested, all model comparisons were conducted via the difference in each model's chi-square value. The Satorra-Bentler scaled chi-square difference test was used to examine differences in fit between models, given that maximum likelihood estimation with robust standard errors was used in each model. Additionally, the sample size-adjusted Bayesian Information Criterion (BIC) was used, with a 10-point difference taken as evidence of a model difference in goodness of fit in favor of the model with the smaller BIC (Raftery, 1993).

CESD-R

In general, both the configural and metric models possessed poor fit to the data, with all model fit indices outside of the acceptable range (see Table 11). Consequently, multifactorial invariance testing was discontinued and post-hoc exploratory factor analysis was conducted. In order to determine if data were suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were assessed, with an overall KMO of .8 or above considered excellent, and an overall KMO of less than .5 considered poor (Tabachnick & Fidell, 2007). KMO for the CESD-R data was .943. Similarly, Bartlett's test of sphericity was significant, indicating that factor analysis on the CESD-R data would be suitable.

An exploratory factor analysis using maximum likelihood with robust standard errors (MLR) with an oblique (geomin) rotation was used. A three-factor solution fit the data best, with

three eigenvalues > 1 and RMSEA = 0.06 (90% CI: .054 - .069). Items within each of the three identified factors are presented in Table 12.

DASS-21

Overall, the metric invariance model fit well, except for the standardized root mean square residual (SRMR) index (see Table 11). The metric model did not exhibit a statistically significant reduction in fit relative to the configural model, $\chi^2(15) = 10.52$, $p = .785$. This was also supported when examining change in the sample size-adjusted BIC, as $\Delta BIC = 28.87$ when moving from the metric model to the configural model. The scalar invariance model also fit well (see Table 11), and there was not a significant decrease in fit in relation to the metric invariance model, $\chi^2(18) = 18.09$, $p = .449$. Similarly, when examining the scalar model in relation to the metric model, $\Delta BIC = 32.34$. Finally, the strict invariance model demonstrated acceptable fit (see Table 11); however, the strict invariance model exhibited a significant decrease in fit relative to the scalar model, $\chi^2(21) = 157.32$, $p < .001$, indicating that scalar invariance was supported in the present sample.

ASRS

The metric invariance model possessed moderate to poor fit to the data (see Table 11). The metric model did not demonstrate a statistically significant reduction in fit relative to the configural model, $\chi^2(14) = 10.77$, $p = .704$. When examining change in sample-size adjusted BIC, there was a difference of 28.95 when moving from the metric model to the configural model. Model fit indices continued to be poorly fit to the data (see Table 11). When examining the scalar model, there was a statistically significant reduction in fit relative to the metric model, $\chi^2(16) = 31.11$, $p = .013$, indicating that scalar invariance of the measure was not supported in the present sample. Finally, model fit indices were poor across all indicators for the test of strict

factorial invariance (see Table 11). Consequently, the ASRS demonstrated metric invariance in the current sample.

Discussion

Individuals with ASD present with high rates of anxiety and depression, with rates that are greater than that seen in the general population (Croen et al., 2015; Joshi et al., 2013; Wigham, Barton, Parr, & Rodgers, 2017). At the same time, the reliability and validity of many traditional measures of these and other mental health conditions have not been tested in the ASD population (Leyfer et al., 2006). Consequently, it is essential to assess whether common self-report measures of anxiety and depression can adequately assess these constructs in individuals with and without ASD. To this aim, the present study included factorial invariance analyses of three self-report measures of psychiatric symptoms—the ASRS, the CESD-R, and the DASS-21—among adults with low and high levels of ASD-related traits.

In comparison to the *low ASD traits* group, participants in the *high ASD traits* group scored significantly higher on all study measures. Specifically, subscale scores and total scale scores on the ASRS, the CESD-R, and the DASS-21 were significantly higher in the *high ASD traits* group, indicating greater self-reported symptoms of depression, anxiety, stress, inattention, and hyperactivity in those with a higher level of ASD-related traits.

Importantly, none of the self-report measures examined in the present study demonstrated full factorial invariance, indicating that the measures are not consistent in their performance across individuals with a high and low level of ASD-related traits.

Hypothesis 1

It was hypothesized that neither the CESD-R nor the DASS-21 would demonstrate metric invariance across groups, given that traditional measures of anxiety and depression may not

capture the presentation of these constructs in individuals with ASD, whether due to diagnostic overshadowing, difficulty interpreting and reporting emotions, or another pathway (Cassidy et al., 2018; Mazzone, Ruta, & Reale, 2012).

CESD-R

The original hypothesis that the CESD-R would not demonstrate metric invariance across groups was supported in the current study. Indeed, the CESD-R did not demonstrate evidence of acceptable model fit within the test of configural invariance, indicating that the same factor model specification did not hold across both the *low ASD traits* and *high ASD traits* groups. Instead, results of an exploratory factor analysis indicated that a three-factor solution fit the data best.

In examining the items that loaded onto the three identified factors, several themes appeared. One factor seemed to be concerned with negative affect (e.g., items included: “I could not shake off the blues”; “I felt depressed”; “I felt sad”; “I did not like myself”; etc.). Another factor involved physical symptoms associated with depression (e.g., items included: “My appetite was poor”; “My sleep was restless”; “I felt like I was moving too slowly”; “I felt fidgety”; etc.). Finally, the third factor comprised only two items, both of which could be related to behavioral components of depression: “I wanted to hurt myself” and “I lost a lot of weight without trying to.” The results of the exploratory factor analysis stand in contrast to previous research from the initial validation of the measure which found that a one-factor solution provided the best fit. Although results of the present study indicate that more than a single factor provides the best fit to the data, it is possible that the overarching construct of depression is common to all three identified factors and thus remains the most parsimonious factor model for the measure as a whole.

DASS-21

The original hypothesis that the DASS-21 would not demonstrate metric invariance across groups was not supported in the present study. In contrast, there was evidence for scalar invariance of the DASS-21, indicating equality in intercepts, factor loadings, and an identical factor model specification across groups. Importantly, however, there was significant degradation in model fit when examining strict invariance of the DASS-21, indicating that there are not equal residual variances across the *low ASD traits* and *high ASD traits* groups. Subsequently, the DASS-21 does not possess an identical item structure in those with a high and low level of ASD-related traits; however, attaining scalar invariance justifies the comparisons of group means on the latent constructs that the DASS-21 purports to measure (i.e., depression; anxiety; stress). In this sense, group differences on items of the DASS-21 are not solely due to differences on the common factors but are a result of some degree of measurement error. Given that scalar invariance of the DASS-21 was supported in the current sample, one can have confidence that the DASS-21 is able to measure symptoms of depression, anxiety, and stress fairly consistently across individuals with a high and low level of ASD-related traits.

ASRS

The ASRS was also examined in the present study in order to obtain further information about discriminant validity, as well as whether factorial invariance would be demonstrated within measures that did not specifically measure internalizing symptoms. The ASRS demonstrated metric invariance in the current sample, indicating equality in factor loadings in addition to an identical factor model specification across groups. Importantly, however, there was a significant decrease in model fit when examining scalar invariance of the ASRS, indicating that there are not equal item intercepts across the *low ASD traits* and *high ASD traits*

groups. Although the ASRS is measuring similar latent factors in both groups, it is not performing equally across both groups at the level of individual items. Thus, the constructs being measured by the ASRS (i.e., inattention; hyperactivity/impulsivity) have similar meanings to individuals with varying levels of ASD-related traits, but the levels and relations among the factors of the ASRS differ meaningfully in those with varying levels of ASD-related traits. Because metric invariance was supported in the present sample, one can justify comparisons of factor variances and covariances across those with a high and low level of ASD-related traits, but one cannot assume that the ASRS functions equally in individuals with different levels of ASD-related traits.

Hypothesis 2

Additionally, it was hypothesized that data from the CESD-R and the DASS-21 would not possess the same factor model specifications in the *high ASD traits* group as were established in general (Eaton, Smith, Ybarra, Muntaner, & Tien, 2004; Lovibond & Lovibond, 1995; Van Dam & Earleywine, 2011) and clinical (Antony, Bieling, Cox, Enns, & Swinson, 1998; Brown, Chorpita, Korotitsch, & Barlow, 1997) adult populations.

CESD-R

The hypothesis that the CESD-R would not possess the same factor model specifications as established in general and clinical adult populations was supported in the present study. In comparison to the standardized factor loadings from a confirmatory factor analysis conducted by Van Dam and Earleywine (2011) of a community sample of 3650 adults, standardized factor loadings of the CESD-R items for the *high ASD traits* group demonstrated a discrepancy of greater than .30 for 9 out of 20 CESD-R items. For instance, items such as “I lost a lot of weight without trying to” and “I felt fidgety” demonstrated respective factor loadings of .36 and .48 in

the *high ASD traits* group of the current sample versus .61 and .76 in the work of Van Dam and Earleywine (2011). In comparison, the same items possessed standardized factor loadings of .54 and .76 in the *low ASD traits* group of the current sample, in alignment with findings of Van Dam and Earleywine (2011). Items that seemed most strongly associated with the construct of depression in the community sample of Van Dam and Earleywine (2011) did not demonstrate comparable factor loadings within the *high ASD traits* group of the current study. Specifically, standardized factor loadings of items including "I felt sad", "I could not get going", "Nothing made me happy", "I felt like a bad person", and "I lost interest in my usual activities" were all within the range of .72-.83. In contrast, standardized factor loadings of the same items in the community sample of Van Dam and Earleywine (2011) ranged from .91 to .98.

Consequently, within the population of adults with a high level of ASD-related traits, several of the CESD-R items are not as highly correlated to the construct of depression as they are in a general population sample; however, the causal explanation for this difference remains unknown. For instance, it may be that there is a difference in the phenomenological experience of depression for those with ASD as compared to neurotypical individuals. Future research is needed to test this hypothesis explicitly.

DASS-21

The hypothesis that the DASS-21 would not possess the same factor model specifications as established in general and clinical adult populations was not fully supported in the present study.

In the original paper of Lovibond and Lovibond (1995), principal components analysis was used to examine the psychometric properties of the DASS in a general sample of 717 university students. In comparison to the principal components analysis (PCA) conducted by

Lovibond and Lovibond (1995), within the *high ASD traits* group, the DASS-21 demonstrated higher factor loadings for every item except one ("I was intolerant of anything that kept me from getting on with what I was doing") in the present study. Specifically, for the Depression factor, standardized factor loadings ranged from .61 to .85 in the present study's test of configural invariance, versus .45 to .80 in Lovibond and Lovibond's (1995) PCA. Similarly, standardized factor loadings for the Anxiety factor in the present study ranged from .63 to .82 versus .47 to .64 in the PCA of Lovibond and Lovibond (1995). Finally, standardized factor loadings for the Stress factor ranged from .67 to .75 in the present study versus .41 to .73 in Lovibond and Lovibond (1995). Overall, results indicated that items of the DASS-21 were more strongly related to the overarching constructs of anxiety, depression, and stress within the group of individuals with a high level of ASD-related traits than they were in the general population group sampled in the original DASS study.

Brown, Chorpita, Korotitsch, and Barlow (1997) examined the psychometric properties of the 42-item version of the DASS in a clinical sample of 241 patients presenting for assessment and treatment at an anxiety disorders clinic. In the confirmatory factor analysis conducted by Brown et al. (1997), factor loadings for the Depression factor ranged from .57 to .87; factor loadings for the Anxiety factor ranged from .45 to .80; and factor loadings for the Stress factor ranged from .60 to .79. Within the present study, factor loadings for all three factors in the *high ASD traits* group were within the ranges identified by Brown et al. (1997) or slightly higher (i.e., Anxiety factor: .63-.82). Importantly, given that the 21-item version of the DASS was used in the present study, these estimates are not fully comparable. In addition, because the DASS-21 has been found to have a cleaner factor structure as compared to the full DASS (Antony et al., 1998),

it is reasonable that the factor loadings in the present study would be somewhat higher, as the short form possesses better psychometrics.

Finally, Antony, Bieling, Cox, Enns, and Swinson (1998) examined the psychometric properties of the 42-item and 21-item versions of the DASS in a clinical sample of 258 adults seeking outpatient treatment for depression or anxiety disorders. In their PCA of the DASS-21, Antony et al. (1998) found factor loadings ranging from .55 to .91 for the Depression factor; .48 to .82 for the Anxiety factor; and .52 to .84 for the Stress factor. In comparison, the *high ASD traits* group in the present study demonstrated similar factor loadings for the Depression factor (.61-.85), and similar factor loadings for the Anxiety (.63-.82) and Stress (.67-.75) factors, albeit that the range of scores was more restricted. Antony et al. (1998) emphasized that their findings provided support for the DASS being consistent with the tripartite model of anxiety and depression (Clark & Watson, 1991), in that scores on the Stress subscale were elevated across anxious and depressed groups, whereas Depression subscale scores were only elevated in the subgroup of individuals with depression. Importantly, however, further exploration of the DASS in relation to the tripartite model within the population of individuals with ASD is needed in order to determine whether the tripartite model would also be applicable to groups with ASD and comorbid psychiatric diagnoses.

Hypothesis 3

Third, it was hypothesized that convergent validity would be demonstrated between the CESD-R and the Depression scale of the DASS-21, as evidenced by significant correlation coefficients. This hypothesis was supported in the present study. Specifically, within the overall sample of 433 adults, the CESD-R and the DASS-21 Depression scale demonstrated a significant, strong positive correlation (r = .86).

This relationship held when looking at the two groups separately. For instance, within the *low ASD traits* group, there was a significant correlation of .89 between the CESD-R total score and the Depression scale of the DASS-21. Similarly, within the *high ASD traits* group, the CESD-R total score and the Depression scale of the DASS-21 were significantly correlated at r = .83. The similar correlations between the *low ASD traits* and *high ASD traits* groups support convergent validity of the CESD-R with the DASS-21 Depression scale irrespective of group membership, thus providing further confidence in the measurement of the construct of depression in those with and without ASD.

Hypothesis 4

Finally, it was hypothesized that anxiety would be divergent from depression both within and between self-report measures among the *low ASD traits* group, but not within the *high ASD traits* group, given the potential for greater diagnostic overshadowing within ASD populations. This hypothesis was not supported in the present study. Contrary to the stated hypothesis, there were stronger correlations between depression and anxiety within the *low ASD traits* group as compared to the *high ASD traits* group.

Specifically, when examining the relationship between the DASS-21 Depression and Anxiety scales, there was a significant correlation of .78 in the *low ASD traits* group, and a significant correlation of .68 in the *high ASD traits* group. Similarly, the DASS-21 Anxiety scale and the CESD-R total score demonstrated a significant correlation of .80 in the *low ASD traits* group versus a significant correlation of .66 in the *high ASD traits* group. These higher correlations in the *low ASD traits* group as compared to the *high ASD traits* group run counter to hypotheses, indicating that the constructs of depression and anxiety may not be highly divergent even in individuals without ASD. Future research may wish to examine the DASS-21 and the

CESD-R in relation to other self-report measures of depression and anxiety to determine the extent to which these constructs are separable.

In addition, the relationship between the ASRS with both the CESD-R and the DASS-21 was also examined for further evidence of discriminant validity. The ASRS Inattention scale and the DASS Anxiety scale demonstrated moderate positive correlations in both the *low ASD traits* (r = .57) and *high ASD traits* (r = .43) groups. The relationship was similar for the ASRS Inattention scale and self-report measures of depression. Specifically, the ASRS Inattention scale demonstrated a significant correlation of .58 with the DASS Depression scale in both the *low ASD traits* and *high ASD traits* groups. The ASRS Inattention scale was also moderately correlated with the CESD-R, with significant correlations of .57 in both groups.

The ASRS Hyperactivity-Impulsivity scale also demonstrated moderate correlations with anxiety and depression measures. For instance, it was correlated .62 with the DASS Anxiety scale in both the *low ASD traits* and *high ASD traits* groups. The ASRS Hyperactivity-Impulsivity scale was moderately correlated with the CESD-R in the *low ASD traits* (r = .57) and *high ASD traits* groups (r = .63), as well as the DASS Depression scale (r = .58 in both groups).

Importantly, symptoms of anxiety and depression may overlap with those of ADHD. In particular, the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5;* American Psychiatric Association, 2013) specifies "restlessness or feeling keyed up or on edge" as well as "difficulty concentrating or mind going blank" as symptoms associated with generalized anxiety disorder. Similarly, "psychomotor agitation or retardation nearly every day" and "diminished ability to think or concentrate, or indecisiveness, nearly every day" are listed as symptoms of major depressive disorder. Therefore, some overlap between ADHD and internalizing symptoms such as depression and anxiety is to be expected; however, the lack of

any strong positive correlations (i.e., $r \geq .70$) between the ASRS and the CESD-R or DASS-21 provides some evidence for the discriminability of ADHD symptoms from these constructs.

Limitations

There are several limitations inherent to the present study. First, individuals were sorted into groups based upon their score on the AQ, rather than a clinically confirmed diagnosis of ASD. Although the AQ has utility in distinguishing individuals with clinically significant levels of ASD traits, with good discriminative validity and screening properties (Hurst et al., 2007; Woodbury-Smith et al., 2005), it is not a diagnostic instrument. Consequently, the present results are not directly generalizable to the population of individuals with and without confirmed autism diagnoses. As a result, it is unknown whether these results would replicate in a sample of individuals with confirmed autism diagnoses.

Secondly, the *low* and *high ASD traits* groups were created on the basis of a cut-off score of 26 on the AQ, in fitting with previous research by Woodbury-Smith et al. (2005) which demonstrated that this cut score correctly identified 83 percent of patients in a referred clinical sample. Although the results of Woodbury-Smith et al. (2005) provide acceptable support for sensitivity, their cut-off score of 26 is not perfectly sensitive in that it did not correctly identify 100 percent of patients with ASD in the sample. Importantly, the use of a cut-off score may be flawed, in that there may not be a meaningful difference between those just above and just below the cut score. In the present study, those with an AQ score equal or above 26 were classified as the *high ASD traits* group; however, those with an AQ score of 25 may not be markedly different from those with an AQ score of 26 or 27. Indeed, there may be meaningful variation in ASD-related traits that is not captured with the use of a cut-off score.

A critical limitation of the present study concerns the use of the online platform Amazon Mechanical Turk. Although MTurk has several benefits, including the ability to collect a large sample at low cost (Horton & Chilton, 2010) and respondent anonymity which may result in greater comfort in disclosing psychiatric symptoms and mental health concerns (Shapiro, Chandler, & Mueller, 2013), it also has several notable disadvantages. Specifically, previous research regarding the use of MTurk to study clinical populations found a high proportion of respondents to endorse items consistent with malingering (Shapiro, Chandler, & Mueller, 2013), indicating that some participants may be exaggerating symptoms or faking distress. Further, because MTurk workers are free to select the tasks that they wish to perform among a variety of alternatives, there is an inherent selection bias that precludes collecting a fully representative sample. Other evidence indicates that MTurk samples are not fully representative of the general population. Indeed, according to the extant research literature, workers on MTurk tend to be younger, overeducated, and underemployed as compared to the larger population of Internet users and individuals in the general population (Paolacci, Chandler, & Ipeirotis, 2010). Of particular relevance to the present study, previous research has indicated that MTurk workers are more likely to possess traits associated with autism spectrum disorders (Mitchell & Locke, 2015), with AQ scores observed within the MTurk population one-third of a standard deviation above those observed in a college student sample (Palmer, Paton, Enticott, & Hohwy, 2015). In the same vein, McCredie and Morey (2018) conducted a study of 455 MTurk workers using the Personality Assessment Inventory (PAI; Morey, 1991), and found that relative to a community sample, MTurk workers scored higher on the social detachment and depression scales. Given these results, it is likely that the present sample may not be fully representative of the general

population and may also be more likely to endorse higher levels of ASD-related traits and/or depression symptoms.

It is especially important to consider the extent to which MTurk is feasible as a tool for behavioral research. Previously, Crump, McDonnell, and Gureckis (2013) replicated a variety of experimental tasks using MTurk, including the Stroop (1935), Flanker (Ericksen & Ericksen, 1974), Simon (Craft & Simon, 1970), and attentional blink (Shapiro, Raymond, & Arnell, 1997) tasks. Although Crump et al. (2013) found evidence for the validity of collecting experimental behavioral data via MTurk, they also found that testing participants' comprehension of instructions was critical to robust data quality. In the present study, at least one attention check was included in each measure (e.g., "Please select '1-2 days' for this question"). Additionally, participants were presented with an open-ended response for several of the demographic information questions (e.g., "How do you currently describe your gender identity?"; "What is your native language?"; "What is your age in years?"). Importantly, however, participants' data were not removed unless it was clear that participants did not comprehend the questions (e.g., a participant answered "282019" when asked for their age in years) or failed all four attention checks. Subsequently, the lack of explicit feedback regarding survey instructions may have hindered some participants' comprehension of survey items.

Finally, the present study is necessarily limited by its examination of a singular population of interest: in this case, adults with and without a high level of ASD-related traits. As such, other important constructs of interest were not examined. For instance, it is unknown to what extent the study measures would demonstrate invariance with regard to age, ethnicity, or other important factors. Future research would do well to investigate the invariance of these measures with other group memberships of interest.

Implications

There are several clinical and research implications inherent to the results of the present study. Simply, and perhaps most notably, the finding of significantly higher scores on the CESD-R, DASS-21, and ASRS within the *high ASD traits* group provides further support for the idea that individuals with ASD experience higher levels of psychopathology as compared to individuals without ASD (Brereton et al., 2006; Hudson et al., 2018; Roy et al., 2015), with ADHD, anxiety, and depression being the most common comorbidities in adults with ASD (Lever & Geurts, 2016). These findings highlight the need for further research into the assessment and treatment of such conditions within this population, as well as any necessary modifications to adapt existing measures and interventions to the unique needs of those with ASD.

In particular, the finding of a lack of the most basic level of factorial invariance for the CESD-R indicates that its factor model specification is not equivalent across adults with and without a high level of ASD-related traits. Although the CESD-R was designed to be a valid assessment of depression symptoms in epidemiological and community-based samples (Eaton et al., 2004), it appears that it does not capture symptoms of depression in those with ASD in the same way as compared to those who are neurotypical. Consequently, the lack of evidence for factorial invariance suggests that the CESD-R may not be an ideal tool for assessment of depression, at least as the construct is currently understood, for adults with a high level of ASD-related traits.

The finding of scalar invariance across the two groups for the DASS-21 provides evidence for cross-group equality in factor loadings and factor intercepts. In other words, scalar invariance indicates that there are similar latent means and factor relationships on the DASS-21

for those with high and low levels of ASD-related traits, such that any differences in the means and covariances of DASS-21 items are due to differences in the latent parameters. These findings provide support that the DASS-21 is operating similarly in individuals with and without a high level of ASD-related traits. Thus, clinicians and researchers can have confidence that the DASS-21 is measuring symptoms of depression, anxiety, and stress similarly and accurately across those with and without a high level of ASD-related traits.

Multigroup factorial invariance analyses of the ASRS provided support for metric invariance of the measure, indicating that the same latent constructs are being measured across individuals with high and low levels of ASD-related traits. At the same time, the lack of evidence for scalar invariance across groups suggests that there are different factor relationships, latent means, and observed error variances for those with high and low levels of ASD-related traits. In this case, when using the ASRS in those with a high level of ASD traits, one can assume to adequately measure the latent constructs of inattention and hyperactivity-impulsivity. Conversely, however, one cannot assume that the levels and relationships among the constructs of inattention and hyperactivity-impulsivity will be the same in those with a high level of ASD traits. In this sense, clinicians should proceed with caution when using the ASRS to assess symptoms of ADHD in those with ASD.

Finally, the finding of stronger correlations between measures of depression and anxiety within the *low ASD traits* group as compared to the *high ASD traits* group provides evidence that these constructs may be relatively more distinct in those with a high level of ASD traits. The reason for this finding is unknown, but it is possible that those with ASD experience depression and anxiety in a way that is qualitatively different from neurotypical individuals and is not adequately captured by items on either the CESD-R or the DASS-21. Future research may wish

to explore additional behavioral and cognitive signs of anxiety and depression that may be unique to those with ASD.

Conclusions

Individuals with ASD experience internalizing symptoms, including depression and anxiety, at a higher rate than do individuals without ASD (Buck et al., 2014; Cassidy et al., 2014; Joshi et al., 2013). Although the extant literature indicates that depression and anxiety are highly prevalent in the ASD population, research on the psychometric properties of commonly used self-report measures of depression and anxiety within this population is limited. Importantly, because most measures of anxiety and depression have not been normed with individuals with ASD, one cannot assume that these measures reliably or validly assess these constructs in people with ASD.

The current study sought to examine the factor structures of the DASS-21 and the CESD-R in individuals with a high and low level of ASD-related traits as measured by the AQ. It also examined convergent and discriminant validity of these measures. This was one of the first studies to examine factorial invariance of the DASS-21 and the CESD-R in individuals with and without a high level of ASD traits. Results suggest that the DASS-21 and the CESD-R are not fully invariant across those with and without a high level of ASD traits, such that scores on these measures include some degree of measurement bias. As a result, the DASS-21 and the CESD-R should be interpreted with caution when assessing symptoms of depression and anxiety in those with ASD. The present analyses provide support for the idea that an alternative assessment is needed in order to adequately measure the constructs of anxiety and depression in individuals with ASD.

Table 1

Demographic Characteristics of Low and High ASD Trait Groups

Variable	Low ASD Traits Sample Mean (SD)	High ASD Traits Sample Mean (SD)	Between-group difference *p* value
Age	36.08 (11.67)	34.81 (10.12)	.301[a]
CESD-R Total	11.36 (14.11)	20.27 (16.79)	< .001[a]
AQ Total	17.39 (5.82)	29.18 (3.56)	< .001[a]
DASS_Depression	3.82 (5.08)	6.71 (5.70)	< .001[a]
DASS_Anxiety	2.60 (3.95)	5.19 (5.05)	< .001[a]
DASS_Stress	3.81 (4.6)	7.13 (5.1)	< .001[a]
ASRS_Inattention	10.78 (7.4)	14.00 (7.3)	< .001[a]
ASRS_Hyperactivity	8.93 (6.36)	12.32 (6.78)	< .001[a]

Note. [a]Mann-Whitney U test.

Variable	Low ASD Traits Sample (*n* = 203)	High ASD Traits Sample (*n* = 231)	Between-group difference *p* value
Gender			0.08[b]
Male	128 (63.05%)	130 (56.28%)	
Native Language			0.06[b]
English	200 (98.5%)	216 (93.5%)	
Racial/Ethnic Background			0.14[b]
American Indian/Alaska Native	0 (0%)	1 (.04%)	
Asian	14 (6.9%)	12 (5.2%)	
Black/African American	14 (6.89%)	13 (5.62%)	
Hispanic, Latino, or Spanish Origin	12 (5.91%)	16 (6.92%)	
Middle Eastern or North African	0 (0%)	1 (.04%)	

Native Hawaiian or Other Pacific Islander	0 (0%)	1 (.04%)
White	153 (75.4%)	160 (69.26%)
Multiracial or multiethnic	9 (4.43%)	16 (6.92%)
I prefer not to answer	1 (.04%)	2 (.08%)

Note. [b]χ^2 test.

Table 2

Bivariate Correlations among ASRS Items, Low ASD Traits Group

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1.	1.0																	
2.	.65	1.0																
3.	.63	.62	1.0															
4.	.62	.61	.57	1.0														
5.	.51	.57	.55	.56	1.0													
6.	.41	.54	.48	.55	.61	1.0												
7.	.49	.57	.50	.51	.55	.61	1.0											
8.	.53	.61	.59	.51	.53	.46	.54	1.0										
9.	.55	.53	.48	.60	.50	.60	.55	.50	1.0									
10.	.35	.42	.43	.46	.40	.49	.49	.43	.49	1.0								
11.	.37	.33	.30	.33	.36	.28	.41	.28	.32	.43	1.0							
12.	.38	.44	.49	.33	.53	.37	.49	.48	.33	.36	.32	1.0						
13.	.46	.48	.41	.47	.45	.53	.49	.52	.47	.71	.52	.40	1.0					

14.	.45	.50	.42	.42	.45	.45	.43	.39	.51	.38	.41	.49	.51	1.0				
15.	.39	.43	.34	.42	.54	.38	.52	.40	.42	.35	.43	.46	.35	.39	1.0			
16.	.33	.33	.30	.36	.38	.33	.50	.31	.37	.38	.38	.30	.39	.24	.56	1.0		
17.	.46	.52	.55	.40	.50	.34	.55	.49	.42	.42	.34	.56	.43	.37	.58	.49	1.0	
18.	.27	.40	.30	.29	.54	.34	.51	.42	.40	.42	.26	.49	.37	.38	.53	.57	.60	1.0

Note. $N = 202$. All correlations were significant at $p < .0001$.

Table 3

Bivariate Correlations among ASRS Items, High ASD Traits Group

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1.	1.0																	
2.	.54***	1.0																
3.	.43***	.56***	1.0															
4.	.38***	.46***	.37***	1.0														
5.	.38***	.46***	.36***	.46***	1.0													
6.	.50***	.44***	.36***	.51***	.47***	1.0												
7.	.35***	.36***	.37***	.48***	.49***	.51***	1.0											
8.	.34***	.48***	.40***	.35***	.43***	.38***	.32***	1.0										
9.	.36***	.41***	.40***	.41***	.45***	.48***	.44***	.37***	1.0									
10.	.37***	.35***	.37***	.36***	.31***	.47***	.36***	.38***	.44***	1.0								
11.	.22**	.21**	.24***	.23***	.32***	.30***	.41***	.25***	.35***	.42***	1.0							
12.	.39***	.52***	.35***	.19**	.36***	.30***	.31***	.46***	.32***	.34***	.39***	1.0						
13.	.25***	.31***	.28***	.24***	.36***	.41***	.37***	.31***	.41***	.59***	.40***	.30***	1.0					
14.	.35***	.35***	.31***	.23**	.25***	.42***	.35***	.28***	.42***	.42***	.33***	.32***	.41***	1.0				
15.	.33***	.24***	.29***	.13	.29***	.24***	.18**	.36***	.34***	.15*	.26***	.44***	.20**	.23**	1.0			
16.	.25***	.27***	.18**	.18**	.45***	.21**	.13	.26***	.27***	.09	.23**	.37***	.19**	.13	.45***	1.0		
17.	.33***	.35***	.32***	.17*	.48***	.28***	.16**	.30***	.33***	.19**	.24***	.44***	.27***	.26***	.50***	.55***	1.0	
18.	.33***	.37***	.31***	.18**	.40***	.34***	.27***	.29***	.37***	.17*	.27***	.41***	.17**	.31***	.40***	.44***	.59***	1.0

Note. $N = 221$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 4

Bivariate Correlations among DASS-21 Items, Low ASD Traits Group

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
1.	1.0																				
2.	.59	1.0																			
3.	.75	.63	1.0																		
4.	.73	.59	.72	1.0																	
5.	.75	.65	.75	.70	1.0																
6.	.72	.61	.72	.75	.68	1.0															
7.	.74	.57	.76	.67	.70	.77	1.0														
8.	.48	.47	.39	.34	.51	.35	.37	1.0													
9.	.48	.44	.45	.44	.41	.46	.42	.45	1.0												
10.	.62	.51	.57	.60	.52	.53	.53	.42	.53	1.0											
11.	.60	.56	.55	.60	.61	.63	.58	.46	.52	.50	1.0										
12.	.54	.49	.50	.53	.59	.55	.51	.52	.57	.59	.58	1.0									
13.	.58	.55	.55	.60	.61	.54	.55	.52	.65	.61	.60	.76	1.0								

14.	.64	.57	.68	.62	.66	.65	.65	.49	.62	.66	.65	.66	.66	1.0							
15.	.47	.54	.51	.44	.55	.49	.44	.40	.40	.47	.50	.54	.49	.51	1.0						
16.	.65	.57	.69	.59	.65	.62	.62	.47	.45	.53	.48	.54	.56	.58	.54	1.0					
17.	.64	.57	.60	.57	.61	.62	.57	.40	.57	.57	.63	.57	.63	.62	.56	.66	1.0				
18.	.59	.62	.60	.64	.60	.62	.57	.45	.53	.55	.64	.62	.65	.58	.56	.67	.63	1.0			
19.	.54	.54	.57	.59	.65	.61	.55	.43	.37	.48	.62	.61	.53	.58	.66	.54	.57	.60	1.0		
20.	.60	.52	.64	.58	.64	.57	.61	.44	.39	.55	.53	.58	.57	.60	.50	.65	.54	.67	.55	1.0	
21.	.57	.53	.53	.61	.59	.64	.47	.46	.52	.55	.64	.61	.61	.63	.53	.61	.61	.74	.59	.64	1.0

Note. $N = 202$. All correlations were significant at $p < .001$.

Table 5

Bivariate Correlations among DASS-21 Items, High ASD Traits Group

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
1.	1.0																				
2.	.55	1.0																			
3.	.66	.49	1.0																		
4.	.65	.47	.72	1.0																	
5.	.63	.51	.55	.61	1.0																
6.	.57	.48	.73	.67	.58	1.0															
7.	.61	.41	.71	.66	.61	.71	1.0														
8.	.38	.40	.40	.35	.45	.41	.37	1.0													
9.	.46	.36	.42	.43	.41	.41	.41	.54	1.0												
10.	.46	.35	.36	.37	.43	.40	.43	.49	.59	1.0											
11.	.39	.47	.45	.50	.42	.47	.41	.45	.45	.44	1.0										
12.	.51	.40	.51	.55	.48	.45	.49	.44	.57	.62	.61	1.0									
13.	.45	.44	.43	.48	.46	.45	.40	.46	.59	.62	.51	.62	1.0								

14.	.47	.40	.43	.42	.49	.45	.40	.49	.52	.51	.56	.64	.59	1.0							
15.	.49	.48	.48	.54	.45	.47	.46	.42	.38	.41	.50	.49	.46	.40	1.0						
16.	.57	.50	.49	.45	.58	.48	.50	.42	.45	.45	.51	.48	.34	.54	.47	1.0					
17.	.41	.43	.47	.49	.43	.46	.41	.46	.45	.50	.61	.63	.58	.49	.46	.44	1.0				
18.	.45	.48	.50	.50	.49	.46	.45	.33	.39	.38	.51	.51	.48	.47	.52	.56	.48	1.0			
19.	.47	.50	.47	.51	.53	.44	.48	.45	.39	.42	.51	.58	.43	.46	.67	.49	.56	.53	1.0		
20.	.45	.41	.46	.49	.53	.49	.51	.35	.31	.31	.44	.40	.40	.38	.41	.52	.35	.55	.41	1.0	
21.	.55	.51	.54	.54	.54	.56	.52	.34	.37	.38	.50	.42	.46	.46	.49	.57	.42	.63	.44	.61	1.0

Note. $N = 220$. All correlations were significant at $p < .001$.

Table 6

Bivariate Correlations among CESD-R Items, Low ASD Traits Group

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1.	1.0																			
2.	.82	1.0																		
3.	.79	.88	1.0																	
4.	.73	.73	.69	1.0																
5.	.66	.69	.70	.73	1.0															
6.	.39	.38	.45	.36	.44	1.0														
7.	.39	.29	.41	.46	.42	.57	1.0													
8.	.56	.51	.49	.54	.50	.33	.29	1.0												
9.	.41	.43	.46	.42	.52	.56	.48	.26	1.0											
10.	.49	.50	.44	.44	.48	.30	.25	.77	.33	1.0										
11.	.62	.67	.69	.71	.67	.45	.48	.39	.52	.39	1.0									
12.	.73	.75	.77	.75	.68	.39	.45	.40	.42	.37	.71	1.0								
13.	.63	.67	.61	.61	.65	.32	.25	.60	.46	.59	.58	.48	1.0							

14.	.61	.61	.65	.61	.62	.39	.38	.66	.36	.57	.54	.62	.66	1.0						
15.	.53	.46	.49	.50	.53	.48	.51	.40	.46	.23	.52	.48	.40	.46	1.0					
16.	.60	.61	.66	.66	.64	.42	.46	.50	.36	.41	.61	.67	.50	.57	.57	1.0				
17.	.68	.65	.67	.63	.71	.40	.47	.54	.42	.51	.64	.63	.68	.63	.52	.62	1.0			
18.	.59	.60	.64	.66	.74	.49	.49	.51	.53	.49	.70	.68	.70	.63	.55	.63	.76	1.0		
19.	.50	.48	.56	.57	.43	.27	.46	.35	.24	.18	.48	.51	.23	.36	.40	.57	.33	.32	1.0	
20.	.36	.51	.55	.46	.52	.48	.47	.27	.41	.28	.62	.50	.37	.38	.38	.54	.53	.47	.42	1.0

Note. $N = 203$. All correlations were significant at $p < .001$.

Table 7

Bivariate Correlations among CESD-R Items, High ASD Traits Group

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1.	1.0																			
2.	.75***	1.0																		
3.	.76***	.80***	1.0																	
4.	.70***	.68***	.69***	1.0																
5.	.69***	.62***	.66***	.67***	1.0															
6.	.43***	.40***	.45***	.37***	.52***	1.0														
7.	.26***	.20**	.19*	.27***	.27***	.47***	1.0													
8.	.49***	.48***	.55***	.51***	.55***	.45***	.2**	1.0												
9.	.43***	.41***	.41***	.37***	.48***	.46***	.45***	.30***	1.0											
10.	.44***	.52***	.50***	.47***	.47***	.38***	.13*	.73***	.29***	1.0										
11.	.62***	.64***	.65***	.67***	.63***	.37***	.35***	.46***	.38***	.44***	1.0									
12.	.69***	.71***	.67***	.66***	.69***	.44***	.30***	.49**	.43***	.49***	.71***	1.0								
13.	.58***	.56***	.53***	.56***	.62***	.43***	.21**	.53***	.46***	.43***	.49***	.56***	1.0							
14.	.38***	.49***	.49***	.48***	.48***	.34***	.05	.51***	.35***	.50***	.35***	.50***	.60***	1.0						
15.	.47***	.50***	.46***	.47***	.53***	.39***	.39***	.41***	.51***	.42***	.50***	.59***	.49***	.45***	1.0					
16.	.26***	.35***	.37***	.31***	.36***	.31***	.23**	.46***	.23**	.48***	.44***	.37***	.34***	.31***	.38***	1.0				
17.	.55***	.59***	.56***	.45***	.54***	.41***	.15*	.47***	.40***	.47***	.48***	.50***	.59***	.44***	.42***	.36***	1.0			
18.	.58***	.63***	.61***	.56***	.64***	.41***	.26***	.55***	.43***	.50***	.61***	.66***	.67***	.49***	.62***	.50***	.72***	1.0		
19.	.46***	.50***	.45***	.45***	.47***	.27***	.53***	.29***	.53***	.34***	.56***	.53***	.34***	.24**	.46***	.24**	.35***	.47***	1.0	
20.	.34***	.38***	.37***	.44***	.37***	.30***	.59***	.17**	.42***	.31***	.48***	.49***	.28***	.19**	.47***	.27***	.22**	.37***	.72***	1.0

Note. $N = 221$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 8

Skewness and Kurtosis Statistics for Items

Variable	Skewness	Kurtosis
AQ1	-.27	-1.94
AQ2	-.45	-1.81
AQ3	1.46	.14
AQ4	-.55	-1.70
AQ5	-.64	-1.60
AQ6	-.27	-1.94
AQ7	.82	-1.34
AQ8	1.46	.14
AQ9	.46	-1.79
AQ10	.41	-1.84
AQ11	-.34	-1.89
AQ12	-1.12	-.75
AQ13	-.52	-1.74
AQ14	.13	-1.99
AQ15	-.12	-.75
AQ16	-.44	-1.81
AQ17	.41	-1.83
AQ18	.74	-1.47
AQ19	-.11	-1.99
AQ20	1.01	-.98
AQ21	.94	-1.13
AQ22	-.40	-1.85
AQ23	-.71	-1.50
AQ24	-.07	-2.00
AQ25	-.61	-1.64
AQ26	-.31	-1.92
AQ27	.96	-1.08
AQ28	.17	-1.98
AQ29	.24	-1.95
AQ30	-.51	-1.75
AQ31	1.33	-.24
AQ32	.41	-1.84
AQ33	.33	-1.90
AQ34	-.005	-2.00
AQ35	.77	-1.42
AQ36	.89	-1.20
AQ37	.61	-1.64
AQ38	-.29	-1.93
AQ39	.58	-1.67
AQ40	.82	-1.34
AQ41	-.04	-2.00
AQ42	.15	-1.99

AQ43	-1.46	.14
AQ44	-.04	-2.00
AQ45	.63	-1.62
AQ46	-.91	-1.18
AQ47	-.03	-2.00
AQ48	.58	-1.67
AQ49	.30	-1.92
AQ50	.52	-1.74
DASS-1	.82	-.20
DASS-2	1.15	.42
DASS-3	1.00	.009
DASS-4	1.54	1.58
DASS-5	.83	-.25
DASS-6	.89	-.23
DASS-7	1.69	1.97
DASS-8	.88	-.38
DASS-9	1.07	.029
DASS-10	.87	-.49
DASS-11	.74	-.45
DASS-12	.80	-.44
DASS-13	.80	-.53
DASS-14	.97	.03
DASS-15	1.29	.53
DASS-16	.95	-.23
DASS-17	1.04	-.15
DASS-18	.83	-.27
DASS-19	1.19	.30
DASS-20	1.36	.83
DASS-21	1.26	.46
ASRS-1	.47	-.27
ASRS-2	.52	-.37
ASRS-3	.63	-.35
ASRS-4	.30	-.69
ASRS-5	.39	-.87
ASRS-6	.54	-.48
ASRS-7	.57	-.14
ASRS-8	.19	-.65
ASRS-9	.63	-.34
ASRS-10	.35	-.57
ASRS-11	.30	-.59
ASRS-12	1.09	.45
ASRS-13	.56	-.27
ASRS-14	.35	-.56
ASRS-15	.81	.03
ASRS-16	.76	-.17
ASRS-17	.77	-.16

ASRS-18	.68	.13
CESD-R-1	1.63	2.20
CESD-R-2	1.23	.54
CESD-R-3	1.08	.43
CESD-R-4.	1.11	.16
CESD-R-5	.76	-.52
CESD-R-6	1.12	.24
CESD-R-7	1.15	.48
CESD-R-8	1.35	.96
CESD-R-9	1.43	1.08
CESD-R-10	1.26	.76
CESD-R-11	1.50	1.70
CESD-R-12	1.48	1.24
CESD-R-13	1.33	.79
CESD-R-14	2.26	4.64
CESD-R-15	2.75	7.81
CESD-R-16	.98	-.14
CESD-R-17	1.1	-.03
CESD-R-18	2.44	5.40
CESD-R-19	1.02	-.10
CESD-R-20	.97	-.03

Table 9

Bivariate Correlations between Subscale Scores on Study Measures

	Low ASD Traits (n = 203)						*High ASD Traits (n =220)*					
Measure	1.	2.	3.	4.	5.	6.	1.	2.	3.	4.	5.	6.
1. CESD-R	1.0						1.0					
2. DASS - Depression	.89	1.0					.83	1.0				
3. DASS-Anxiety	.80	.78	1.0				.66	.68	1.0			
4. DASS-Stress	.82	.84	.83	1.0			.77	.80	.77	1.0		
5. ASRS - Inattention	.57	.58	.57	.62	1.0		.57	.58	.43	.56	1.0	
6. ASRS – Hyperactivity Impulsivity	.57	.58	.62	.67	.77	1.0	.63	.58	.62	.67	.75	1.0

Note. All correlations were significant at $p < .001$.

Table 10

Internal Consistency of Study Measures

Measure	*Total Sample* *(n = 422 - 424)*	*Low ASD Traits* *(n = 202- 203)*	*High ASD Traits* *(n = 220 -221)*
CESD-R	.953	.955	.944
DASS-21	.962	.966	.95
DASS – Depression	.931	.94	.913
DASS – Anxiety	.905	.904	.891
DASS – Stress	.906	.915	.875
ASRS – Total	.927	.936	.903
ASRS – Inattention	.90	.917	.869
ASRS – Hyperactivity Impulsivity	.853	.87	.813

Note. All estimates are Cronbach's α.

Table 11

Goodness of Fit Indices for Alternative Confirmatory Factor Analysis Models

Measure	Model	X^2	*df*	*p*	RMSEA [90% CI]	CFI	SRMR	TLI	AIC	BIC
CESD-R	Configural	949.14	338	< .001	.092 [.085, .099]	.808	.077	.785	20145.31	20252.23
	Metric	978.45	357	< .001	.091 [.084, .097]	.805	.086	.793	20150.28	20240.55
DASS-21	Configural	527.06	373	< .001	.04 [.035, .053]	.954	.229	.949	16959.46	17073.65
	Metric	539.86	388	< .001	.043 [.034, .051]	.955	.228	.951	16943.67	17044.78
	Scalar	560.47	406	< .001	.042 [.034, .051]	.954	.229	.953	16927.02	17012.44
	Strict	761.68	427	< .001	.061 [.054, .068]	.901	.230	.903	17246.68	17313.79
ASRS	Configural	672.44	268	< .001	.084 [.077, .092]	.849	.108	.827	19752.64	19848.79
	Metric	687.47	282	< .001	.082 [.075, .09]	.848	.110	.84	19735.93	19819.84
	Scalar	720.08	298	< .001	.082 [.074, .089]	.842	.110	.84	19735.49	19805.42
	Strict	807.66	316	< .001	.086 [.078, .093]	.816	.116	.822	19808.46	19862.65

Note. RMSEA = root mean square error of approximation; CFI = comparative fit index; SRMR = standardized root mean square residual; TLI = Tucker Lewis Index; AIC = Akaike Information Criterion; BIC = sample size-adjusted Bayesian Information Criterion.

Table 12

Results of Exploratory Factor Analysis of the CESD-R

Item	Factor 1: Negative Affect	Factor 2: Physical Symptoms	Factor 3: Behavior Changes	Communality
My appetite was poor.	-.021	**.505**	.323	.359
I could not shake off the blues.	**.865**	.050	-.150	.773
I had trouble keeping my mind on what I was doing.	.130	**.673**	-.003	.469
I felt depressed.	**.997**	-.021	-.236	1.04
My sleep was restless.	-.227	**.950**	-.004	.954
I felt sad.	**.928**	.022	-.183	.895
I could not get going.	.031	**.784**	-.034	.616
Nothing made me happy.	**.730**	.121	-.025	.548
I felt like a bad person.	**.597**	.175	.143	.407

I lost interest in my usual activities.	.362	**.474**	.066	.360
I slept much more than usual.	.045	**.416**	.375	.315
I felt like I was moving too slowly.	.031	**.542**	.346	.414
I felt fidgety.	.026	**.572**	.156	.352
I wished I were dead.	**.674**	-.179	.353	.610
I wanted to hurt myself.	.377	.008	**.531**	.424
I was tired all the time.	-.024	**.775**	-.059	.604
I did not like myself.	**.743**	.114	.026	.565
I lost a lot of weight without trying to.	-.016	.220	**.711**	.554
I had a lot of trouble getting to sleep.	-.187	**.862**	-.002	.778
I could not focus on the important things.	.010	**.789**	.156	.646
Eigenvalues	10.681	1.606	1.140	

Correlations among factors			
	1	2	3
1	-		
2	.825	-	
3	.383	.193	-

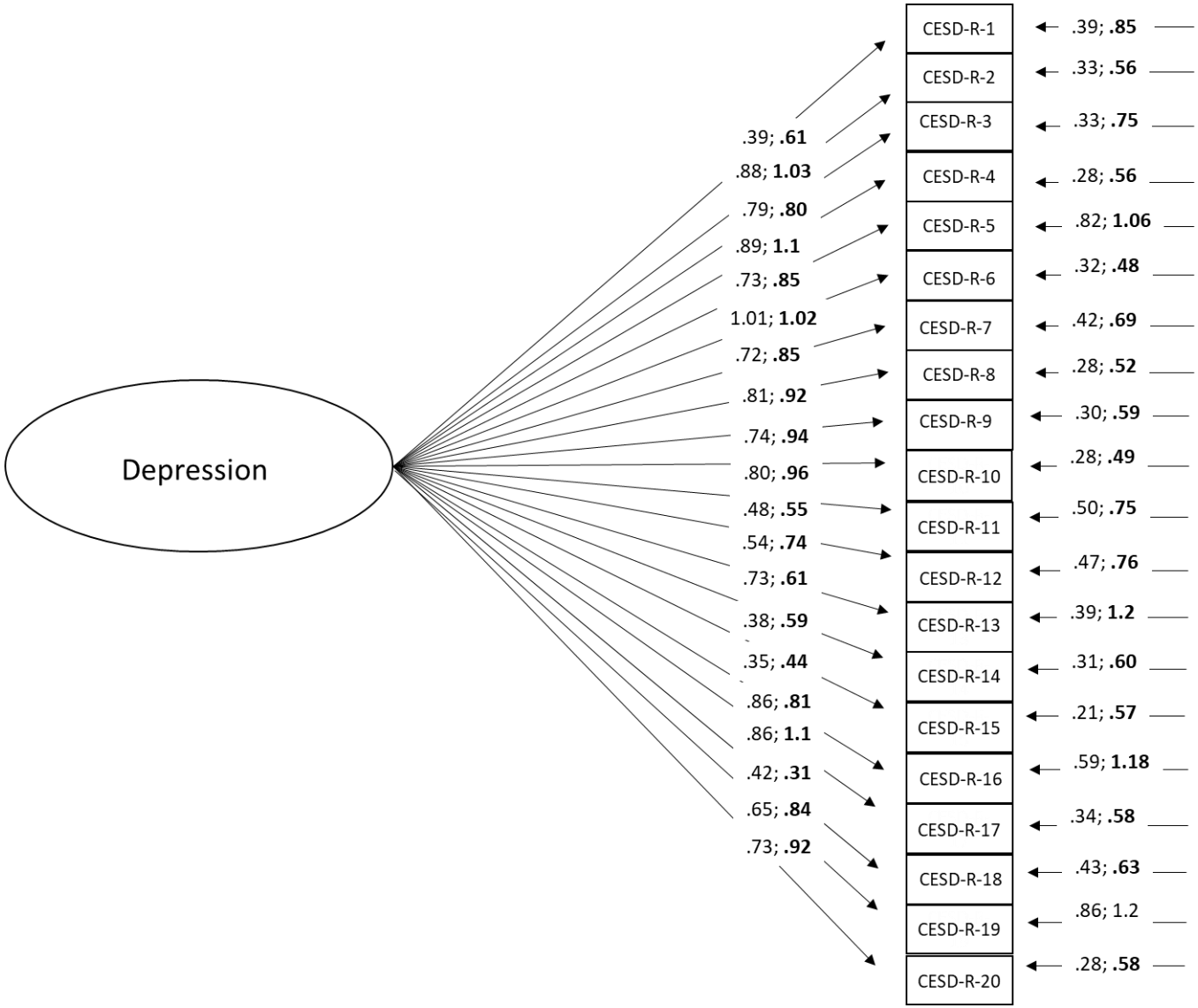

Figure 1a. Unstandardized parameter estimates for configural invariance of the CESD-R. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

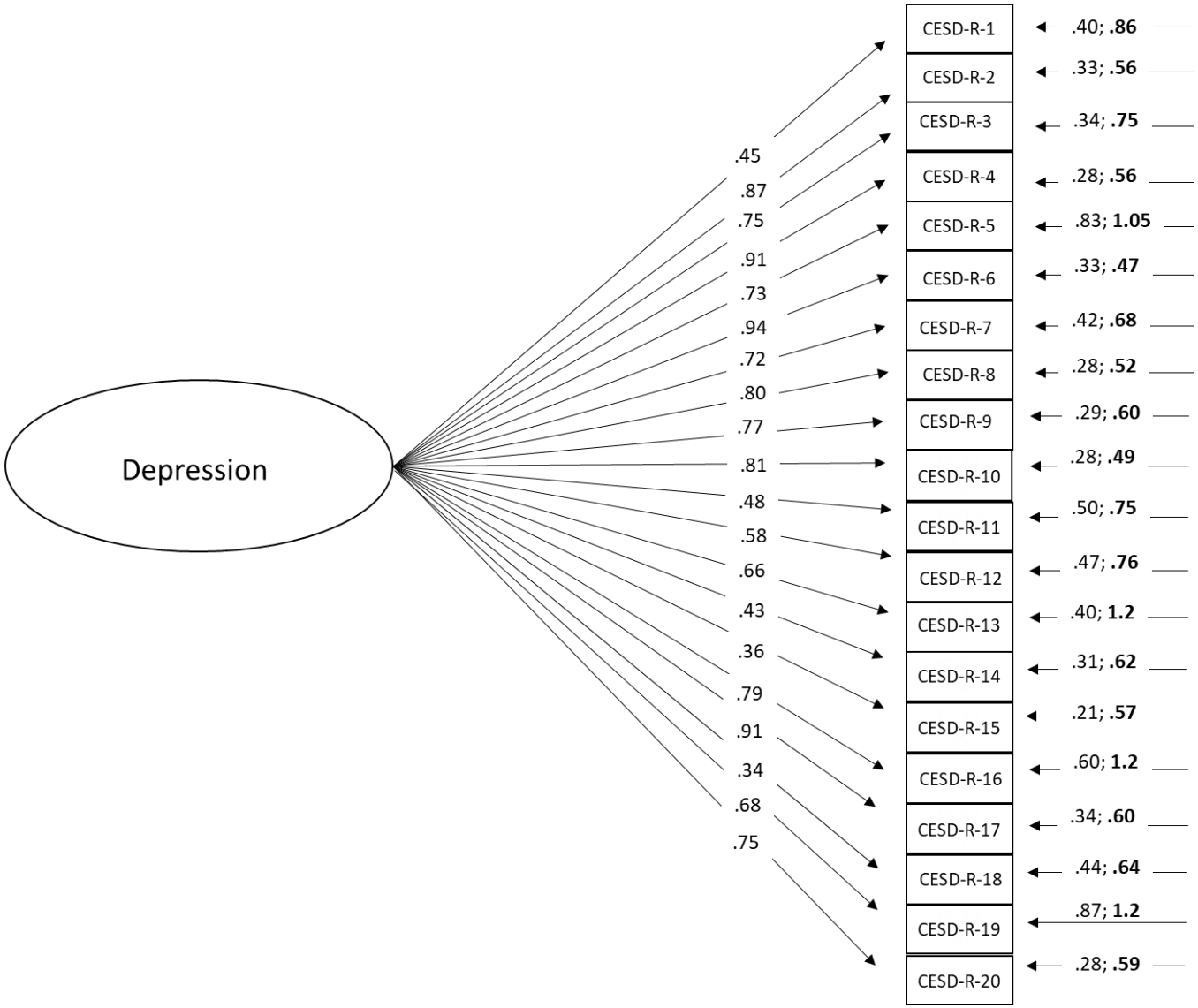

Figure 1b. Unstandardized parameter estimates for metric invariance of the CESD-R. Factor loadings were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

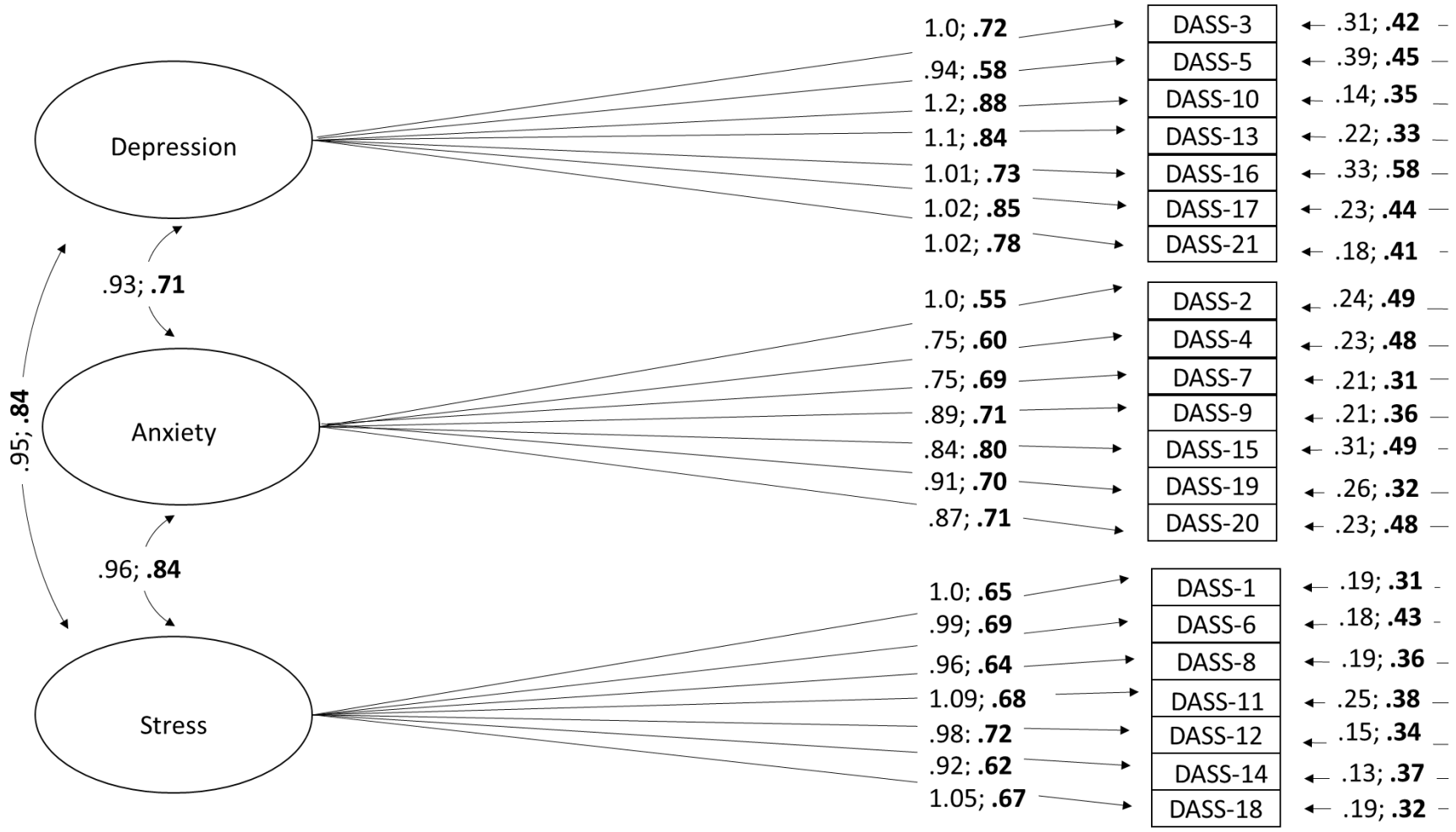

Figure 2a. Unstandardized parameter estimates for configural invariance of the DASS-21. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

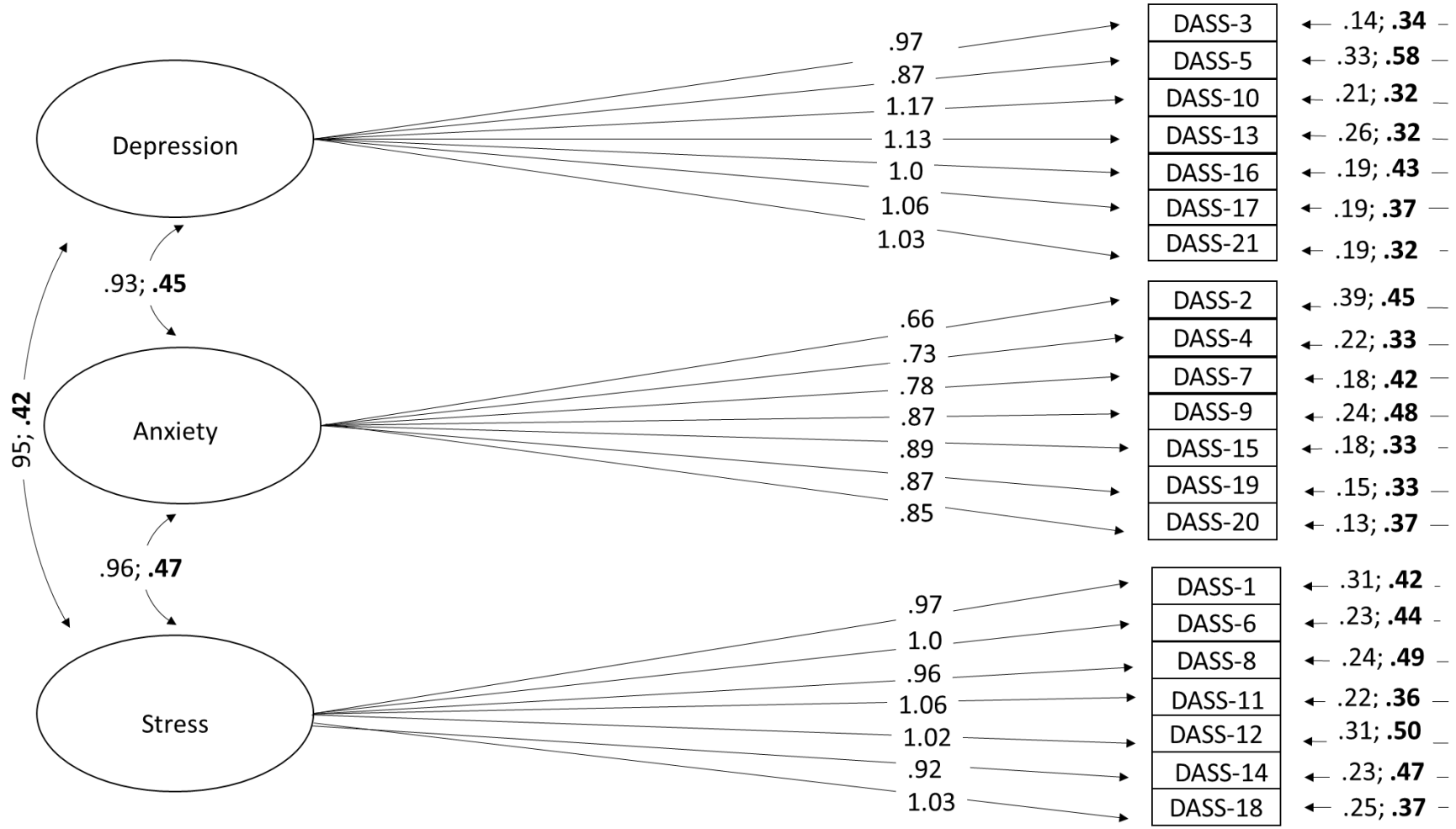

Figure 2b. Unstandardized parameter estimates for metric invariance of the DASS-21. Factor loadings were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

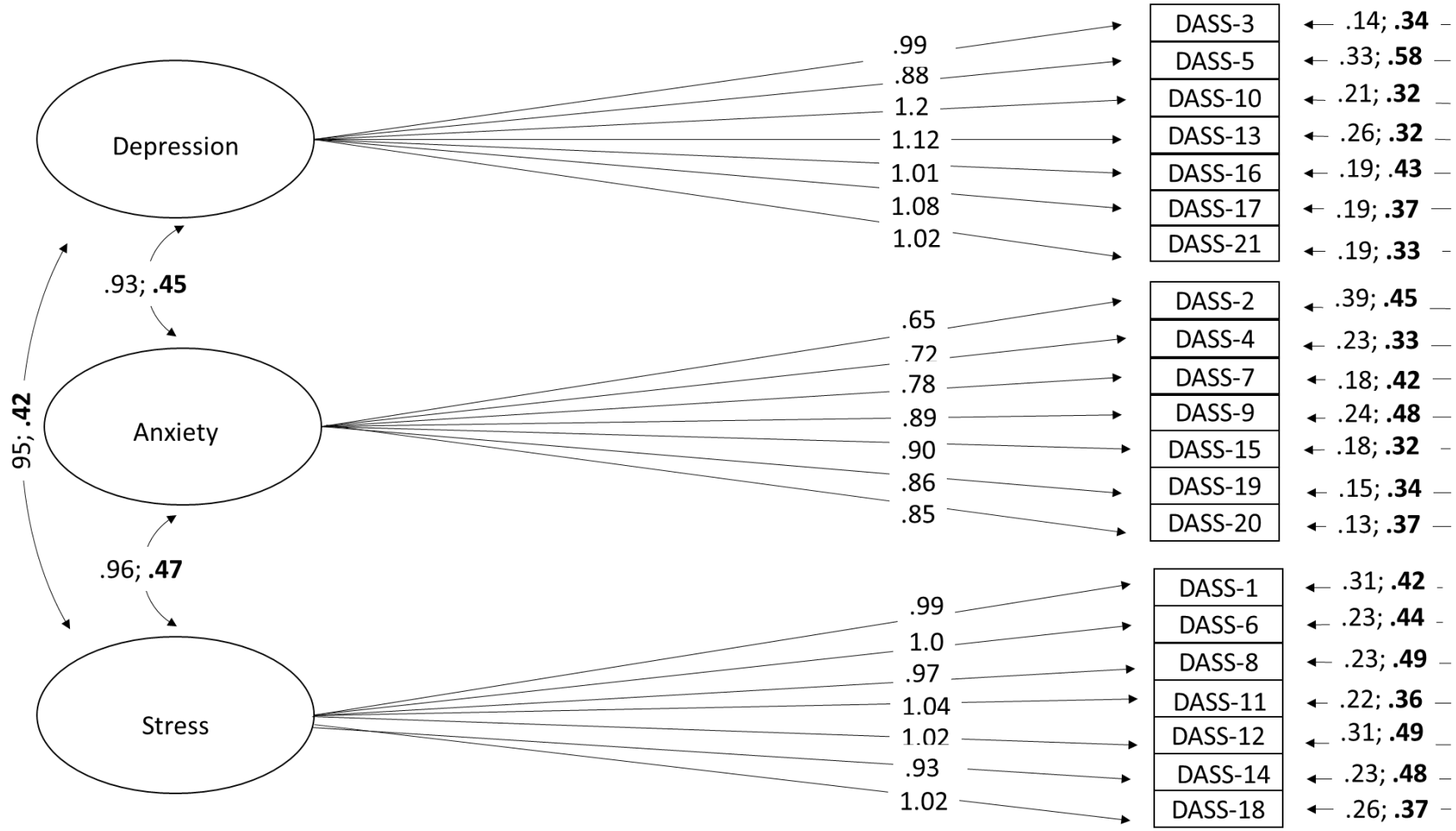

Figure 2c. Unstandardized parameter estimates for scalar invariance of the DASS-21. Factor loadings and intercepts were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

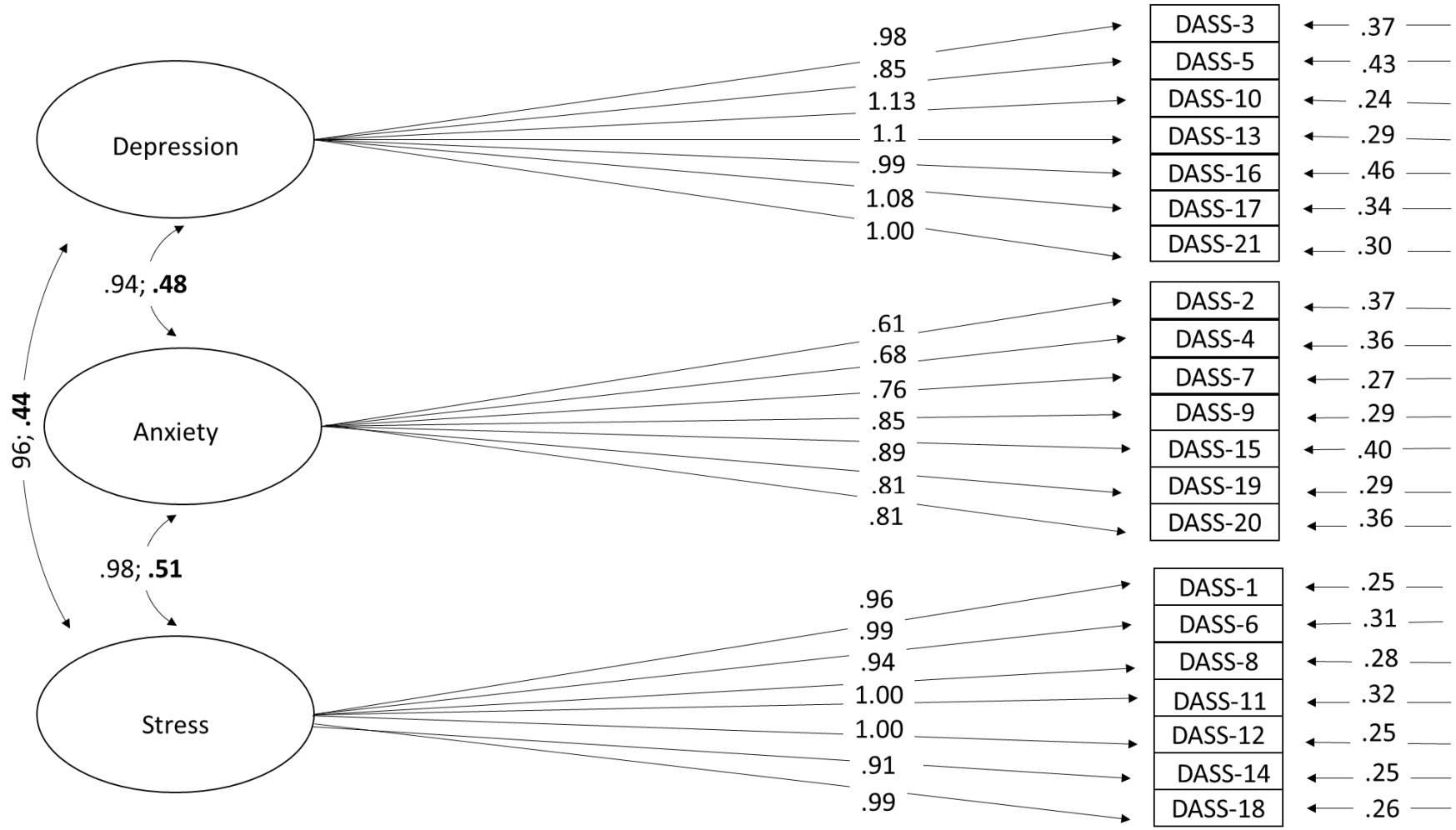

Figure 2d. Unstandardized parameter estimates for strict invariance of the DASS-21. Factor loadings, intercepts, and residual variances were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

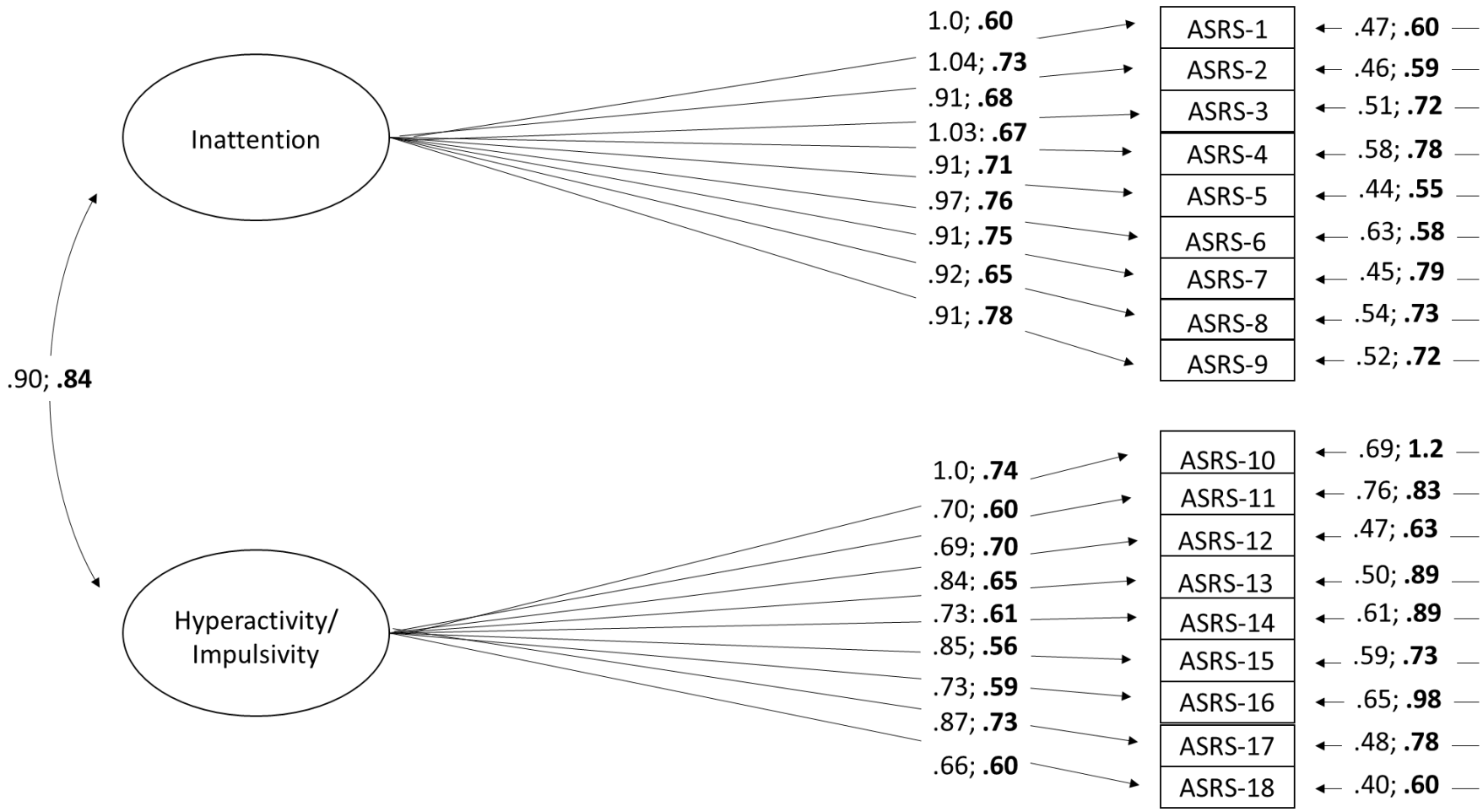

Figure 3a. Unstandardized parameter estimates for configural invariance of the ASRS. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

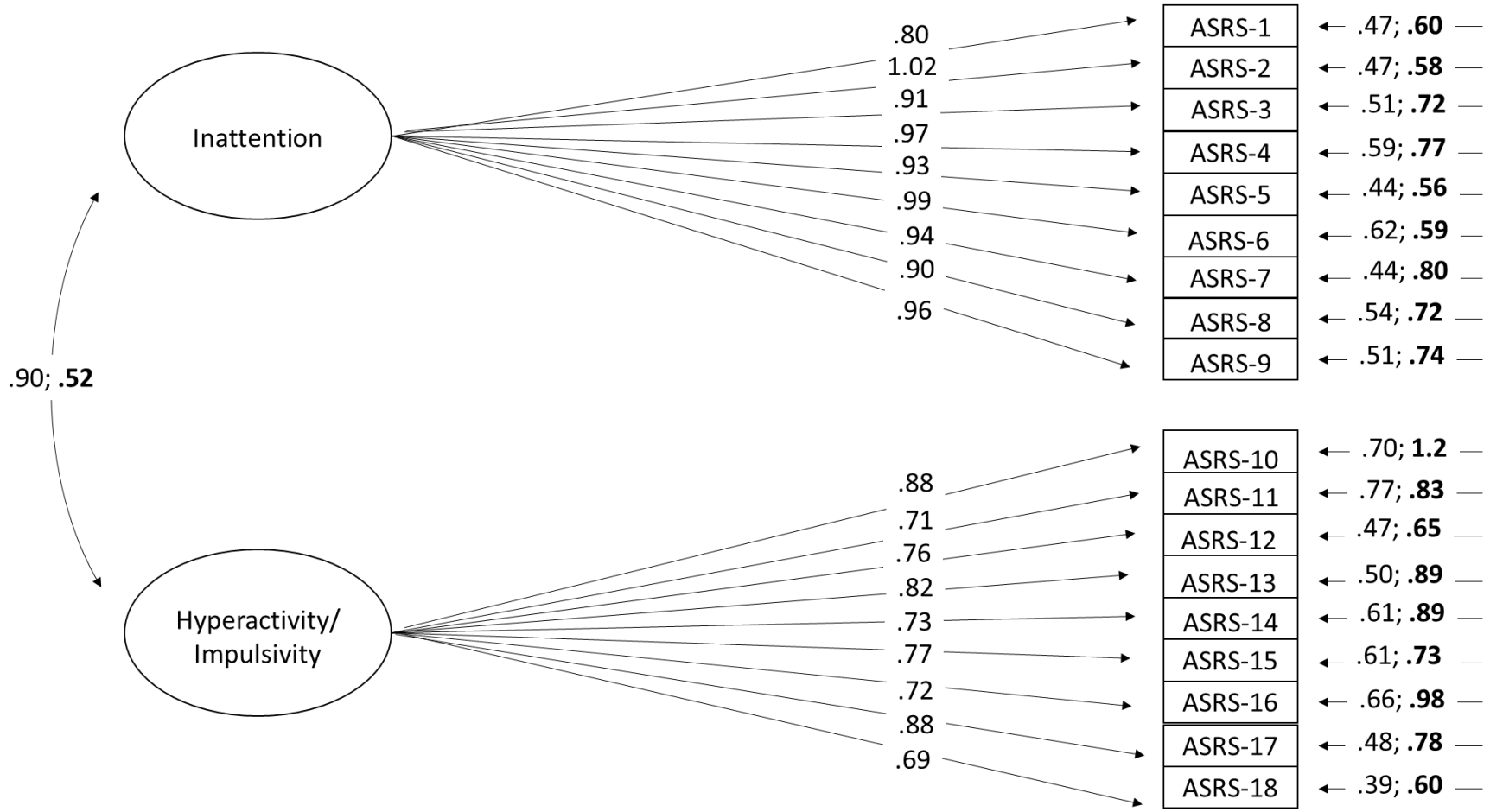

Figure 3b. Unstandardized parameter estimates for metric invariance of the ASRS. Factor loadings were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

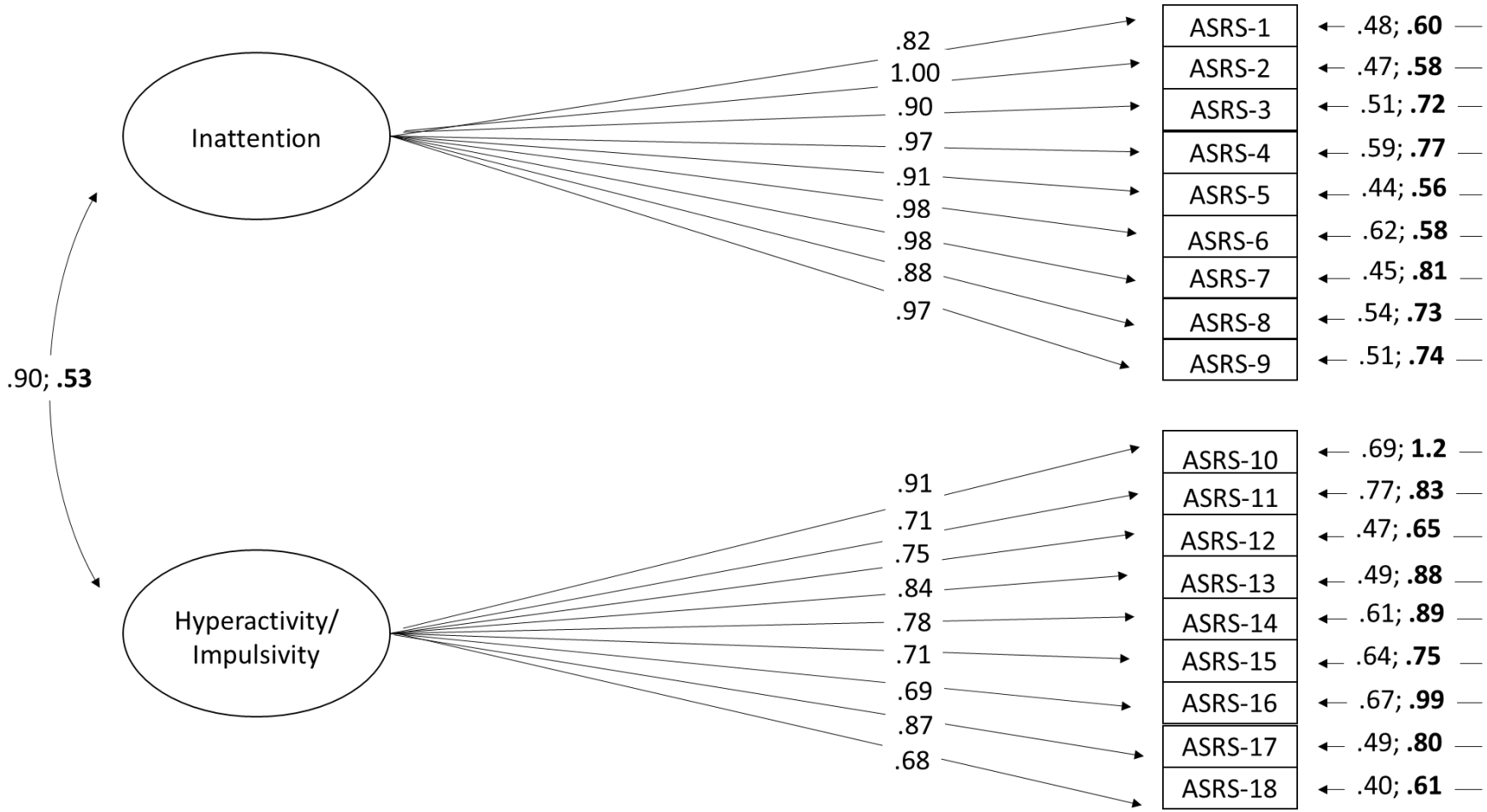

Figure 3c. Unstandardized parameter estimates for scalar invariance of the ASRS. Factor loadings and intercepts were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

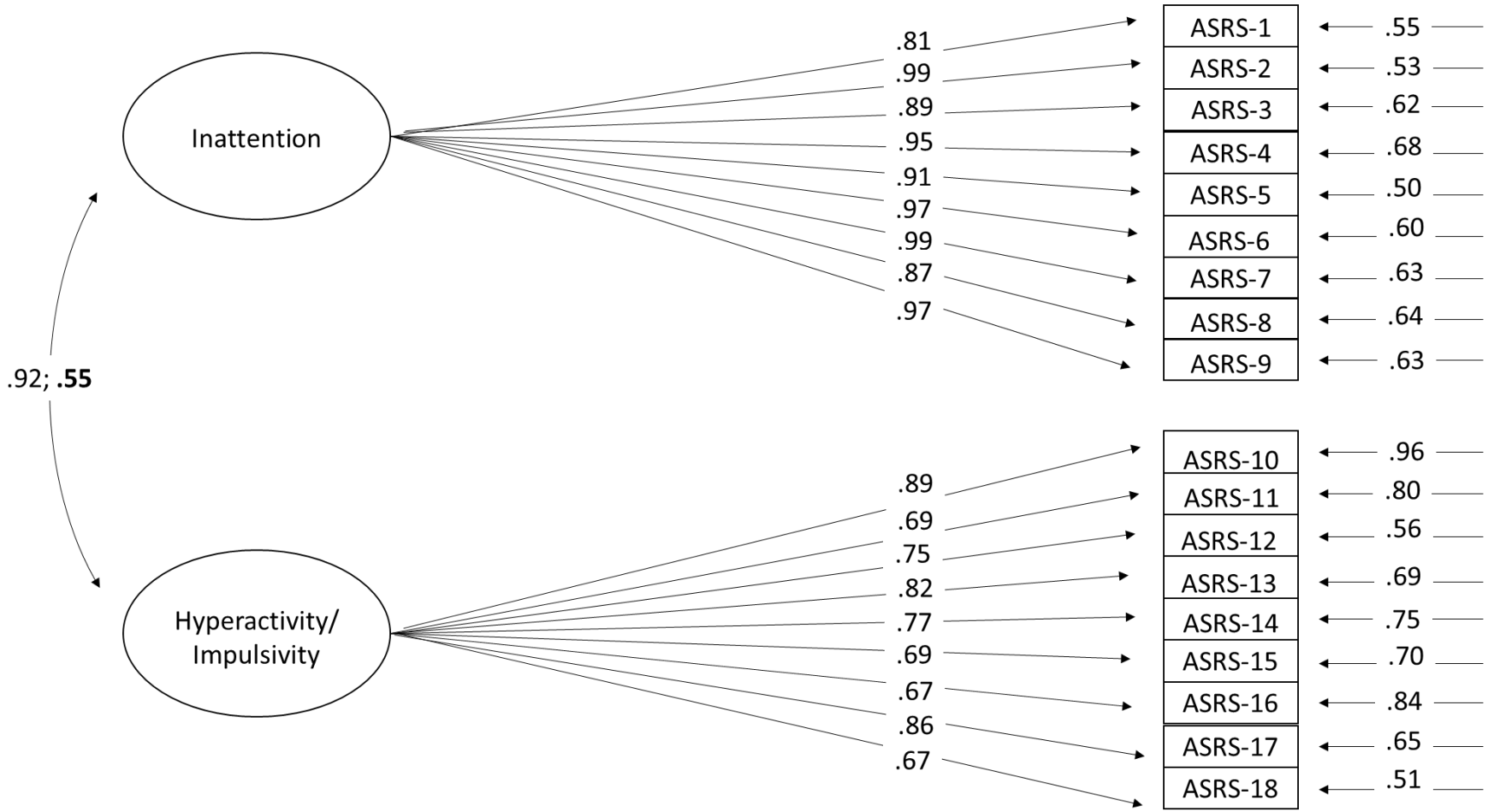

Figure 3d. Unstandardized parameter estimates for strict invariance of the ASRS. Factor loadings, intercepts, and residual variances were constrained to be equal across groups. Estimates for the *high ASD traits* cohort are presented in boldface following estimates for the *low ASD traits* cohort.

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Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta psychiatrica scandinavica, 67*, 361-370. doi: 10.1111/j.1600-0447.1983.tb09716.x

Zohar, A. H., & Konfortes, H. (2010). Diagnosing ADHD in Israeli adults: The psychometric properties of the adult ADHD self-report scale (ASRS) in Hebrew. *Israel Journal of Psychiatry and Related Sciences, 47*(4), 308-315.

Zung, W. W. K. (1965). A self-rating depression scale. *Archives of General Psychiatry, 12*, 63-70. doi: 10.1001/archpsyc.1965.01720310065008

Vita

Elizabeth P. McKernan

Education and Training

Predoctoral Internship, Penn Center for Mental Health, Perelman School of Medicine, University of Pennsylvania — 2019-2020

Ph.D., School Psychology — 2020 (Anticipated)
Syracuse University
Advisor: Natalie Russo, Ph.D.
Dissertation: *Factor invariance of anxiety and depression measures in autism*
GPA: 3.98/4.0

M.S., Psychology — December 2017
Syracuse University
Advisor: Natalie Russo, Ph.D.
Thesis: *Concordance and discordance: Cognitive and neuropsychological performance of twins with ASD*

B.A., Psychology; Human Services, *summa cum laude* — May 2014
Villanova University
Minors: Sociology; French
GPA: 3.95/4.0

Honors and Awards

2018, 2017 & 2016	Psychology Department Graduate Travel Award. Syracuse University
2018	International Society for Autism Research (INSAR) Student Travel Award.
2014	Member, Phi Beta Kappa.
2014	Member, Psi Chi.
2014	Medallion of Academic Excellence. College of Arts and Sciences, Villanova University

Professional Development

2018-present	Women in Science and Engineering Future Professionals Program. Syracuse University.
2018	Safer People, Safer Spaces Training. LGBT Resource Center, Syracuse University.

2017 Autism Diagnostic Observation Schedule (ADOS-2) Research Training. Center for Autism and the Developing Brain, White Plains, NY.

- *Research reliable (2018).*

2016 Autism Diagnostic Observation Schedule (ADOS-2) Clinical Training. Upstate Medical University, Syracuse, NY.

2016-2018 Future Professoriate Program.
College of Arts and Sciences, Syracuse University.

Clinical Experience

2019-present Predoctoral Internship, Penn Center for Mental Health,

Perelman School of Medicine, University of Pennsylvania

Supervisors: Keiran Rump, Ph.D. (licensed psychologist); Melanie Pellecchia, Ph.D., BCBA (licensed psychologist); Julie Worley, Ph.D. (licensed psychologist); Brenna Maddox, Ph.D. (licensed psychologist)

- Conduct diagnostic and treatment planning evaluations of individuals with autism spectrum disorder (ASD).
- Implement naturalistic developmental behavioral interventions (NDBI) for preschool children with ASD and other developmental delays.
- Consult with autism support teachers in the School District of Philadelphia regarding evidence-based practices for students with ASD.
- Lead a social skills group for children ages six through ten with ASD and other social challenges.
- Provide individual cognitive-behavioral therapy to children and adolescents with anxiety disorders.

2018-2019 School Psychology Practicum, Huntington K-8 School, Syracuse, NY

Supervisors: Brienan Dubiel, M.A.; Larry Lewandowski, Ph.D. (licensed psychologist)

- Administered psychoeducational evaluations, wrote integrated reports, conducted functional behavioral assessments, assisted in implementation of positive behavioral supports, and provided consultation to teachers/staff.

Spring 2018 ADHD Clinic, Psychological Services Center, Syracuse University

Supervisor: Kevin Antshel, Ph.D. (licensed psychologist)

- Performed weekly diagnostic assessments for children suspected of having attention-deficit/hyperactivity disorder (ADHD).

Spring 2018 — Consultation Practicum, Huntington K-8 School, Syracuse, NY

Supervisors: Brienan Dubiel, M.A.; Brian Martens, Ph.D.

- Provided academic and behavioral consultation services to students (kindergarten through fifth grade), teachers, and administrators.

2017-2018 — Student Clinician, Psychological Services Center, Syracuse University

Supervisors: Sarah Felver, Ph.D. (licensed psychologist); Aaron Gleason, Ph.D. (licensed psychologist); Joseph Himmelsbach, Ph.D. (licensed psychologist)

- Provided weekly psychotherapy (including cognitive-behavioral therapy, psychodynamic therapy, and motivational interviewing techniques) to children, adolescents and adults under the supervision of licensed psychologists.
- Conducted psychological assessments for a variety of presenting concerns (e.g., depression, anxiety, ADHD, OCD, PTSD, autism, personality disorders).

Fall 2017 — Behavior Therapy Practicum, SPICE at Park Hill School, East Syracuse, NY

Supervisors: Leah Phaneuf, Ph.D., BCBA (licensed psychologist); Brian Martens, Ph.D.

- Designed, implemented, and monitored behavioral interventions using applied behavior analysis (ABA) to preschool students receiving special education services.

2016-2017 — Group Cognitive Behavior Therapy, Department of Psychology, Syracuse University

Supervisor: Kevin Antshel, Ph.D. (licensed psychologist)

- Led a ten-week group designed to improve social functioning in children experiencing social difficulties (e.g., children with ASD, ADHD, anxiety).
- Engaged in instruction and modeling of appropriate social problem-solving and communication skills and facilitated dyad skill practice.

2016-2017 Social Skills Parent Group Leader, Department of Psychology, Syracuse University

Supervisor: Kevin Antshel, Ph.D. (licensed psychologist)

- Led a group for parents of children experiencing social difficulties (e.g., children with ASD, ADHD, anxiety).
- Reviewed skills children were learning in a concurrent group, and provided overviews of topics (e.g., homework compliance).

2016-2019 Research Clinician, Center for Autism Research in Electrophysiology
Department of Psychology, Syracuse University

Supervisor: Natalie Russo, Ph.D. (licensed psychologist)

- Conducted ASD evaluations for research participants using the ADOS-2.
- Administered intelligence (WASI-II), language (PPVT-4), and achievement (WJ-IV Ach) tests to research participants.
- Wrote integrated clinical reports for research participants/families.

2014-2015 Direct Support Professional, STRIVE/PSL Services,
South Portland, ME

- Supported youth and young adults with developmental and intellectual disabilities in educational and social programs, and provided assistance with activities of daily living.

2014 Play Therapy Intern, Social Enrichment Center, Springfield, PA

Supervisors: Beth Roberts, M.A., LPC; Michelle Martin, M.S.W.

- Facilitated group play therapy sessions for children ages 5-13 with a variety of diagnoses (e.g., ASD, ADHD, anxiety) with an emphasis on developing social skills in the context of play.

Publications

McKernan, E. P., Cascio, C. J., & Russo, N. (2020). Sensory overresponsivity as a predictor of amplitude discrimination performance in youth with ASD. In F. R. Volkmar (Ed.), *Encyclopedia of Autism Spectrum Disorders.* New York, NY: Springer.

McKernan, E. P., Wu, Y., & Russo, N. (2019). Sensory overresponsivity as a predictor of amplitude discrimination performance in youth with ASD. *Journal of Autism and Developmental Disorders, xx,* 1-9. doi: 10.1007/s10803-019-04013-0

Shea, N., **McKernan, E. P.,** Kopec, J. B., & Russo, N. (2018). Autism Rating Scales. In E. Braaten (Ed.), *SAGE Encyclopedia of Intellectual and Developmental Disorders*. Thousand Oaks, CA: SAGE Publications, Inc.

McKernan, E. P., Russo, N., Burnette, C., & Kates, W. R. (2017). ASD concordance of twins across DSM-IV-TR and DSM-5 diagnostic criteria. *Research in Autism Spectrum Disorders, 41,* 51-56. doi: 10.1016/j.rasd.2017.08.004

Kaplan, E. A., **McKernan, E.,** Kopec, J., & Russo, N. (under review). Attention in individuals with Down syndrome. In J. A. Burack, J. Edgin, L. Abbeduto, & J. Busciglio (Eds.), *Oxford Handbook of Down Syndrome and Development*. New York, NY: Oxford University Press.

Conference Presentations

McKernan, E. P., Kopec, J., Kaplan, E. A., Koelmel, E. L., Masters, E., & Russo, N. (2019, May). Individuals with higher levels of autistic traits are less susceptible to social conformity on a perceptual decision-making task. Poster presented at the International Society for Autism Research Annual Meeting, Montreal, Canada.

Levitskiy, D., Wagner, K., Rajan, A., Ericson, R., Shea, N., **McKernan, E. P.,** … & Middleton, F. A. (2019, May). Correlations between psychological assessments and RNA concentrations in saliva of adolescents and adults with ASD. Poster presented at the International Society for Autism Research Annual Meeting, Montreal, Canada.

*Wu, Y., Kopec, J., Prawl, A., **McKernan, E.,** Kaplan, E., Koelmel, E., & Russo, N. (2019, May). Correlation between accuracy of multispeed color task and autism quotient scores in typically developing children and children with ASD. Poster presented at Syracuse University Department of Psychology Undergraduate Poster Session, Syracuse, NY.

McKernan, E. P., Kopec, J., Kaplan, E. A., Koelmel, E. L., & Russo, N. (2018, May). The relationship of sensory overresponsivity to amplitude discrimination. Poster presented at the International Society for Autism Research Annual Meeting, Rotterdam, Netherlands.

Kaplan, E. A., Russo, N., **McKernan, E. P.,** Kopec, J., & Koelmel, E. L. (2018, May). EEG correlates of the attentional blink: Correlation to autism symptoms. Poster presented at the International Society for Autism Research Annual Meeting, Rotterdam, Netherlands.

Kopec, J., Prawl, A., **McKernan, E. P.,** Kaplan, E. A., Koelmel, E., & Russo, N. (2018, May). Children and adults with autism detect rapidly presented temporal information more accurately than typically developing individuals. Poster presented at the International Society for Autism Research Annual Meeting, Rotterdam, Netherlands.

Miseros, M., Russo, N., **McKernan, E.**, Masucci, R., Lum, W., Stewart, J., Brodeur, D., & Burack, J. A. (2018, May). Dynamic visual filtering in individuals with Down syndrome: Effects of time and space. Poster presented at Development 2018, St. Catharines, Ontario, Canada.

*Bell, C., *Wu, Y., **McKernan, E.,** & Russo, N. (2018, May). Color choice: Autistic traits and accuracy. Poster presented at Syracuse University Department of Psychology Undergraduate Poster Session, Syracuse, NY.

McKernan, E. P., Russo, N., Burnette, C., Kaplan, E. A., Kopec, J., Shea, N., & Kates, W. R. (2017, May). ASD concordance of twins across DSM-IV-TR and DSM-5 diagnostic criteria. Poster presented at the International Meeting for Autism Research, San Francisco, CA.

Shea, N., Payne, E., **McKernan, E. P.,** Kopec, J., Kaplan, E. A.**,** Antshel, K., Kates, W. R., Russo, N. (2017, May). The relationship between socialization and externalizing problems in ASD and VCFS. Poster presented at the International Meeting for Autism Research, San Francisco, CA.

*Fiore, C., *Bell, C., **McKernan, E.,** & Russo, N. (2017, May). Amplitude discrimination as a measure of tactile processing in children with autism spectrum disorder. Poster presented at Syracuse University Department of Psychology Undergraduate Poster Session, Syracuse, NY.

Shea, N., Payne, E., Kopec, J., **McKernan, E.,** & Russo, N. (2016, May). The interaction of socialization and externalizing problems in autism spectrum disorder. Poster presented at the International Meeting for Autism Research, Baltimore, MD.

* denotes undergraduate mentee.

Teaching and Mentorship Experience

2015-2016 Teaching Assistant, Department of Psychology, Syracuse University.
PSY 205-Foundations of Human Behavior

- Independently taught three weekly 80-minute recitation sections.
- Provided lectures and facilitated discussions.
- Graded homework, quizzes, papers, and exams.

2016-2017 Graduate Assistant, Department of Psychology, Syracuse University.
Allport Project, Office of Undergraduate Advising

- Led seminars for undergraduate students in psychology.
- Organized research opportunities for undergraduates.
- Coordinated internship placements for undergraduates.
- Facilitated application process for all undergraduate programming.
- Directed annual undergraduate poster session.

2016 & 2018 Guest Lecturer, Department of Psychology, Syracuse University.
Spring 2018: PSY 445-Behavior Disorders in Children

- Guest lecture on autism spectrum disorder assessment/diagnosis.

Summer 2016: PSY 335-Psychology of Childhood

- Guest lecture on autism spectrum disorder.

Professional Service

2018-2019 Communications Committee Member, School Psychology Program, Department of Psychology, Syracuse University
- Managed social media and public relations for graduate program.

2017-2018 Co-President, Psychology Action Committee, Syracuse University
- Represented interests of psychology graduate student body to department administration and relayed faculty concerns to psychology graduate student body.

2015-2019 Student Affiliate to National Groups, School Psychology Program, Department of Psychology, Syracuse University
- Student representative of National Association of School Psychologists (NASP) and New York Association of School Psychologists (NYASP).

2015-2019 Diversity Committee Member, School Psychology Program, Department of Psychology, Syracuse University
- Create events for graduate students to increase multicultural awareness and competency.

2015-2019 Center for Autism Research in Electrophysiology (CARE) Lab, Syracuse University
- Mentor and supervise undergraduate students on research projects.
- Assist in training and professional development for undergraduates.

Professional Memberships

2015-present National Association of School Psychologists (NASP), student member.
2016-present International Society for Autism Research (INSAR), student member.

Skills and Certifications

Achieved research reliability in administration and scoring of ADOS-2.
Proficient in statistical software (i.e., R, SPSS).
Skilled in use of eye tracking and EEG technology.
Proficiency in French language.