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Meta-Analysis of Psychometric Measures in Autism Assessment Tools Across the Lifespan

Gwendolyn Barnhart
Antioch University

ABSTRACT

There is a myriad of tools that are used for mental health professionals to diagnose individuals with autism/ autistic people, however, there are a lack of tools that professionals can use to assess where a person's strengths and challenges lie. The purpose of this meta-analysis was to garner and understanding of the measures available to providers as well as assess the limitations. Attention was focused on the sub-domains in each measure to ascertain patterns in categorical applications. A table of measures available regarding autism symptomology was created which included categorical sorting. This process was one of the first steps taken to create another measure that focused on strengths and challenges of those on the autism spectrum.

Keywords: Autism, Assessment, Psychometrics, Meta-analysis, Diagnosis.

Meta-Analysis of Psychometric Measures in Autism Assessment Tools Across the Lifespan
A meta-analysis of 45 measures commonly used in autism assessment were analyzed. As part of this review, I sought to determine which domains were used in other psychometric measures. Most of the domains fit easily into the categories of *restrictive/repetitive behaviors*, *social aspects*, *emotional regulation*, and *communication.* The infrequent categories were *cognition*, *developmental aspects*, *regression*, *imagination and creativity*, *self-injurious behaviors*, *adaptive behavior*, and *activities of daily living*. The purpose was to locate evidence relating to facets of individual autism expression and their associated strengths and weaknesses, in preparation of the creation of a new measure of autism expression.

ADULT AUTISM MEASURES

While most measures focus on the assessment of autism in children, specific measures exist for adults as well (Baron-Cohen et al., 2006; Dell'Osso, Eriksson et al., 2013; Gesi, et al., 2016; Grodberg et al., 2012; Lord et al., 1989). Their presentations are often different, and their symptomology is not as obvious, especially since some adults were not diagnosed as children. While the Autism Diagnostic Observation Schedule (ADOS–2) is most widely known for its use in the diagnosis of children with autism, there is also an adult module (Lord et al., 1989). Inter-rater reliability was assessed within five different raters. The Adult Subthreshold Spectrum (AdAS Spectrum; Dell'Osso, Gesi, et al., 2016) consists of six domains consisting of aspects common in adult autism. Validation consisted of internal consistency and test-retest reliability. Like the ADAS, the Adult Asperger Assessment (AAA; Baron-Cohen et al., 2006) is comprised of four subscales and takes three hours to administer. The data is collected through an interview format. The creators used inter-rater reliability as well as comparing their results with the results from other measures. In the Autism Mental Status Examination (AMSE) (Grodberg et al.,

2012), there are a total of eight items and was created to further facilitate the assessment process across multiple settings. The ADOS was also used in the creation of this measure to determine the cut-off score. Internal consistency and inter-rater reliability was used in the procedural validation process. Similarly, the Ritvo Autism and Asperger Diagnostic Scale (RAADS–14) (Eriksson et al., 2013; Ritvo et al., 2008) is a self-report screener for adults who exhibit autistic traits. The measure consists of 14 items, hence the name RAADS-14. A ROC analysis was used in the item analysis as well to assess the autism component when compared to those with other psychiatric concerns. Items with low discriminate power were removed. The ASD in Adults Screening Questionnaire (ASDASQ) (Ferriter et al., 2001; Nylander & Gillberg, 2001) was created to fill a gap as no screeners for adults with possible autism existed. Across rater reliability was fair-moderate, within rater reliability was moderate-good, and internal consistency was noted as excellent. Similarly, the (RAADS–R) (Eriksson et al., 2013; Ritvo et al., 2008) contains four domains. This measure consists of 80 items with respondents endorsing items on a four-point Likert scale. An exploratory factor analysis was used to determine construct validity. Cronbach's alpha was also used to determine internal consistencies. The Autism Spectrum Disorder Diagnosis for Adults (ASD–DA) (Matson et al., 2007, 2010) is another tool to be used to assess for autism in adults who also present with intellectual disability. Inter-rater and test-retest reliability were assessed as well as an item analysis, resulting in a 31-item scale. The Autism Symptom Self-Report for Adolescents and Adults (ASSERT) (Posserud et al., 2013) is a self-report screener which includes seven items. For validation procedures, the creators performed a descriptive analysis using Cronbach's alpha along with ROC analyses within SPSS. A bifactor analysis, incorporating both exploratory and confirmatory factor analysis, was conducted using Mplus. The Autism Checklist (ACL) (Sappok, Heinrich, & Diefenbacher, 2014) is a measure to assess autism in those with accompanying intellectual disability. Cronbach's alpha was used to determine internal consistency. Cohen's kappa and Spearman's coefficient was also used to determine inter-rater-inter-time reliability. Lastly, The Autism Quotient (AQ) (Baron-Cohen et al., 2001; Freitag et al., 2007) consists of 50 items and is given to those suspected of autism with average intelligence. A factor analysis was used to determine validity.

Childhood Measures

Infant and Early Childhood Measures:

As in adults, IOS/A may present with different symptomologies in their infancy or in early childhood. As such, there exists a number of measures that can be used specifically for those suspected of autism in this early age. One of the most popular measures is the Baby and Infant Screen for Children with Autism Traits (BISCUIT) (Matson et al., 2007, 2010). The BISCUIT is comprised of five domains. Convergent validity was established with the Modified Checklist for Autism in Toddlers (M-CHAT) and the Battelle Developmental Inventory (BDI2). The Checklist for Autism in Toddlers (CHAT) (Baird et al., 2000) is used by professionals to evaluate for autism in children ages 18 – 24 months and is comprised of 14 questions. Children are given a rating as being at low, medium, or high risk for autism. The CHAT is significant because it was the first measure of autism in very young children. Similarly, the Autism Detection in Early Childhood (ADEC) (Nah, Young, & Brewer, 2014; Nah, Young, Brewer, & Berlingeri, 2014; Young, 2006) is used to assess children for autism ages 12 to 36 months. Validation procedures consisted of determining internal consistency which was high along with inter-rater and test-retest reliability. An exploratory factor analysis also took place to determine construct validity. Furthermore, concurrent validity was also established while comparing scores of the ADOS

with the same participants. The Quantitative Checklist for Autism in Toddlers (Q–CHAT) (Allison et al., 2008, 2012) is a parent-report screener that helps with the early detection of autism in children 18-24 months of age. It is comprised of 15 Likert-scale items. Lastly, the Screening Tool for Autism in Toddlers and Young Children (STAT) (Stone & Ousley, 1997; Stone et al., 2000, 2004) is used in children ages 24-36 months of age. The STAT consists of 12 items and is meant for use by service providers. Creators of this measure utilized inter-rater agreement, test-retest reliability, and compared the findings with those of the ADOS.

Childhood Measures – Provider:

The Monteiro Interview Guidelines for Diagnosing Asperger's Syndrome (MIGDAS–2) (Monteiro, 2008) is used by providers to help diagnose autism in school-aged children. This measure has three primary components: a pre-interview checklist, a semi-structured interview for parents and teachers, and the student diagnostic interview which consists of a number of prompts given by the provider. The Childhood Autism Rating Scale (CARS) (Schopler et al., 1988) is a tool to be used by professionals and is comprised of four subtests. Internal consistency reliability was assessed by using Cronbach's alpha and was deemed to be excellent. In order to assist in determining cut-off scores, Kappa analyses were used and compared with the ADOS and DSM-IV. The Autism Diagnostic Observation Schedule (ADOS–2) Toddler Modules 1- 3 inter-rater reliability was assessed within five different raters. Furthermore, this measure was determined to have high discriminant validity as well as high reliability. The Autism Diagnostic Inventory (ADI) (LeCouteur et al., 1989) is a structured interview that the professional conducts with caregivers of those thought to exhibit autistic traits. This measure was tested for reliability and validity through inter-rater reliability, test-retest reliability, and internal validity tests. Given the high level of reliability and validity, the ADI is widely used in clinical practice as well as in research.

Childhood Measures – Provider/Parent/Guardian/Teacher:

Autism Spectrum Rating Scales (ASRS) (Camodeca, 2019) is designed to assess children ages 2 -18 for autism and consists of 15 - 71 items (depending on the age of the child and the version of the form). Primarily this measure is to be completed by the provider, however there are forms available for teachers and caregivers to complete. The Autism Behavior Checklist (ABC) (Eaves & Milner, 1993) consists of 57 items and is meant to be completed by professionals, parents, or teachers. Reliability and construct validity were determined using alpha coefficients, and while the measure was deemed as adequate for screening, the scales were deemed as not reliable for use in formal assessment.

Asperger Syndrome Diagnostic Scale (ASDS) (Campbell, 2005; Myles et al., 2001) consists of 50 yes or no questions and is meant to be a quick measure to help ascertain the likelihood of autism in a child presenting with symptomology. The ASDS is completed by a parent, teacher, or professional who knows the child. Wing Subgroup Questionnaire (WSQ) (Castelloe & Dawson, 1993) is meant to classify children with autism into one of three groups: *aloof*, *passive and friendly*, and *active-but-odd*. Inter-rater reliability was established by intraclass correlations. Some correlations between scores, however, were weak. The Gilliam Asperger's Disorder Scale (GADS) (Gilliam, 2006a) consists of 32 items with eight additional items pertaining to the child's early development. In order to validate the measure, construct validity was determined along with inter-rater reliability. The Autism Spectrum Disorder Diagnosis for Child (ASD–DC) (Matson et al. 2009) consists of a 40-item Likert scale used to assess children ages 2 – 16

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suspected of having autism. Creators of this measure conducted a factor analysis in order to establish validity and to make the scales, including both children on the spectrum and typical children.

Childhood Measures- Parent/Caregiver/Teacher:

The Childhood Asperger Syndrome Test (CAST) (Scott et al., 2002) is a 37-item measure to be completed by parents of children thought of exhibiting autistic traits. Creators determined that the measure had good test-retest reliability after using the kappa statistic for agreement and Spearman's rho to assess the correlation. Australian Scale for Asperger's Syndrome (ASAS) (Garnett & Attwood, 1995) consists of 34 items, four subscales, and is meant for someone who knows the child to complete. Norming procedures consisted of participants from 27 states, Canada, and Australia.

Gilliam Autism Rating Scale/Gilliam Autism Rating Scale–Second Edition (GARS/GARS–2) (Gilliam, 1995, 2006b) consists of four subscales and was validated using both criterion-related validity and inter-rater reliability. This measure is meant for persons who know the child well to complete, such as caregivers, parents, and teachers.

Childhood Measures - Screening Tools:

The Autism Spectrum Screening Questionnaire (ASSQ) (Ehlers et al., 1999; Posserud et al., 2009) consists of 27 questions while using a Likert scale posed to parents and teachers. Test-retest reliability and inter-rater reliability between teachers and parents were analyzed in the validation process. The Asperger-Syndrome-Diagnostic Interview (ASDI) (Gillberg et al., 2001) is a 20-question screener to be completed by psychiatrists to screen for high-functioning autism. Cohen's Kappa coefficient was used to determine both inter-rater reliability and test-retest reliability, where 0.90 was surpassed in both. The Early Screening for Autistic Traits (ESAT) (Willemsen-Swinkels et al., 2001) is a screening measure to be used when assessing children from 0 through 36 months old and consists of 19 items. To determine test-retest reliability, the intraclass correlation coefficient was analyzed. Discriminant validity was also established. The Diagnostic Behavioral Assessment for ASD–Revised (DiBAS–R) (Sappok, Gaul, et al. 2014) is a screener consisting of 20 items meant to assess for autism in persons with intellectual disabilities. Diagnostic validity was assessed through the use of a ROC and was deemed acceptable. Item difficulties were analyzed as well as internal consistency through Cronbach's alpha. The Pervasive Developmental Disorders Screening Test (PDDST–II) is a tool completed by parents of children aged 12 – 48 months and screened for pervasive development disorders such as autism. It is important to note that this measure is out of print. The Modified Checklist for Autism in Toddlers (M–CHAT) (Bilszta & Justin, 2013; Dumont-Mathieu & Fein, 2005; Robins et al. 2001) is another screening tool used to screen for autism in children ages 16 through 30 months. The Krug Asperger's Disorder Index (KADI) (Campbell, 2005; Krug, 2003) is a 32-item measure to be completed by the parent/caregiver or teachers to screen for autism. Reliability and validity were sound. The Developmental Behaviour Checklist–Autism Screening Algorithm (DBC–ASA) (Brereton et al., 2002; Steinhausen & Metzke, 2004) is a screener by which pervasive developmental disorders can be assessed in children. Validity and reliability were deemed as sufficient. The Social Communication Questionnaire (SCQ) is a 40-item measure used to assess pervasive development disorders such as autism in children aged 4 – 18 years. Discriminant validity was shown between children with autism and those without and showed that the SCQ to be beneficial as a screener.

Communication and Social Skills Measures

The Communication and Symbolic Behavior Scales (CSBS) (Wetherby & Prizant, 1993) is used in the assessment process of children ages 6 – 24 months old and suspected of communication delays. This measure had good test-retest reliability over a four-month testing interval. The Empathy Quotient (EQ) (Baron-Cohen & Wheelwright, 2004) was based on the empathizing-systemizing theory and incorporates the measurement of an individual's cognition and affect along with aspects of theory of mind. Face validity was established with the assistance of six psychologists. Inter-rater and test-retest reliability was also established. Concurrent validity was also established by assessing the correlation with another measure of empathy (Interpersonal Reactivity Test). The Children's Social Behavior Questionnaire (CSBQ) (Luteijn et al., 2000) is often used in children who present with behavioral challenges, including behaviors seen in autism. Five domains were included and reliability and validity were deemed good. The Social and Communication Disorders Checklist (SCDC) (Bölte et al., 2011; Skuse et al., 2005) is available for use in children ages 3 -19. It is comprised of 12 questions and is used to assess for communication disorders, such as those often found in IOS/A.

Developmental Measures

The Vineland–3 (Sparrow et al., 1984) consists of five domains and is used to assess individuals who are suspected of having a disability, not only autism. There are forms for teachers, parents/caregivers, and the interviewer. Internal consistency was evaluated with the use of a coefficient alpha. Inter-rater reliability was assessed as well as test-retest reliability. The Bayley Scales of Infant and Toddler Development (Bayley, 2006) is used to assess development in young children ages 1 – 42 months. This measure is often used in the diagnosis of autism as development is an important aspect. It is important to note however that early validity and reliability were poor.

Overall Themes

Most of the measures analyzed consisted of protocols to be completed by the individual, caregiver/parent, or teacher. Others consisted of protocols that were to be completed by the person conducting the assessment. Most of these measures consisted of multiple-choice and true-false answers. Very few measures consisted of subjective observation such as with the ADOS and the MIGDAS. Many more measures exist for the diagnosis of children rather than adults. Measures for children included aspects of play, regression, and development, whereas, in measures for adults, it is less common. Interestingly, protocols exist for children that measure aspects of autism in various settings, such as home and school. This is not true for adults. For example, no measures exist for employers to complete and few exist for significant others to complete.

Since autism is a developmental disorder, early behaviors are important for diagnosis. Again, the measures that focus on children include items that were more inclusive of severe behavior and developmental aspects rather than measures for adults. Often, those with more significant challenges receive diagnoses earlier on in life, while those with fewer challenges go undiagnosed until later in life. It is important to look at these variances and how they manifest themselves across the lifespan rather than focusing just on childhood (Begeer et al., 2013; Lai et al., 2014, 2015; Lehnhardt et al., 2016).

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IN-DEPTH MEASURE ANALYSIS RELATING TO POTENTIAL SUBDOMAINS/CATEGORIES

Following the completion of the in-depth measure analysis discussed above, 13 initial categories emerged. These included main themes from common psychological measures often used in diagnosing IOS/A. All 13 categories are discussed below.

Survey Categories

This section encompasses 13 of the categories that emerged from the autism-focused psychometric measure analysis. The rationale for these categories is that psychologists most often use these categories in assessment procedures, as discovered as a result of the psychometric measure analysis. There are significant variances in the strengths and challenges of IOS/A (Armstrong, 2012). Furthermore, these categories can be construed as entities that are most impactful for IOS/A and those offering support.

Activities of Daily Living:

IOS/A have been shown to have differences in (ADLs) (Piccin et al., 2018). These differences have shown to significantly impact functioning (Hull et al., 2017). Autism symptomology can hinder ADLs, and this has links to the three tiers of support in the DSM–5 (American Psychiatric Association, 2013). It can be beneficial to assess the extent to which IOS/A may need assistance in their activities of daily living. Differences also exist in individual perceptions of appropriate ADLs and the appropriate frequency of these activities. For example, individuals' ideas surrounding bathing may differ due to factors such as culture or sensory seeking or aversion constraints. Conversely, when individuals appear not to have difficulties surrounding ADLs, masking can have an impact, as people can hide their vulnerabilities (Hull et al., 2017). Proper assessment is necessary to decipher what assistance the individual may need, and it can assist those who care for the individual to provide adequate support (Ros et al., 2018).

While there does not appear to be much research on ADLs and autism specifically, Bleijenberg et al. (2017) looked at the risk factors for declining ADL skills in older adults, as it is important to look at how variances in ADLs can vary across the lifespan. Currently, many ADL measures have a developmental standpoint. Bleijenberg et al. analyzed ADLs such as bathing and dressing, and instruments of daily living such as the individual's ability to manage finances, shop for necessities, and mobility. There were 15 participants in the study, which took place in the Netherlands. Not surprisingly, Bleijenberg et al. found that individuals with chronic conditions were at a higher risk of declining ADL skills later in life. Females were more likely to decline in the area of travel, and males were more at risk of declining skills in medication management and meal preparation.

Conversely, to heighten the awareness of the variances in ADLs across the spectrum further, Otsuka et al. (2017) sought to ascertain the predicting factors in functional ability in IOS/A who exhibit minimal challenges. A total of 41 participants were included, and a regression analysis was conducted. They discovered that poor emotion perception and low verbal generativity indicated poorer adaptive functioning skills.

Furthermore, findings from the in-depth measure analysis only identified one measure that ascertained the degree to which individuals attend to their ADLs. This measure was the BISCUIT (Matson et al., 2007, 2010). This measure is designed for diagnostics, and it only attends to the skills of infants and toddlers. The name of the subtest was *eating and sleeping problems*. One

could argue that persons on the autism spectrum can exhibit varying degrees of ADL skills across the lifespan. The addition of this subtest may be helpful, in that it may help to assess individuals' strengths and challenges in this domain, as it could be impactful to measure their skill in basic living tasks.

Cognition:

IOS/A have been shown to have differences in cognition (Schaller & Rauh, 2017). These differences have shown to significantly impact functioning (Golshan et al. (2019). Furthermore, individuals' cognitive function can differ greatly across the ASD spectrum. Some individuals may have heightened, even genius-level intellectual capabilities, while others can have profound limitations (Schaller & Rauh, 2017). For those who serve IOS/A, it may be helpful to know the cognitive abilities of those for whom they provide services.

Many neuropsychological tests assess for executive function, which is an aspect of intellectuality. Golshan et al. (2019) sought to ascertain whether there were variances in individuals' executive functioning ability regardless of their cognition. Researchers included 15 IOS/A but limited challenges and persons without autism. All participants had IQs greater than 80 and they ranged in age between eight and 12 years old. Golshan et al. used the NEPSY–II test, and they administered the three domains of inhibition, design fluency, and animal sorting. Similarly, they administered the CHEXI, a parent-report measure, to parents. Their results indicated that children with autism, even with seemingly limited difficulties, still performed significantly worse than their non-ASD peers.

Lieb and Bohnert, (2017) conducted another study focused on executive function and how it can inhibit individuals' abilities. Their study included 127 adolescents with autism, pervasive development disorder, or Asperger's according to the DSM–IV–TR criteria. From there, each participant and parent were matched to form a dyad. Lieb and Bohnert administered the Social Responsiveness Scale (Constantino & Gruber, 2005), the Behavior Rating Inventory of Executive Function, Parent Report (Gioia et al., 2000), the Children's Loneliness and Social Dissatisfaction Scaler (Asher et al., 1985), the Friendship Quality Questionnaire–Abbreviated Edition (Parker & Asher, 1993) and the Achenbach Child Behavior Checklist–Depression Scale (Clarke et al., 1992). The results indicate significant hindrances in the domains of social impairment and friendship quality as a result of deficits in executive functions.

Within this domain, there were few current measures that incorporate cognition or intelligence into their tests. The ASAS (Garnett & Attwood, 1995) was one such test with a subtest of *cognitive skills*. Another was the GARS (Gilliam, 1995), with the subdomain of *cognitive style*. The RAADS–14 (Ritvo et al., 2008) applies the subdomain of *mentalizing deficits*. Out of 42 psychometric tests concerning autism, only three had some type of subdomain that focused on cognition or intelligence. This is surprising, since a diagnosis of autism comes either with or without an accompanying intellectual disability. However, since these tests have largely diagnostic purposes, it is understandable, as many psychologists and other diagnosing professionals may use an accompanying intelligence test during initial diagnoses such as the Wechsler Adult Intelligence Scale (Kaufman & Lichtenberger, 2006), the Wechsler Intelligence Scale for Children (Wechsler, 2014), or the Woodcock-Johnson Tests of Cognitive Abilities (Semrud-Clikeman & Teeter-Ellison, 2009).

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Social Aspects:

IOS/A have been shown to have differences in social aspects (Cage & Troxell-Whitman, 2019). These differences have shown to significantly impact functioning (Hull et al., 2017). Social challenges can vary for those with ASD. Some people on the spectrum seek out others, craving acceptance and inclusion from others, and when they experience difficulties in this area, it can lead to depression and anxiety. Often, especially those with elevated FSIQs, persons on the spectrum struggle with what to say, how to say it, or how to act in differing social settings. One common factor is that many people on the autism spectrum *mask* (Cage & Troxell-Whitman, 2019). Masking refers to the practice of suppressing one's own autism traits to fit in more with others within the social context. While this works for many, it can leave them feeling exhausted and only able to attend to social functions for a minimum amount of time (Hull et al., 2017). However, others on the spectrum prefer to be alone and to do things by themselves.

Cage and Troxell-Whitman (2019) studied the effects of social masking or camouflaging. They strove to understand how masking or camouflaging affected the mental health of 262 persons on the autism spectrum/ autistics. Their results showed that masking was emotionally taxing on those on the spectrum and that the task of switching back and forth between their authentic selves and their masked selves was a contributory factor in poorer mental health.

Similarly, Hong et al. (2016) conducted a study to ascertain the various factors in the subjective quality of life of adults with an autism spectrum diagnosis/autistics. This study included 60 participants and it utilized the World Health Organization Quality of Life measure. Hong et al. discovered that levels of perceived stress and bullying were factors in individuals' quality of life. More specifically, they derived eight domains of quality of life, measuring interpersonal relations, social inclusion, personal development, physical well-being, self-determination, material well-being, and human and legal rights (Schalock, 2004). This study is impactful in that it highlights the negative effects of social exclusion for those on the spectrum. It may be important to highlight this aspect of autism symptomology in the Autism Trait Survey so that caregivers and therapists may be able to ascertain individuals' strengths or challenges in this domain.

The in-depth measure analysis of the psychometric measures currently in place revealed that the assessment of social aspects within these tests is extensive. The AAA (Baron-Cohen et al., 2006) applies a *social* domain, as does the ASDS (Campbell, 2005) and the Bayley Scale (Bayley, 2006). The ASAS (Garnett & Attwood, 1995) incorporates a *social and emotional abilities* subscale, while the ABC (Eaves & Milner, 1993) incorporates the subscale of *social and relating*. The ADI (LeCouteur et al., 1989) has a scale that measures the individual's *social development and play*.

Similarly, the ADOS–2 Adult and Adolescent (Lord et al., 1989) has domains that measure individuals' socialization through the subtest of *social affect* in Toddler Modules 1-3, and *reciprocal social interaction* in the modules for adults and adolescents. Interestingly, the AMSE (Grodberg et al., 2012) used the subtest *eye contact/interactions*, and it was one of the few that specifically incorporated an entire scale dedicated to eye contact. In the Autism Quotient (AQ; Baron-Cohen et al., 2001; Freitag et al., 2007), the subscale *social skill* became the EQ (Baron-Cohen & Wheelwright, 2004). Similarly, the ASRS (Camodeca, 2019), a measure for all ages, applies the domains of *peer socialization* and *adult socialization*. The CHAT (Baird et al., 2000)

incorporates the domains of *producing a point*, *protodeclaractive pointing*, *following a point*, and *producing a point* when assessing for the social aspects in those with autism. The CAST (Scott et al., 2002) incorporates a subscale known as *reciprocal social behavior*.

Another well-known test, the CARS (Schopler et al., 1988) utilizes the subtest, *relating to people*. Both the GADS and the GARS/GARS–2 (Gilliam, 1995, 2006a, 2006b) use the subscale of *social interaction*, as does the SCQ (Berument et al., 1999; Rutter et al., 2003). This makes sense, as the same person created these two scales. The MIGDAS–2 also assess individuals' social skills through the subscale *social relationships and emotional responses*. The RAADS–14 (Ritvo et al., 2008) applies the subtest of *social anxiety*, while another version of the same test incorporates the subscale of *social relatedness*.

The RAADS–R (Ritvo et al., 2008) assesses for social aspects with the use of the scale *imitation.* Similarly, the Social and Communication Disorders Checklist (SCDC; Bölte et al., 2011; Skuse et al., 2005) tests for social aspects through the *reciprocal social interaction skills* subtest. The Vineland–3 (Sparrow et al., 1984) simply applies the subscale of *socialization*, while the AdAS Spectrum (Dell'Osso, Gesi, et al., 2016) utilizes the *non-verbal communication* domain.

Emotional and Adaptive Behaviors:

IOS/A have been shown to have differences in emotional and adaptive behaviors (Fenning et al., 2018). These differences have shown to significantly impact functioning (Yang et al., 2017). Individuals' ability to regulate their emotions is an important factor when deciphering the amount of care an individual may need. For instance, emotional dysregulation can present in a few ways. Presentations may include emotional shutdown or aggressive forms of behavior that can seem explosive (Fenning et al., 2018). How individuals' present is important for caregivers and other professionals providing services and support. Perhaps the most important factor is safety: are the individuals threats to themselves, others, or property (Yang et al., 2017)? It is important to know how redirectable individuals are and how they respond to various forms of intervention.

Samson et al. (2015) sought to understand the nature of emotional regulation and emotional distress in IOS/A. Some participants had autism; others were typical persons. Samson et al. used questionnaires to ascertain the experiences surrounding emotion, such as regulation and maladaptive behavior. There were 31 participants on the spectrum, and 28 were typical participants. Samson et al. discovered that IOS/A used cognitive reappraisal or reframing less often than their typical counterparts. Furthermore, they opined that if support staff were to work with individuals to combat the negative emotions surrounding maladaptive behavior, then treatments might be more successful. Such treatments include Cognitive Behavioral Therapy.

Similarly, Conner and White (2018) sought to decipher an evidence-based approach for advancing emotional dysregulation treatment in persons on the spectrum. They surmised that since there is a higher incidence of psychological maladies that are often comorbid in those with autism, and there is some evidence that of mindfulness-based therapy is effective, the method ought to receive research. Nine participants contributed to the study, in which Conner and White examined both treatment fidelity and posttherapy satisfaction. The main findings were that seven out of nine participants found mindfulness-based therapy helpful in emotional

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regulation. Mindfulness is a part of some Cognitive Behavioral Therapy-based treatments such as Acceptance and Commitment Therapy and Dialectical Behavioral Therapy.

The ASD, (Campbell, 2005; Myles et al., 2001) applies a subtest called *maladaptive [behaviors].* Similarly, the ASAS (Garnett & Attwood, 1995) has incorporated the *social and emotional abilities* scale. Curiously, the ABC (Eaves & Milner, 1993) has a scale just for deciphering individuals' level of potential aggression through the *aggressive* domain. While the ADI (LeCouteur et al., 1989) takes into account behaviors in general through the *general behaviors* subscale, the ASRS (Camodeca, 2019) measures individuals' *social-emotional reciprocity*, and the BISCUIT (Matson et al., 2007b, 2010) measures a number of factors relating to emotion and behavior through the *avoidance behavior/tantrum/conduct behavior/aggressive/destructive disorder* scale.

The Bayley Scale (Bayley, 2006) incorporates the use of an *emotional/adaptive behavior* scale to parse emotional functioning. Similarly, the CARS (Schopler et al., 1988) incorporates an *emotional response* subscale, while the CAST (Scott et al., 2002) applies a similar scale by the name of *reciprocal social behavior*. The CHAT (Baird et al., 2000) concentrates on more specific behaviors using a number of different scales known as the *producing a point*, *prodeclaractive pointing*, *following a point*, and *producing a point* domains. The EQ (Baron-Cohen & Wheelwright, 2004) applies two domains to measure emotionality, namely the *cognitive empathy* and *emotional reactivity* domains. The GADS also rates the emotionality of others by using an *emotional responses* subscale. The MIGDAS–2, which is similar to the ADOS, incorporates two domains to measure emotions: the *social relationships* and the *emotional responses* domains. The SCDC applies the *behavioral problems* subtest. Similarly, the AdAS Spectrum (Dell'Osso, Gesi, et al., 2016) applies an *empathy* subscale. Last, the WSQ (Castelloe & Dawson, 1993) applies the *aloof*, *passive and friendly*, and *active-but-odd* domains.

Communication:

IOS/A have been shown to have differences in communication (Berthier et al., 2017). These differences have shown to significantly impact functioning (Alexander & Dille, 2018). According to the DSM–5 (American Psychiatric Association, 2013), communication difficulty is one of the diagnostic criteria for autism. However, communication difficulties can become complicated, as there are different types of communication. One type is nonfunctional language such as echolalia, which is actually a stim and which concerns emotional regulation rather than communication (Berthier et al., 2017). Another aspect is receptive communication, in which the individual may have difficulties understanding language (Alexander & Dille, 2018). Conversely, individuals engage in expressive communication as well. It is also important to recognize that people do not communicate solely through vocalizations. Persons communicate in a variety of other ways, such as using assistive technology, sign language, or body language. When working with people on the spectrum, it is beneficial to understand where their strengths and challenges lie regarding communication. Communication is one of the biggest facets of therapy, and without understanding the individual's capacity for language, both receptive and expressive, it would be difficult to surmise an adequate method of communication, especially if the individual exhibits challenges.

Several of the psychometric measures incorporated communicative domains such as the AAA (Baron-Cohen et al., 2006) and its *communication* domain. Likewise, the ADOS–2 Adult and

Adolescent version (Lord et al., 1989) incorporates the *communication* domain, as does the AQ (Baron-Cohen et al., 2001; Freitag et al., 2007). Equally, the ASDS (Campbell, 2005; Myles et al., 2001) incorporates the *language* domain into its measure. The ASAS (Garnett & Attwood, 1995) utilizes the *communication skills* domain. The ABC (Eaves & Milner, 1993) gets more specific with its *echolalic speech and language* and *non-responsive* domains. The ADI (LeCouteur et al., 1989) incorporates the *language and communication functioning* domain. Similarly, the AMSE (Grodberg et al., 2012) applies the *language/pragmatics* domain, and the ASRS (Camodeca, 2019) includes the domain of *atypical language*. Furthermore, the CARS (Schopler et al., 1988) includes the *verbal communication* domain to assess the client's degree of communicative capabilities. Not surprisingly, the CSBS (Wetherby & Prizant, 1993) incorporates the domains of *communication* and *expressive speech scale & symbolic scale* in its measure.

The GARS/GARS–2 (Gilliam, 1995, 2006b) applies the domain known as *communication*. The GADS utilizes a domain called *maladaptive speech*, while the MIGDAS-2 incorporates the *language and communication* domain. Similarly, the RAADS–R (Ritvo et al., 2008) applies the *language* domain, while a different version of the measure, the RAADS–R incorporates the *communication* domain. The SCDC (Bölte et al., 2011; Skuse et al., 2005) applies the *communication skills* domain, while the SCQ (Berument et al., 1999) applies the *language and communication* and *current language functioning* domains. Last, the AdAS Spectrum (Dell'Osso, Gesi, et al., 2016) incorporates the *verbal communication* domain, while the Vineland–3 (Sparrow et al., 1984) applies the *communication* domain.

Motor Skills:

IOS/A have been shown to have differences in motor skills (Hodges et al., 2019). These differences have shown to significantly impact functioning (Hillus et al., 2019). Motor skills refer to the ability of an individual to move independently and the quality of that movement. Some IOS/A also have comorbidity in motor disability alongside their autism diagnoses. However, the focus of motor skills in many psychometric measures is to parse out muscle rigidity, toe walking, hypotonia (low muscle tone), or difficulty with coordination (Hodges et al., 2019). These aspects of motor skills can have an impact in individuals' lives.

Hillus et al. (2019) sought to attain empirical evidence for the difficulty in motor skills in those with autism without accompanying intellectual disability. They recruited 19 participants with autism and 22 persons without autism. The participants took the Toronto Alexithymia Scale, the Motor Skills in Everyday Situations Test, and the Purdue Pegboard Test to determine whether there were differences between the two groups and to ascertain whether there were deficits in semantic processing relating to action words. Interestingly, the results showed that the IOS/A have limitations in the semantic processing of action words. Furthermore, Hillus et al. corroborated evidence from previous studies that IOS/A exhibit deficits in motor skills.

Liu et al. (2017) conducted a study to ascertain the usefulness of four different measures of motor skills in children with autism. This was a case study where a 5-year-old child took the Bruininks–Oseretsky Test of Motor Proficiency–2, the Movement Assessment Battery for Children–2, the Peabody Developmental Motor Scales–2, and the Test of Gross Motor Development–2. They determined that one must determine the overall goal of the assessment and where the purpose lies. The Movement Assessment Battery for Children–2 and the Bruininks–Oseretsky Test of Motor Proficiency–2 are quantitative tests. The Test of Gross

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Motor Development–2 is qualitative. The Peabody Developmental Motor Scales–2 measure the qualitative and quantitative factors of motor skill development.

Of the 42 psychometric tests analyzed, only two incorporated domains to measure the motor skill facet of autism. The Vineland–3 (Sparrow et al., 1984) has a domain entitled *motor skills.* Similarly, the ASAS (Garnett & Attwood, 1995) uses the domain of *movement and skills*.

Restrictive/Repetitive Behaviors:

IOS/A have been shown to have differences in restrictive and repetitive behaviors (Berthier et al., 2017). These differences have shown to significantly impact functioning (Jacques et al., 2018). Restrictive and repetitive behaviors are often useful in assessing for an autism diagnosis (American Psychiatric Association, 2013). Restricted and repetitive behaviors can look different in those on the autism spectrum. Repetitive behaviors may include rocking or stereotypical hand-flapping (Jacques et al., 2018). Individuals engaging in strict adherence to routines or having intense special interests in subjects can exhibit restricted behaviors.

Jacques et al. (2018) sought to explore restrictive and repetitive behaviors in children with autism through play and items that may be interesting to them. Their participants were 49 children with autism and 43 without. Jacques et al. concluded that children with autism have a higher propensity for restrictive and repetitive behaviors for longer durations than their same-age peers. Interestingly, the researchers further noted that while some therapeutic efforts may enhance individuals' interest, the most efficient way to increase interest in other things is to offer the individual opportunities to interact with potentially preferred items of interest through object exploration.

Several psychometric measures incorporate, to some degree, a subdomain relating to restrictive and repetitive behaviors. For instance, the AAA (Baron-Cohen et al., 2006) utilizes a domain by the name of *obsessions*, while the ASAS (Garnett & Attwood, 1995) uses the *specific interests* domain. Similarly, the ABC (Eaves & Milner, 1993) incorporates a scale known as *stereotypical (behavior)*. The ADI (LeCouteur et al., 1989) incorporates the *interests and behaviors* domain, while the ADOS–2 Adult and Adolescent (Lord et al., 1989) incorporates one of two domains depending on age range and whether the client is nonverbal: *stereotyped behaviors and restricted interests* or *restricted and repetitive behavior* domains. The AMSE (Grodberg et al., 2012) includes the domain of *repetitive behaviors/preoccupations*, while the ASRS (Camodeca, 2019) uses the *stereotypy and behavioral rigidity* and *body and object use* domains to assess clients' restricted and repetitive behavior inclinations.

For very young children, the BISCUIT (Matson et al., 2007, 2010) is useful, and it incorporates the domain *anxiety/repetitive behavior/stereotypes*, while the CARS (Schopler et al., 1988) incorporates the *body and object use* domain. The GARS–2 (Gilliam, 2006b) uses the domain, *stereotyped behaviors* while the GARS and the GADS from the same author (Gilliam, 1995, 2006a) use the *restricted/repetitive behaviors* domain. The RAADS–R (Ritvo et al., 2008) utilizes the *circumscribed interest* domain. Last, the AdAS Spectrum (Dell'Osso, Gesi, et al., 2016) uses the *inflexibility and adherence to routine* and *restricted interests and rumination* domains to measure clients' propensity towards restricted and repetitive behaviors.

Sensory Aspects:

IOS/A have been shown to have differences in sensory aspects (Mayer, 2017). These differences have shown to significantly impact functioning (Robertson and Baron-Cohen, 2017). Sensory challenges can take on several manifestations. For instance, there are two main categories of sensory behavior, sensory seeking and sensory aversion (American Psychiatric Association, 2013). Sensory seeking behaviors relate to a set of phenomena when an individual seeks out sensory stimulation such as licking things, looking at a bright light, or watching a rapidly moving river (Mayer, 2017). IOS/A will often stim by seeking out sensory stimuli such as a glitter wand, a strobe light, or a furry cat. Aspects of sensory aversion could be manifested by the irritation of a clothing tag, aversion to bright light or sound, or difficulty in large crowds or noisy places such as amusement parks. Each sensory aversion or seeking behavior is individual to the person. IOS/A can have both sensory seeking and sensory aversion behavior (Robertson & Baron-Cohen, 2017).

Mayer (2017) examined both persons on the autism spectrum and others for traits relating to autism and sensory processing differences. The participants were 580 adults who were not on the spectrum and 42 adults on the spectrum with a confirmed diagnosis. Participants took psychometric measures, both the AQ and the Adult/Adolescent Sensory Profile. The results of the study showed that sensory differences increase with heightened levels of autism symptomology. Within the parameters of the scope of this study, this information is important, as it highlights that there are variances in sensory processing among those on the autism spectrum.

As in Mayer's (2017) study, Robertson and Baron-Cohen (2017) sought to understand the sensory differences between IOS/A and others given that this facet is paramount in assessing for autism. They found significant evidence that in IOS/A, there are neurological differences. These differences are like the differences other studies found.

Several psychometric measures incorporate a sensory-type domain into their measures. For instance, the ASDS (Campbell, 2005; Myles et al., 2001) incorporates a domain of *sensorimotor*, while the ABC (Eaves & Milner, 1993) uses the *sensory* domain. The ASRS (Camodeca, 2019) incorporates the domain of *sensory sensitivity* to measure sensory aspects in IOS/A. Similarly, the RAADS–14 (Ritvo et al., 2008) uses the *sensory reactivity* domain, while a different version of the same measure, the RAADS–R uses a domain called *sensory/motor*. Last, the AdAS Spectrum (Dell'Osso, Gesi, et al., 2016) incorporates the *hyper-hypo reactivity to sensory input* domain.

Development:

IOS/A have been shown to have differences in development (Lin & Koegel, 2018). These differences have shown to significantly impact functioning (Zhang et al., 2018). Development can have an impact in the lives of those with ASD, as there are several factors to consider. First, some individuals have obvious constraints in their development, and as such, these constraints are easy to decipher and notate, and it is easy to create a plan of care accordingly (Lin & Koegel, 2018). Others appear to have typical growth and development patterns but then regress (Zhang et al., 2018). However, hypotonia (low muscle tone) is a common factor in those with ASD, which can impact individuals' growth and development, particularly their gross and fine motor skills, which is why many receive services from physical and occupational therapists (Gowen &

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Hamilton, 2013; Gowen & Miall, 2005). Similarly, Ehlers Danlos Syndrome is common (Cederlof et al., 2016). For those providing treatment, it is important to be cognizant of these development aspects. Developmentally, this is impactful, as professionals in the field often focus on early childhood development rather than development across the lifespan.

On current measures that assess for developmental aspects, the ABC (Eaves & Milner, 1993) incorporates the *infant-like* subscale. Similarly, the ADI (LeCouteur et al., 1989) uses a similar subscale by the name of *early development*. The AdAS Spectrum (Dell'Osso, Gesi, et al., 2016) uses a subscale called the *childhood/adolescence* subscale.

Regression:

IOS/A have been shown to have instances of regression (Zhang et al., 2018). These instances have shown to significantly impact functioning (Hillus et al., 2019). Regression refers to individuals losing their skills after initial acquisition (Zhang et al., 2018). This often occurs in young children with speech regression, for example. Similarly, persons with ASD can exhibit regression in expressive communication while having minimal difficulty in other areas of development. Regarding the outcome after the summary and comparison of all known psychometric tests that assess persons on the autism spectrum, the *regression* subtest only occurred in the ADI (LeCouteur et al., 1989).

Imagination and Creativity:

IOS/A have been shown to have differences in imagination and creativity (Hillus et al., 2019). These differences have shown to significantly impact functioning (Quirici, 2015). IOS/A with limited cognitive challenges have alternative and concrete thinking patterns. Imagination and creativity are parts of these patterns that can vary between individuals. Many tests that focus on diagnostics of young children also use the notion of play as part of this factor. However, it is difficult to parse the imagination and creativity part from the social aspect of actual play.

Quirici (2015) attributed the common belief that creativity and imagination have more to do with neurological abnormalities than true creativity and imagination. However, Quirici highlighted the notion that many artists on the spectrum are, in fact, both. Quirici sought to interview several persons on the spectrum to challenge the notion that they are void of imagination or creativity. After conducting these interviews, Quirici opined that we as a society should do more to help to thwart stereotypes.

Both the AAA (Baron-Cohen et al., 2006) and the ASAS (Garnett & Attwood, 1995) include subdomains of *imagination*. Similarly, the ADOS–2 Adult and Adolescent (Lord et al., 1989) includes a subdomain of *imagination and creativity*. The CHAT (Baird et al., 2000) also assesses for creativity and imagination by utilizing the *pretend play and pretending* subdomain. Similarly, the RAADS–R (Ritvo et al., 2008) uses the *play* subdomain.

Self-Injurious Behaviors:

IOS/A have been shown to exhibit self-injurious behaviors (Soke et al., 2018). These behaviors have shown to significantly impact functioning Richards et al., 2017). If clients have a history of self-injurious behaviors, it is important for caregivers and therapists to know so that they are aware of any potential triggers and what the purpose of the behavior might be. For instance, some self-injurious behaviors come from dysregulation, where the individual is participating

in this behavior to self-regulate (Soke et al., 2018). In some other cases, individuals may be engaging in self-injurious behaviors as they are trying to communicate. This behavior may look like banging a fist onto a table at mealtime. Conversely, clients can use self-injurious behaviors to manipulate therapists or caregivers (Richards et al., 2017). Few psychometric measures focus on the domain of self-injurious behaviors. Both the BISCUIT (Matson et al., 2007, 2010) and the SCQ (Berument et al., 1999; Bölte & Poustka, 2006; Bölte et al., 2000; Rutter et al., 2003; Schanding et al., 2012) incorporate subscales entitled *self-injurious behavior*. The Vineland–3 (Sparrow et al., 1984) incorporates a scale that may relate to self-injurious behavior known as the *maladaptive behavior* subscale.

Attention and Self-Regulation:

IOS/A have been shown to have differences in attention and self-regulation (Quirici, 2015). These differences have shown to significantly impact functioning (Shephard et al., 2018). As in the earlier categories, this scale is more appropriate in the *emotional and adaptive behaviors* subtest, and as such, it was combined. Attention concerns the way the individual can attend to tasks and for how long (Boxhorn et al., 2018). ADHD is often a comorbidity of those on the autism spectrum, and as such, it is important to parse out where the person's strengths or challenges lie (Shephard et al., 2018). Self-regulation refers to the ability of individuals to regulate their emotions and actions and to adapt to external stimuli.

Of the 42 psychometric measures assessed, only four incorporated measures concerning attention and self-regulation. The AMSE (Grodberg et al., 2012) uses the domain of *shared attention*, while the AQ (Baron-Cohen et al., 2001; Freitag et al., 2007) uses the domains of *attention switching* and *attention to detail*. Similarly, the ASRS (Camodeca, 2019) encompasses the domain of *attention/self-regulation*, while the BISCUIT (Matson et al., 2007, 2010) incorporates the *inattention/impulsivity* domain.

CONCLUSION

The purpose of this meta-analysis was to improve the understanding of autism by developing a new tool to help to measure autism within various spheres of symptomology. This analysis served as the first steps in the creation of such a measure. Use of this measure could produce data showcasing individuals' challenges and strengths such as those previously noted (Barnhart, 2017). These data can provide professionals who work with IOS/A a better idea of where individuals' needs may lie, which may help to create individualized treatment goals. This meta-analysis encompassed 45 measures commonly used in autism assessment. As part of this review, I sought to determine which domains were used in other psychometric measures. I used this information to inform the development of the domains for this measure. Each of these domains were analyzed, compared, and grouped into categories. As a result of the creation of these categories, 13 initial domains emerged: *Activities of Daily Living* (AD), *Cognition* (CD), *Social Aspects* SA), *Motor Skills* (MS), *Sensory Aspects* (SY), *Emotional and Adaptive Aspects* (EA), *Restrictive and Repetitive Behaviors* (RB), *Communication* (CO), *Development* (DV), *Attention and Self-Regulation* (AR), *Regression* (RG), *Imagination and Creativity* (IC), and *Self-Injurious Behaviors* (SB).

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