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Evaluating Treatment Outcomes: A Closer Look at Outcome Measures used in Early and Intensive Behavioral Interventions

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Preface

I'd like to thank my family, who encouraged me to pursue my graduate degree in a foreign country and who have always shown me support in my endeavors. I'd also like to thank my supervisor, Sigmund Eldevik for his ongoing support and supervision of my masters thesis and practical fieldwork towards becoming a Board Certified Behavior Analyst.

Abstract

Written as an article-based masters thesis, the two articles explore the usage and validity of different assessment tools used to measure treatment outcomes for children with autism who have received early and intensive behavioral interventions (EIBI). The project begins with the extended summary, followed by the article manuscript *Measures Used to Assess Treatment Outcomes in Children with Autism Receiving Early and Intensive Behavioral Interventions: A Review* intended for the Review Journal of Autism and Developmental Disorders (ed. Jill C. Fostad). The extended summary aims to elaborate on the rationale behind the methodological structure, and clarify theory and context as it relates to Early Intensive Behavioral Intervention models. Through the use of systematic-narrative review, the article manuscript intends to answer the following research questions: 1) What assessment tools are being used in the EIBI literature to measure treatment outcomes in children with autism? 2) Are the identified tools valid measures of outcomes for young children with autism? Forty three articles met inclusion criteria for the review, and a total of 92 outcome measures were identified. Results are reported as percentages, and psychometrics are discussed. Findings indicate that previous recommendations from the literature have been followed, though few domains remain underreported. Brief recommendations for service providers are discussed.

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1. Introduction

This project is written to fulfill the requirements of the masters of philosophy in Special Needs Education at University of Oslo. The masters thesis consists of an extended summary and the article manuscript written with the intention of publication in the Review Journal of Autism and Developmental Disorders. Upon reading the extended summary, one should have a more complete understanding of the theoretical underpinnings and behavioral approach to specific interventions discussed in the text, in addition to the context in which this project is situated. Rationale for choice of design and methods will be described in depth (see Chapter 2), as space was not permitted in the article manuscript. The analysis will be explored within the extended summary; results will be touched upon, but will not be discussed in detail. The article manuscript seeks to answer the research question by way of systematic narrative review. As per the guidelines for the Review Journal of Autism and Developmental Disorders, tables will be cited in-text and listed at the end of the manuscript.

1.1 Rationale for the Intended Journal

In collaboration with the supervisor, the Review Journal of Autism and Developmental Disorders, edited by Jill C. Fostad, was chosen as the intended journal. The current project fits within the journal's scope as defined by the journal's "Aims and Scope" (Springer, 2021). Topics of this review include: applied behavior analysis and measurement of treatment effects as it relates to autism spectrum disorder. Although this review provides recommendations based on the U.S model of early intervention, the project also touches on current practices in Europe. Publications included in the review reflect EIBI practices from North America, Europe, Australia, the UK and Israel, to name a few. Thus, the journal's intended international audience is in line with the interests of this project.

1.2 Implications for Special Needs and Inclusive Education

As trends towards universality are being adopted in schools worldwide, it is important for early childhood educators and special educators to recognize the needs of their students and intervention techniques which are considered best-practice. Some naturalistic developmental behavioral interventions such as Pivotal Response Treatments (PRT) (R. L. Koegel & Koegel,

2006) are designed to be incorporated into educational settings and employed by teachers utilizing the common core curriculum. The Early Start Denver Model has been used in group-based formats in inclusive settings (Vivanti et al., 2019), and direct-teaching formats like the UCLA model have been adapted to fit the needs of young children in mainstream preschool settings (Eldevik et al., 2012, 2019). This project extends the knowledge for special needs and inclusive education by familiarizing early childhood educators and special educators, not only for the need for intensive interventions in early childhood but also awareness of empirically validated intervention strategies to incorporate into inclusive classrooms. Investigation into outcome measures used to evaluate the effectiveness of these treatments also has implications for the special and general educator. Teachers are often tasked with providing input for assessments, and therefore the discovery of quick, psychometrically strong and easy-to-use instruments are of importance to the practitioner and educator alike.

1.3 Autism in Toddlers and Early Childhood

Autism spectrum disorder is a complex neurodevelopmental disorder characterized by pervasive impairments in social communication and interaction and the presence of restricted, repetitive patterns of behavior (CDC, 2020). These symptoms are often present in early childhood and infancy, thus initial assessment and diagnosis must emphasize a developmental approach. For example, sensorial exploration has an adaptive function within the first 12 months of life, yet persistence into the toddler years may signal developmental delay. Alternatively, some children may seem to be reaching developmental milestones on time, then plateau or regress. At two years, a lack of response to joint attention bids from caregivers often signals early symptomatology. Not surprisingly, parents' initial concerns are often related to their child's atypical or lack of speech development and social behavior (Chawarska et al., 2014 p. 122). Evidence suggests that impairments in social interactions, considered core symptoms in children and adults with autism, are present during the toddler years (Webb & Jones, 2009). For example, toddlers with autism may show reduced interest or responsiveness to social stimuli such as faces and voices, and may exceedingly orient themselves towards nonsocial stimuli (Webb & Jones, 2009).

It is suggested that 80-90% of parents recognized signs of atypical behavioral development prior to 24 months (Chawarska et al., 2014 pp. 122). Diagnostic assessment tools

such as the ADOS and ADI-R have been shown to reliably diagnose ASD by the age of two, though some children's symptoms may not be recognizable until the preschool years and the average age of diagnosis is still around four years of age (Hedges et al., 2018) . It should be noted that onset of symptomology and developmental trajectories are considered to be highly variable (Webb & Jones, 2009). Early identification and diagnosis is further complicated by the heterogeneity of the disorder, in addition to symptom expression and presentation are likely to change through different developmental periods (Powell et al., 2018). Though complex, early identification and eventual diagnosis of ASD is important to eligibility for service delivery.

1.4 Importance of Early Intervention

Despite complexities in identification and diagnosis, experts can agree that interventions should begin at the earliest stages possible (L. K. Koegel et al., 2014; Reichow et al., 2018). Lack of appropriate diagnosis and/or the “wait and see” method prevents access to proper early intervention services and may have negative, long-term downstream consequences (L. K. Koegel et al., 2014). Children who receive interventions which target areas of core symptoms of autism (social communication, joint attention etc.) may have reduced symptoms of anxiety and depression in adolescence and adulthood (Koegel et al., 2013). Secondary symptoms such as aggression, excessive tantruming and a variety of problematic behavior have been significantly reduced or eradicated with early intervention techniques such as teaching functionally-equivalent replacement behaviors (Carr & Durand, 1985; Hanley et al., 2014; L. K. Koegel et al., 2014). Other important outcomes include increased IQ scores, increases in adaptive functioning and reduction in core symptomatology (Reichow et al., 2018; Smith et al., 2019) in comparison to children who received no treatment, or non behavioral, eclectic treatments. Perhaps more indicative of the success of early intervention services are the effects it has on individual and family functioning and familial satisfaction (L. K. Koegel et al., 2014). Increasingly reports of parental well-being are being reported in the literature, though more research into satisfaction of intervention is warranted. Finally, fiscal implications of these early and intensive behavioral interventions have been demonstrated to dramatically reduce state educational costs (Chasson et al., 2007).

Though widely considered to be the best course of action, there are some challenges to implementing and evaluating psychoeducational treatment models. The first being the initial

financial and time commitment. Comprehensive treatment programs can be expensive and require extensive staff and parent training by qualified professionals (Lord et al., 2005). Implementation of these models into community settings such as mainstream preschools can take upwards of 3 months to one year (Eldevik et al., 2019). Instigating parents as primary therapists may help reduce start up costs, but this is an empirical question that needs more investigation (L. K. Koegel et al., 2014). Another barrier to treatment are questions regarding the methodological soundness of research conducted with these interventions. RCTs are generally considered the gold-standard of research (Odom et al., 2010), but very few studies evaluating EIBI are RCTs. However, practical and ethical considerations are made. Historically, a lack of funding has prevented large scale RCT trails. Additionally, given the nature of the diagnosis, excluding children from potentially effective treatment due to randomization is considered by many to be an ethical violation (Lord et al., 2005; Odom et al., 2010).

In summary, Experts agree that early identification and implementation of early intervention services can drastically improve the developmental trajectory of many children. Empirically- validated interventions implemented in the toddler years and early childhood are time- and cost effective and have positive impacts on familial well-being (L. K. Koegel et al., 2014).

1.5 Measures of Treatment Outcomes: The Problem Statement

Above, challenges and considerations to early identification and diagnosis as well as implementation of early intensive behavioral interventions were discussed. Heavy consideration has been given to comprehensive diagnostic assessment (Ozonoff et al., 2005), though gaps in measurement selection have been identified when considering how to best evaluate treatment outcomes (Matson & Rieske, 2014). Bolte and Diehl (2013) identified 239 unique measurement tools. Use of these tools were widely inconsistent and none were reported in more than 7% of trials. In another review, Stolte, Hodges and Smith (2017) found 53 measurement tools. They found measures of adaptive behavior and cognitive functioning to be the most reported outcomes. They identified strengths to be the use of multiple assessment tools and ASD specific instruments, and found limitations within test substitutions and underreporting of test modifications (Stolte et al., 2016). Guidelines regarding the selection of best-fit measurement tools are limited in the literature, though some information on *what* outcomes should be reported exists. Treatment outcomes have often been reported as standardized gains in intellectual and

adaptive functioning. More recently, outcomes reporting parental-stress and core symptoms of ASD have been reported with increasing frequencies (Matson & Rieske, 2014). However, measures of challenging behavior, treatment side effects and use of behavioral measures remain scarce.

Discussions raised by Lord and colleagues (2006) suggest outcome measures are selected a priori, are socially valid and represent changes important to stakeholders (eg. parents and teachers) and are sensitive to change. McConachie et al. (2018) recently investigated parent suggested indicators of progress and outcomes. Outcome measures of communication, emotional well-being, relationships with others, parent stress, safety, and other bodily functions (sleep, sensitivity to environmental stimuli) etc. were indicated as “most important”, though measures reporting all aspects of these outcomes were seldom reported.

Equal consideration must be given to what is feasible in clinical practice. Outcome measures should reflect what is considered of importance to parents and stakeholders, practical from a cost, time-effective, and administrative standpoint, and comply with policies from private payers. This calls into question the sensitivity of many standardized assessment tools and whether they are designed to measure and detect change within short-time intervals. For example, measures like the Autism Diagnostic Interview and Autism Diagnostic Observation Schedule were not designed to measure subtle changes (Gotham et al., 2009; Hus et al., 2014). Additionally, practitioners tasked with assessing outcomes in clinical practice seldom have the required qualifications needed to administer these tests, though this will be explored further in Chapter 4.

Selecting measurement tools to report outcomes in research and practice remains complex. Psychometrics, sensitivity to change and what actual scores represent must be considered, as well as selecting measures that are of social validity and indicate quality of life to consumers and stakeholders. The purpose of this review was to identify the measures used to report outcomes specific to EIBI research, and investigate the validity of these measures. In addition, information on how scores were reported and intervals between assessments were sought. Implications of results along with the general recommendations in the literature will help clinical professionals select measures appropriate for use within the framework in which they are providing services.

2. Choice of Research Design and Methods

The goal of the research project was to identify and determine the validity of the instruments used to measure outcomes in the published EIBI literature. A secondary goal was to look at the general recommendations for evaluating outcome of early interventions for ASD in order to move towards developing a set of recommendations and guidelines for selecting appropriate assessment measures. Therefore, I first conducted a systematic narrative-type review of the literature. The intent was to follow the guidelines of a systematic review, but to stop short of conducting statistical analysis and interpretation of results (as this was not the goal). The database search was conducted with help from a librarian at the University of Oslo, eligible articles were evaluated for scientific rigor, data was extracted and analyzed using tables with narrative components. The following sections aim to take a closer look into the search procedures, evaluation of articles and data extraction than was permitted in the article manuscript.

2.1 Inclusion Criteria

Selection of inclusion criteria began with the research question and identifying key elements based on the PICO (population, intervention, control, outcome) framework. The inclusion criteria was selected before the search was conducted, as is generally recommended when conducting a systematic review. Based on the research question, five keywords were selected which served as the basis for developing the inclusion criteria., Articles were considered eligible if they met specified criteria (See Table 2.1). The intent was to apply a focussed approach to the database search, but cast a “wide net” within EIBI research in order to capture as much of the published literature as possible. We determined recency to be defined as journals published within the last 15 years to ensure a large enough span of time to capture all relevant literature. Interventions were included only if they were developed and based on the principles of applied behavior analysis (ABA) and were delivered for at least 5 hours per week. According to standards, treatment intensity of 5 hours per week falls far below the recommended 25-30 hours of intervention per week set forth by the Behavior Analysis Certification Board (BACB, nd.). Treatment intensity and intervention type “EIBI” were kept intentionally broad. EIBI interventions included those based on the UCLA Young Autism Project (Lovaas, 1987),

Pivotal Response Treatments (R. L. Koegel & Koegel, 2006) and the Early Start Denver Model (Rogers & Dawson, 2010). Treatment was considered to start early if the child began receiving interventions before 7 years of age (although most early intervention programs begin in the preschool years). Studies included were to employ group designs, these included randomized controlled trials, quasi-experimental designs, pre-post single group studies, comparison control trials, follow-up and retrospective studies.

Table 2.1

Inclusion Criteria for Studies Included in Review

Inclusion Criteria	Specification
Recency	Within the last 15 years
Treatment/Intervention Program	EIBI program based on applied behavior analysis
Treatment Intensity	At least 5 hours/week
Language	English
Study Design	Group designs / comparison (clinically or randomly controlled), pre-post design, retrospective, follow-up
Assessment tool	Specifies use of a standardized test to measure treatment outcomes
Outcome domains	Specificities which domains were assessed (Social skills, symptom severity etc.)
Age	Maximum of 7 years old
Intensity of Intervention	At least 5 hours/week

2.2 Search String Development and Database Search

With consultation of a librarian at the University of Oslo, keywords were selected and extrapolated using synonymous terms according to the two intended databases. The Thesaurus function was utilized in both ERIC and PsycINFO to identify keywords and their synonymous

identifiers. Keywords were connected with commas in ERIC; Boolean Operators were used during the search in PsychINFO. In both databases, filters were applied to include only studies published in the last 15 years (ERIC) or since 2006 (PsychINFO), and to include only articles published in peer reviewed journals. See Table 2.2 for specific search string combinations with applied filters.

Table 2.2

Search String Combinations Utilizing Boolean Operators

Search Date	Database	Keyword combination	Filters
1/12/21	ERIC	autism, eibi, early intensive behavioral intervention, early intervention, treatment outcomes, outcome measures, children, preschool, prekindergarten, applied behavior analysis	Published in the last 15 years, peer reviewed journal
1/14/21	PsychINFO	children OR preschool children OR young children) AND (expAutism spectrum disorders OR pervasive developmental disorders) AND (early intensive behavioral intervention OR “eibi” OR applied behavior analysis OR behavior modification OR early intervention) AND (outcome measures OR treatment outcomes)	Since 2006, peer reviewed journal

The database search was conducted on January 12, 2021 (ERIC) and January 14, 2021 (PsychINFO). Combined initial results yielded 517 articles. Articles were excluded for irrelevance, failing to meet criteria for recency or treatment intensity, utilizing case studies or series of case studies, and inappropriate intervention methods. Thirty five articles remained eligible for quality appraisal after full text scans. Eight additional articles were found by searching through eligible article’s background, discussion and reference lists. A total of 43 articles were included for quality appraisal.

2.3 Quality Appraisal of Articles

Articles were scored for scientific merit using the *Council for Exceptional Children’s Standards for Evidence-Based Practices in Special Education Quality Index Rating Tool* (Lane,

Common, Royer and Muller, 2014). The *Standards for EBP* are used to rate the quality of educational research using absolute and weighted coding. The appraisal tool addresses 8 quality indicators which pertain to both group and single-case designs. The study is determined to have positive, neutral/mixed, or negative effects. Finally, based on the scores of the quality indicators, the papers are classified as Evidence- Based, Potentially Evidence Based, Mixed or Insufficient Evidence (Royer, Lane, & Common, 2017).

2.4 Risk of Bias

Articles were appraised by two raters, the first being the author and the second, an independent rater with no further affiliation with the project. The first 10 articles were scored together to establish confidence and consistency in the overall appraisal. Interrater agreement was determined as the percentage of agreement over total articles. Interrater agreement was determined to be 95.25%.

2.5 Data Extraction and Analysis

Primary variables of interest were the assessment tools used to measure outcomes in the EIBI literature. Data were extracted from each article using a matrix. Outcome measures reported in each article were classified in one of seven categories: measures of intellectual ability, adaptive functioning, autism core symptoms, language ability, maladaptive behavior, parent/caregiver well-being and criterion-based measures. Results were reported as frequencies and percentages of total articles. I decided to report results as frequencies and percentages to identify not only *what* measures were being selected, but also how often. As the literature included spans the entire 15 years, it is important to note that instruments are revised over the years. This is reflected in Table X to the article manuscript where measures like the Bayley Scales of Infant Development are listed as Bayley Scales, Bayley- Revised, Bayley -2 and so forth. It is important to note that information given in the descriptive table (see Appendix A to the article manuscript) are reflective of only the most recent version of the measure.

A secondary variable of interest were the psychometric properties associated with each outcome measure. Reliability was determined as ranging from poor-excellent based on the scale provided in *Assessment of Children: Cognitive Foundations* (Sattler, 2018). Validity was deemed

satisfactory if published evidence of criterion related and construct validity could be provided. I did not have access to each instrument's published manual, and therefore I used secondary sources such as the most recent versions of *Assessment of Children: Cognitive Foundations* (Sattler, 2018), and *Assessment in autism spectrum disorder* (Goldstein & Ozonoff, 2018) who report published reliability and validity for some measures. Additionally, publication summaries obtained through the publishers website were used for measures not listed in the aforementioned sources. Finally, a literature search was performed for recently published evidence of psychometric properties, if evidence could not be obtained from the publisher's website. If no evidence for psychometric properties could be found, reliability and validity were listed as "no information".

Background variables such as time between assessments and how authors reported scores (standard scores, ratio IQ's, age-equivalents) were coded and used for some analysis as well. These analyses were used as supplementary information that may be of interest to third party payers, but were not primary variables in the present study.

2.6 Limitations

There were some weaknesses associated with this research project. The time frame to complete the masters thesis and my inexperience in conducting systematic reviews probably contributed to some methodological shortcomings. Although great effort was made to identify and capture all relevant literature within my topic, it is possible and probable that some articles were missed. Thus, selection bias cannot be ruled out. Additionally, no statistical analyses were carried out. Further research into what measures are being used in clinical practice is another topic for future research as this would identify a gap between research and practice, if any such exists.

3. Theoretical Orientation and Framework

3.1 *Applied Behavior Analysis, What is it?*

Behavior analysis is the science and study of functional relationships between the environment and human behavior. Three branches extend from behavior analysis: the conceptual analysis, the experimental analysis of behavior or basic research, and the applied realm (application of the science to human subjects). Applied behavior analysis (ABA) is the pragmatic and systematic approach to discovering and manipulating environmental variables to influence socially significant behavior (definition adapted from Cooper et al., 2019). The practice of applied behavior analysis uses environmental manipulations of antecedents and consequences along with shaping, fading and differential reinforcement to decrease problematic behavior and build skill repertoires in order for consumers to achieve socially meaningful outcomes, and improve quality of life. Applications of the science of behavior are widely utilized in education, from classroom management strategies to school-wide positive behavior supports, precision teaching and the education of all students regardless of needs status (Cooper et al., 2019).

3.2 *A Brief History*

Psychology in the early 20th century was largely dominated by studies of mental processes. Early behaviorism differed as it focussed only on observable behavior. John B. Watson, often considered the father of behaviorism, proposed that it was not mental states that should be the focus psychology, but the direct observation of the relationships between environmental stimuli and responses to those stimuli; thus, Stimulus-Response (S-R) psychology emerged (Cooper et al., 2019 p. 10). Finding that S-R relations within the environment could not account for all facets of behavior, specifically “voluntary” behavior, through his research B.F. Skinner proposed that it’s not the antecedent stimuli that has an affect on human behavior, but the history of the consequent stimuli that has followed the response in the past. This three- term contingency (S-R-S) became known as it is today, operant learning. Skinner’s investigations led to the development of the experimental analysis of behavior, guided by his philosophy: *radical behaviorism*, and eventually the application of the principles of operant learning to human behavior, or applied behavior analysis (Cooper et al., 2019 pp. 10-14)

3.3 Trends in Behavioral Interventions

As discussed earlier, early identification and intervention in toddlerhood and early childhood is widely recommended by experts over the “wait and see” approach (L. K. Koegel et al., 2014). Upon diagnosis, parents may be somewhat overwhelmed by the wide variety of different choices of intervention, all with varying underlying methodologies. These interventions can range from dietary supplements and restriction, behavioral interventions and a number of eclectic approaches (Grey et al., 2019). Supported by over 30 years of research, early behavioral interventions are considered well-established treatment methods of choice, and have been shown to increase adaptive functioning levels and decrease core symptoms of ASD. Children receiving behavioral interventions early in life may require less specialized support across the lifespan (L. K. Koegel et al., 2014; Lovaas, 1987), and most will be included in their regular education classrooms. Experts agree that favorable outcomes are possible with early intensive treatments, as compared to the 1960’s and 70s where children with autism were largely thought to be “uneducable”.

Considerable improvements have been made in behavioral interventions over the past couple of decades. Behavioral interventions consist of both direct-teaching and naturalistic formats. Though they utilize differing instructional formats, the underlying methodologies remain the same. Both direct-teaching and naturalistic behavioral interventions utilize operant learning techniques, target socially significant intervention goals, systematically and objectively analyze the child's performance before, during and after treatment, and are informed by the research in the experimental analysis of behavior (Schreibman et al., 2015). Naturalistic Developmental Behavioral Interventions (NDBI’s) have growing support in the literature and are influenced by developmental psychologists such as Piaget, Vygotsky and Bruner (Schreibman et al., 2015). Taking a constructivist approach, children are taught within developmental sequences building upon prior skills to help them contact new experiences and environmental contingencies. Not surprisingly, NDBI’s are considered to be family-friendly intervention approaches as they are often embedded throughout child's day, within familiar routines and occurring in their natural environment (Schreibman et al., 2015).

3.4 ABA-Based Early Intensive Behavioral Interventions

Comprehensive Treatment Models (CTMs) can be described as “brand name” interventions that focus on broad behavioral and developmentally appropriate goals aimed specifically to impact core deficits of autism spectrum disorders. CTMs are delivered early, at high intensities (e.g 25+ hours a week), and occur over long periods of time (typically two or more years) (Odom et al., 2010). Though not entirely synonymous, Early Intensive Behavioral Interventions fall under an overarching CTM umbrella. Early Intensive Behavioral Interventions, though implemented with some variance, all share some fundamentals. The first being that EIBI interventions blend and incorporate the principles of ABA, autism, and developmental psychology to provide tailored intervention goals to meet the needs of the child and the family. Second, intervention goals address all domains of child development. Third, skill building procedures are based on positive reinforcement, and behavior reductive procedures are based on input from a functional analysis. Fourth, teaching is systematic and data based, and skills are broken down into step-by-step teachable units. Fifth, measurement of treatment goals are ongoing, and supervision by qualified professionals is provided frequently (usually weekly). Lastly, treatment is conducted in multiple settings with a variety of people, and explicit generalization training is used (Green, 2011 in Eldevik et al., 2019). The following models are evidence-based EIBI and CTM models.

UCLA Model

The UCLA Model is based on the works of Ivar Lovaas in the 1970’s and 1980’s. Though modernization and variations exist, the underlying principles, as with all the models discussed in this chapter, remain the same. The underlying theory of the UCLA model is of operant learning, using principals such as reinforcement, shaping, prompting and fading techniques, task analysis and discrimination training (Cohen et al., 2006; Eikeseth et al., 2002, p. 2; Lovaas, 1987). Treatment often begins in a 1:1 Discrete Trials format, where the child learns basic listener skills. Skills gradually increase in complexity, moving from vocal and non-verbal imitation, building receptive and expressive vocabulary, eventually moving to abstract tasks such as color identification and prepositions (Eikeseth et al., 2002). Tangible reinforcers are often used in the beginning but are eventually faded out and replaced with social reinforcers such as praise, hugs, tickles and high-fives, as is appropriate for young children (Cohen et al., 2006).

Treatment intensity is aimed at 35+ hours per week, and parents are integral in the treatment progress. Generalization and maintenance are programmed for and are included in weekly treatment hours. Usually, in the second or third year of treatment, social skills such as functional toy play, conversation skills, turn taking and symbolic play are targeted (Cohen et al., 2006; Eikeseth et al., 2002). Finally peer-play and general education placements are carefully faded in as 1:1 therapist support is gradually faded out. Frequent supervision by trained and qualified professionals is a hallmark of the UCLA model. Variations of this model are frequent in the literature and have expanded from exclusively research-based facilities into effectiveness studies in real-world community settings in both North America and Europe (Eldevik et al., 2012, 2019; T. Smith et al., 2015).

Pivotal Response Treatment

Pivotal Response Treatments are comprehensive early intervention treatment models that incorporate both a developmental approach and procedures based upon applied behavior analysis (R. L. Koegel & Koegel, 2006; Schreibman et al., 2015). PRTs target pivotal skills such as motivation, responding to multiple cues and self-initiations, that once acquired, have cascading generalizing effects. Like other Naturalistic Developmental Behavioral Interventions (NDBIs), PRT's are generally child-led and focus on using naturally reinforcing stimuli, or contextual reinforcers in place of arbitrary reinforcers used in some direct-teaching formats. Children often help select stimuli used for teaching, and teaching is embedded into the child's natural environment, often by following the child's lead or motivation. Parental involvement plays an imperative role in Pivotal Response Treatments. Parents are trained to incorporate and embed teaching strategies within familial routines or daily activities, with the goal being that intervention is intensive in that it is embedded into all of the child's waking hours. Parents are taught to arrange their environments to evoke discrete opportunities for language and social interactions. Attempts at communication are reinforced, and techniques such as modeling and shaping are utilized as the child begins to master the skill (R. L. Koegel & Koegel, 2006). PRT is compatible with inclusive educational environments as teachers and special educators can learn to incorporate intervention strategies into the general curriculum, and has been used in community settings (I. M. Smith et al., 2010, 2015) suggesting its effectiveness and sustainability in "real life".

Early Start Denver Model

The Early Start Denver Model is a developmental, relationship-based and behavioral intervention for very young children with or at risk for autism. ESDM aims to foster warm, positive relationships between child and therapist or child and caregiver, and embeds developmentally appropriate and empirically validated teaching strategies based on ABA into natural routines in the child's life. The model takes a collaborative approach between family and professionals including speech and language pathologists, the child's pediatrician, occupational therapists and so on. The ESDM is manualized and targets therapist and child behavior. Goals and learning objectives are individually designed based on the child's current skills and deficits and goals that are deemed culturally important to the family. Learning objectives target all areas of the child's development, but focus on core developmental areas specific to ASD such as: imitation, joint attention, verbal communication, social development and pretend play (Talbot et al., 2016). Unlike in discrete trial format, teaching is embedded into joint activities with the child, and are often child-led. Like other behavioral interventions, shaping, prompting and prompt fading are utilized to facilitate learning; data is collected and monitored on an ongoing basis (Talbot et al., 2016). Because of the flexible nature of the intervention, the ESDM can be implemented where the child spends most of their time. Delivery of the model has been validated globally in childcare facilities, inclusive preschools and outpatient clinics (Costanza et al., 2018; Estes et al., 2015; Lin et al., 2020; Vivanti et al., 2019) Best outcomes are achieved when started early (Vivanti & Dissanayake, 2016), and are delivered with intensity (>15 hours therapist implementation) (Talbot et al., 2016).

4. Context

4.1 ABA Service Delivery and Providers

Comprehensive EIBI treatment models are typically center or home-based, and are created, implemented and supervised by masters and doctoral level Board Certified Behavior Analysts (BCBAs). As of 2021, Board Certified Behavior Analysts have a graduate degree in special education, psychology or behavior analysis and have completed additional coursework at the graduate level in behavior analysis. In addition, they have completed 1500 hours of supervised practical experience (as per guidelines by the Behavior Analysis Certification Board), and have passed a qualifying exam (Behavior Analyst Certification Board, n.d). BCBAs and BCBA-Ds are considered by policy makers to be the most qualifying practitioners to provide applied behavior analytic services to consumers (Zhang & Cummings, 2020).

Behavior Analysts provide focussed and/or comprehensive services. They are responsible for the design, implementation, training and evaluation of behavior analytic services such as early intensive behavioral interventions. BCBCAs are regulated by the Behavior Analyst Certification Board (BACB). The BACB was established in 1989 in order to provide credentials and a set of standards to professional behavior analysts worldwide (Zhang & Cummings, 2020). Certificant data from the BACB indicates there are over 40,000 masters-level BCBAs holding credentials in the United States and over 3,500 masters-level certificants world-wide (Behavior Analyst Certification Board, n.d).

Over the years there have been a number of disputes and lawsuits for the denial of aba services, claiming EIBI programs as experimental (L. K. Koegel et al., 2014), largely due to lack of RCTs. These claims have been overturned and ABA is now considered medically and educationally necessary (Keenan et al., 2015). In the United States, coverage of ABA services for children with autism is funded through private insurance payers and is now mandated by law in 48 states and the District of Columbia (Zhang & Cummings, 2020).

4.2 Challenges to Measuring Treatment Outcomes in Applied Settings

Through efforts of literature reviews like Bolte & Diehl (2013), Stolte et al (2016), and the current project, a great deal has been uncovered about the usage of outcome measures for individuals with autism and individuals receiving behavior analytic interventions in early

childhood. Previous reviews found measures to be inconsistent and large in number. This was true in some cases in my review. I found domains of language assessment and challenging behavior to lack preference in measurement, with many measures being used only once. These domains were also found to be reported in less than 20% of articles, along with criterion-based measures and measures of parent and caregiver well being. Reporting measures of parental well being and social validity is a critical area for improvement in the field of EIBI. Grey and colleagues (2019) defined social validity in EIBI as the social importance and acceptability of the intervention relating to the goals, procedures and outcomes produced by the intervention. They comment on the underrepresentation of intervention acceptability in EIBI research. Similar to their findings, my review did not discover any measures of intervention satisfaction, or other measures of social validity.

Currently we do not have nation-wide information on the instruments being used to measure outcomes at the clinical level. Additionally, the interval between measurements and the domains in which outcomes are being measured in practice remain largely unknown. Services are provided by insurance-funded agencies and practitioners, and therefore authorization for the continuation of services is largely determined by these providers. Authorization periods and requirements likely differ between companies and states. For example, outcome measures may be required every 3 months, 6 months, or on an annual basis. This presents a challenge in two respects: 1) outcome measures currently in use may not be sensitive enough to display change over periods of months, and 2) masters -level practitioners often do not have the qualifications to administer gold-standard instruments found in recent reviews. Insurance providers are likely looking for measures that are quick to administer, cheap, reliable, valid and sensitive to measure change over short intervals. With these criteria in mind and keeping with the recommendations set forth by previous research, the article manuscript intends to discuss current trends in outcome measurement and provide brief recommendations for clinical practice.

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Appendices to the Extended Summary

1. Instructions for Authors

Appendix 1: Instructions for Authors

Instructions for Authors

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Manuscript Submission

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References

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- Online document
Abou-Allaban, Y., Dell, M. L., Greenberg, W., Lomax, J., Peteet, J., Torres, M., & Cowell, V. (2006). Religious/spiritual commitments and psychiatric practice. Resource document. American Psychiatric Association.
http://www.psych.org/edu/other_res/lib_archives/archives/200604.pdf. Accessed 25 June 2007.

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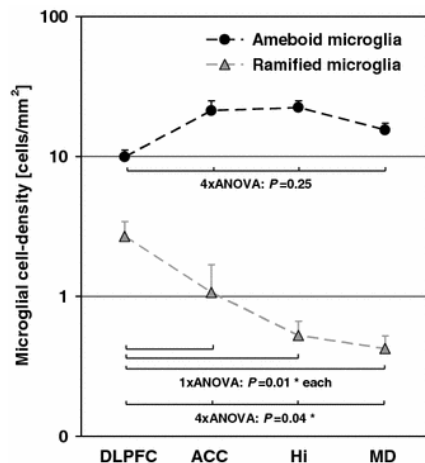
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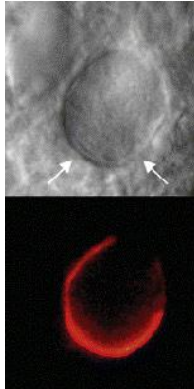
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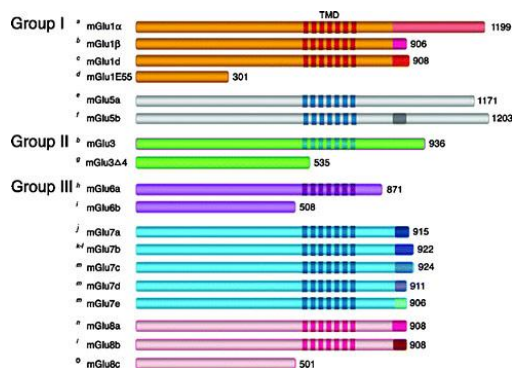
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Measures Used to Assess Treatment Outcomes in Children with Autism Receiving Early and Intensive Behavioral Interventions: A Review

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Abstract

This review aimed to identify and assess the psychometrics of assessment instruments used to measure treatment outcomes in children with autism spectrum disorder who received early and intensive behavioral interventions. Forty three articles were included and appraised using the Council for Exceptional Children's Standards for Evidence Based Practice quality index rater. Ninety-two outcome measures were discovered. Measures of adaptive functioning (91%), intellectual functioning (86%) and core symptoms (67%) of autism were represented with the highest frequencies. Measures of challenging behavior, and parent/caregiver well being were under reported at 30% and 14% respectively. Reliability and validity of each measure was determined by recently published psychometric data. Utility of outcome measures in clinical practice are discussed.

Keywords

Autism, early intensive behavioral intervention, outcome measures, treatment outcomes

Word Count: 6330 (excluding references and tables)

Autism spectrum disorder is classified as a neurodevelopmental disorder with marked impairments in social communication and the presence of restricted and repetitive behaviors. Heterogeneity of the disorder is large, with presentation or symptom severity ranging from mild to severe. (American Psychological Association, 2013). It is estimated that 1 in 54 children in the United States will receive an autism spectrum diagnosis (Center for Disease Control, 2021). The diagnostic process includes a clinical evaluation alongside caregiver reports, with most children receiving their diagnosis between the ages of 2 and 6 years old (Fletcher-Watson & McConachie, 2017).

Naturally, parents with children presenting symptoms of autism in early childhood will seek information regarding appropriate early intervention services. In the United States, treatment models based on the principles of applied behavior analysis are considered to be the “treatment of choice”. Intensive behavior analytic interventions are well structured, individualized teaching programs that are designed to address a wide range of developmental areas (Vismara & Rogers, 2010), and focus on acquiring new skill repertoires and/or decreasing challenging behavior. In the United States, these interventions are typically carried out in the child’s home or at a centre and are funded through insurance. Given the substantial empirical support for early intensive behavioral intervention (hereafter referenced as EIBI), when considering treatment alternatives, EIBI is generally considered to be a well-established and effective treatment for children with autism (Reichow et al., 2018).

Several systematic reviews and meta-analyses have discussed positive outcomes in intellectual functioning and adaptive behavior regarding treatment outcomes for children who participated in EIBI programs (Eldevik et al., 2009; Peters-Scheffer et al., 2011; Reichow et al., 2018). Additional findings from Smith et al., 2019 suggests that gains made in intellectual and adaptive functioning, as well as some reduction in autism symptomatology had maintained overtime. Although additional outcome research in follow-up studies are needed. Emerging evidence for similar behavioral based interventions has shown results in developmental changes in infants and toddlers such as normalized brain activity (Dawson et al., 2012) and improvements in verbal developmental quotients (Vivanti & Dissanayake, 2016). However, gains differ between individuals, and several factors may influence treatment outcomes such as: milder symptom severity and intellectual functioning at intake (Ben-Itzhak & Zachor, 2007; Fossum et

al., 2018; Smith et al., 2015; Zachor et al., 2007), age of treatment onset, and intensity of supervision (Eikeseth et al., 2009), and treatment intensity (Eldevik et al., 2009). The Behavior Analyst Certification Board recommends 30-40 treatment hours per week to achieve optimal outcomes. In keeping with this Lotfizadeh et al., 2020 found moderate treatment gains made on the Verbal Behavior Milestones and Placement Program (VB-MAPP; Sundberg, 2008) for children who received between 8 and 15 hours of ABA per week, indicating that although moderate, treatment gains can be made at lower-intensities. Similarly, Eldevik and colleagues, 2019 compared outcomes of adaptive and intellectual functioning and ASD symptom severity in groups of children who received low intensity, high intensity, or eclectic special education. Although below the recommended treatment hours, those in the “high-intensity” group made significantly better gains than both the low-intensity and eclectic group, suggesting a dose-response relationship.

Despite the growing body of literature supporting improved outcomes for children receiving early and intensive behavioral interventions across core domains, the field lacks a consensus regarding the selection of valid and appropriate outcome measures. This could be due to a host of difficulties surrounding the heterogeneity of the disorder; for example, the wide range in cognitive abilities, deficits in motor planning and social skills, and comorbid challenging behaviors (Matson & Rieske, 2014). Ozonoff et al. (2005) suggests a core initial assessment battery to include measures of autism diagnosis, intellectual functioning, adaptive functioning and a language assessment. Matson and Rieske (2014) extend this core battery to represent assessment of outcomes. They propose measures of challenging behavior, direct measures of targeted behavior (focused measurement), family or consumer satisfaction, and treatment side effects to be included in a comprehensive assessment battery. Though there is some agreement as to what should be measured, how to measure outcomes remains complex.

Previous reviews have identified high volumes and wide varieties of outcome measures in ASD research (Bolte & Diehl, 2013; Stolte et al., 2016). The high volume and inconsistencies found in these reviews reflect frequent revision of measures, shifting requirements of these measures and the sheer amount of tools available for purchase today. Identification of valid instruments for use within asd populations is critical. In addition, practicalities such as administration qualifications, time and cost to administer, and sensitivity to detect subtle change

over shorter time frames (eg. 3-6 months) must be considered in keeping in line with policies set forth by insurance providers.

The purpose of this study is to review the current EIBI literature and identify what measurement tools are being used to assess outcomes of children with ASD. In addition, the review seeks to determine the validity of these measures in order to provide brief recommendations in selecting appropriate assessment tools as part of a developing set of standards for research and clinical practice.

Methods

Inclusion Criteria

Selection criteria was determined *a-priori*. In order to capture as much published literature as possible, inclusion criteria were kept intentionally broad. Outcome studies were selected and appraised if: 1) interventions were comprehensive and based on the principles of applied behavior analysis, including Lovaas-style EIBI programs (Lovaas, 1987), Pivotal Response Treatment (Koegel & Koegel, 2006) and the Early Start Denver Model (Rogers & Dawson, 2010); 2) participants received at least 5 hours/week of 1:1 treatment; 3) participants were a maximum of 7 years of age at the onset of treatment; 4) children had a diagnosis of Autism Spectrum Disorder or PDD-NOS; 5) the study specified the use of at least one standardized measurement tool to assess treatment outcomes in one or more domains, such as: adaptive functioning, cognitive functioning, autism core symptom severity, or language functioning; 6) the study utilised group designs; 7) the study was published in a peer-reviewed journal, in English, between 2006 and 2021.

Search and Search Strategy

The electronic search was performed between the 12th and 14th of January in 2021 in the databases PsycINFO and ERIC using a combination of the following keywords: *autism and/or pervasive developmental disorders, children, eibi or early intensive behavioral intervention, applied behavior analysis, and outcome measures or treatment outcomes*. The search was conducted in consultation with a librarian from the University of Oslo. The electronic search retrieved a total of 517 peer-reviewed articles, 383 articles were excluded for irrelevance, publication before 2006, incorrect diagnosis and/or duplication. Of the remaining 135 articles,

104 articles were selected for full-text screening and more detailed coding. Studies were deemed eligible for inclusion and quality appraisal if they met all of the inclusion criteria listed above. Thirty five articles from the database search met inclusion criteria, an additional 8 studies were retrieved through hand search yielding a total of 43 articles included in the present review. See Figure 2.1 for search and selection procedure.

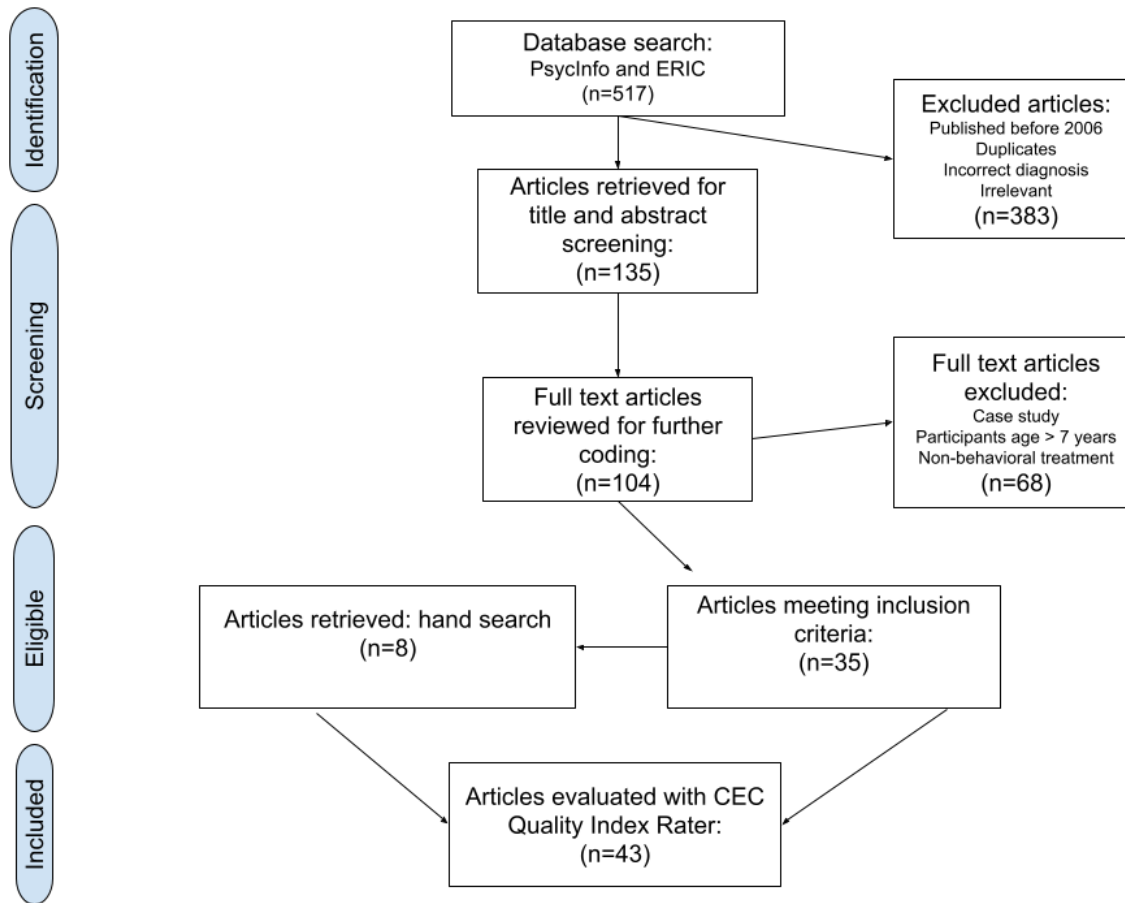


Figure 2.1 Database search and selection procedure.

Quality Appraisal and Inter-Rater Agreement

Articles were appraised for methodological rigor using the *Council for Exceptional Children Standards for Evidence- Based Practices in Special Education* (Council for Exceptional Children, 2014). The *Standards for EBP* is a quality index matrix which appraises scientific publications based on eight domains. Quality indicators are met when raters agree the study

satisfactorily addresses the content outlined in each indicator (CEC, 2104). All included studies were evaluated by the author and one independent rater. Raters worked together on the first 10 articles before scoring independently, disagreements were discussed and inter-rater agreement was determined to be > 95%.

Analysis

Outcome measures were extracted and coded using a matrix of whether they assessed (1) intellectual functioning, (2) language ability, (3) adaptive functioning, (4) ASD symptom severity, (5) challenging behavior, (5) parental well being or (7) a criterion-referenced or direct observation measure. A total of 92 outcome measures were found across the 43 included articles in this review. This total reflects sequential revisions to instruments as separate measures (eg. Vineland 2 and Vineland 3 are recorded as two independent measures). Measures of intellectual (86%) and adaptive functioning (91%) were reported most frequently, followed by measures of symptom severity (67%). Measures of language ability and challenging behavior were found in 33% and 30% respectively. Parental and caregiver wellness was underrepresented at 14%. Similarly, only 6% of articles found reported the use of manualized, criterion-based measures to assess outcomes. Brief descriptions of each measure, including cost, administration, reliability and validity can be found in Appendix A.

Reliability of the measures used for individual assessment was evaluated based on the following coefficient scale: .00 to .59: very poor reliability, .60-.69: low or poor reliability, .70-.79: moderate to fair reliability, .80-.89 good reliability, .90-.99 excellent reliability (Sattler, 2018). Validity of the assessment was determined as satisfactory if the measure provided published evidence of criterion, concurrent validity, or construct validity. Recent reliability and validity for measures with a frequency of 3 or more are discussed below.

Secondary variables such as score reporting methods and time intervals between assessments were also examined. Table 3.1. provides frequencies of scores reported in standard scores (SS), age equivalents (AE), ratio scores (RA), or raw scores (RW).

[Insert Table 3.1 here]

Time between assessments was determined as the interval between the initial assessment (T1) and outcome measurement (T2). If more than two assessments were provided, the time interval between each assessment was recorded (ex. T1: baseline, T2: after 3 months of treatment, T3: outcomes after 6 months of treatment = 3 month intervals between assessments). Table 3.2 describes measures used in assessment intervals of one year or less.

[Insert Table 3.2 here]

Measures of Cognition

Similar to previous research in EIBI, measures of intellectual functioning appear frequently (Matson and Rieske, 2014). Thirty-seven of the forty-three articles report at least one measure of cognitive ability. Thirty measures of intellectual functioning were reported and more than half (53%) of the articles reported the use of more than one measure of cognitive functioning, either across participants or across time. Forty percent (17/43) of articles computed ratio IQ scores for at least some of their participants. Full Scale Measures of Intelligence (FSIQ) were reported in 32/43 (74%) of articles. Some articles used a mix of FSIQ and NV intelligence tests (4/43, 9%), and few articles (2/43, 5%) reported only use of NV tests to measure cognition. Measures of full scale intelligence included : Bayley Scales of Infant Development (Bayley-4; Bayley, 2019), Mullen Scales of Early Learning (MSEL; Mullen, 1995), Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV; Wechsler, 2012), PsychoEducational Profile- Revised (PEP-3; Schopler et al., 2005), Differential Abilities Scale (DAS-II; Elliot, 2007), Stanford Binet (SB-5; Roid, 2003) and the Wechsler Intelligence Scale for Children (WISC-V; Wechsler, 2014). See Table 3.3 for frequencies and percentage of use for measures of intellectual functioning.

[Insert Table 3.3 here]

Both Wechsler tests (WPPSI-IV, WISC-V) are considered to have excellent internal consistency reliability (.88-.96) and show satisfactory criterion validity, though tests are limited (Sattler, 2018). SB-5 has excellent internal consistency and test retest reliability. SB-5 has satisfactory concurrent validity (.84), and may be useful for older children with significant developmental delays (Klinger et al., 2018). DAS-II is considered to have excellent reliability,

with internal consistency coefficients $>.95$, and shows satisfactory concurrent validity (.80) (Sattler, 2018). PEP-R has been reported to have good internal reliability (Reed et al., 2007a) and has been found to correlate highly with measures like Childhood Autism Rating Scale and the original Vineland Adaptive Behavior Scales, Expanded Form (Naglieri et al., 2018). Bayley 4 is reported to have excellent internal consistency reliability and good test-retest reliability; correlates with similar developmental measures and has a good degree of classification accuracy (convergent validity) (Bayley, 2019). Construct and convergent validity of the MSEL has been demonstrated in young children with asd (Swineford et al., 2015). Internal consistency reliability of the scales ranges from satisfactory to good, and from good to excellent for the Early Learning Composite. Test retest reliability is good for children ages 1month-24 months, but poorer reliability has been reported for children 25-56 months (Shank, 2018).

Measures of Non-Verbal Intelligence were reported for some participants, but were typically used as part of a comprehensive intellectual assessment. In two articles, the Merrill-Palmer Scale of Mental Tests Revised (M-P-R; Roid & Sampers, 2004) was used in place of a FSIQ (Fossum et al., 2018; I. M. Smith et al., 2010). M-P-R has excellent reliability and has evidence of content and criterion- related validity, correlations to the Bayley Scales and Abbreviated version of the SB-5.

Measures of Adaptive Behavior

Adaptive functioning was predominantly measured by the Vineland Adaptive Behavior Scales (Vineland-3; Sparrow, Cicchetti, & Saulnier, 2016). All 39 articles reporting a measure of adaptive functioning used either the first or the second edition of the VABS to assess outcomes of adaptive functioning (see table 3.4). In three articles, the Child Behavior Checklist was used as a supplement or follow up to the Vineland (Eikeseth et al., 2007; Fava et al., 2011; Peters-Scheffer et al., 2010), and in one case, the Developmental Profile 1 and 2 was used (Waters et al., 2020).

[Insert Table 3.4 here]

The Vineland Adaptive Behavior Scales -III (Sparrow et al., 2016) is a standardized instrument intended to measure the degree to which the individual performs daily activities

required to maintain self-sufficiency for personal and social independence (Sattler & Hoge, 2006). Vineland-3 has excellent internal consistency reliability (.90-.98). Test-retest reliability at the domain level ranges from moderate to excellent (.73-.92), while test-retest reliability for the adaptive behavior composite is considered good to excellent (.80-.92). The Vineland-3 demonstrates satisfactory construct, content, and concurrent validity as reported by the Vineland-3 publication summary (Sparrow et al., 2016).

Measures of Autism Core Symptoms

Measures of autism core symptoms were identified in 33 articles. Of these articles, 15 assessment tools were identified. Table 3.5 shows frequencies and reported percentages of use found in the current review. The original and revised versions of the Autism Diagnostic Interview (ADI-R; Rutter et al., 2003), Autism Diagnostic Observation Schedule (ADOS-2; Lord et al., 2012), and Childhood Autism Rating Scale (CARS2-ST; Schopler et al., 2010) reported outcomes most frequently. Both the ADI-R and ADOS-2 are considered the “gold standard” in autism diagnosis and measurement (Ozonoff et al., 2005). The ADOS demonstrates excellent internal consistency, interrater and test-retest reliabilities, as well as excellent diagnostic validity in distinguishing individuals with autism and those without autism. ADI-R has good intraclass correlations (Ozonoff et al., 2005) and has been shown to correlate with the Social Communication Questionnaire (Naglieri et al., 2018 p. 43.). Although the ADI-R has empirical support for discriminating ASD from other developmental disorders, these findings are limited to children whose mental age is above 2 years (Ozonoff, 2005). The CARS2-ST demonstrates excellent internal reliability and many studies demonstrate diagnostic and criterion-related validity (Ozonoff et al., 2005; Naglieri et al., 2018 p.51). The Gilliam Autism Rating Scale (GARS-2; Gilliam, 2006) has internal consistency and test-retest reliabilities are good (>.80) for the subscales, and excellent for the Autism Indexes (.90+). Interrater reliability for the Autism Index is good. GARS has excellent sensitivity and specificity, and correlates with other measures of ASD diagnostics, though specifics were not provided. Reliability and validity of the GARS was obtained from Pearson Assessments website (Pearson Assessments, nd). The Social Responsiveness Scale (SRS-2; Constantino & Gruber, 2012) was the final measure used in three or more articles. Internal consistency reports are in the range of excellence (.90-.99) for all age ranges. Interrater reliability between parents and teachers for both school age and preschool

forms were low to fair. Correlations between SRS-2 and Child Behavior Checklist were found by the authors to be moderate, noting SRS-2 was more sensitive to specific behaviors associated with ASD (Naglieri et al., 2018 p. 61-65).

[Insert Table 3.5 here]

Measures Repetitive and Challenging Behavior

Thirteen articles reported a measure addressing either repetitive or challenging behavior (30%). Of these articles, 11 measures were reported. The Child Behavior Checklist (CBCL 1.5-5; Achenbach, 2000) (n=4) , Nisonger Child Behavior Rating Form (NCBRF; Aman et al., 1996) (n=2), and Maladaptive Domain of the Vineland (n=2) were reported more than once. Both articles reporting use of the NCBRF used only the Positive Social subscale to report outcomes of challenging behavior; a 10-item likert scale providing general descriptions of prosocial behaviors and may not accurately reflect specific challenging behaviors. Recent (from 2006-present) reliability and validity for the NCBRF could not be found. The Maladaptive Behavior subscale of the Vineland Adaptive Behavior Scales was reported in two articles (Eikeseth et al., 2007; Eikeseth et al., 2012), though recent reliability and validity of this subscale could not be found. Test retest reliabilities for the CBCL 1.5-5 are considered good, though interrater reliabilities between parents and teachers was low. Additionally, the manual provides evidence of construct, criterion and content validities (Achenbach, 2000). The Repetitive Behavior Scale- Revised (RBS-R; Lam & Aman, 2007) was the only assessment tool used to measure restrictive and repetitive behaviors observed in individuals with autism. Outcomes related to the reduction of RRBs were reported in 3/43 (7%) articles. RBS-R shows good internal consistency reliability has been validated in asd populations though sample sizes were small (Hooker et al., 2019; Lam & Aman, 2007). Use of each measure is reported in Table 3.6.

[Insert Table 3.6 here]

Language Assessment

Measures designed to assess language were found in 14 of 43 articles, fourteen measures were found. The following measures were reported in three or more articles: the Reynell

Developmental Language Scales- 3rd edition (Edwards et al., 1999) (n=5), The third and fourth editions of the Peabody Picture Vocabulary Tests (PPVT V; Dunn, 2019) (n=4), Macarthur Bates Communicative Developmental Inventories (CDI; Fenson et al., 2006) (n=3), Expressive One Word Picture Vocabulary Tests (EOWPVT-R; Martin & Brownell, 2011) (n=3), and Preschool Language Scales- fourth edition (PLS-5; Zimmerman et al., 2011) (n=3) All measures are reported in Table 3.7 below. Thirteen of the 14 measures used to report language functioning focus exclusively on receptive and expressive vocabulary. All reliability and validity measures for the PPVT-5 indicate good to excellent reliability, good clinical validity in autism populations and moderate correlations to similar measures (Dunn, 2019). Internal consistency reliability of the EOWPVT is reported as acceptable, with excellent test-retest reliability. Additionally, the EOWPVT has been shown to correlate with other measures of vocabulary such as the WISC-4 VCI and WISC-4 FSIQ (Frauwirth et al., 2018). Most recent psychometrics were not available for the PLS-5, NRDLs, or the Macarthur Bates CDI.

[Insert Table 3.7 here]

Parent or Caregiver Well Being

Parent or caregiver wellness was measured in 6 out of the 43 articles. The Short-Form of the Parenting Stress Index (PSI-4 SF; Abidin, 2012) was used in 50% of the articles reporting a measure of parental well-being. The PSI-4 provides a measure of 120 items designed to quantify parent and child characteristics, as well as situational and demographic information which may be influencing familial stress. Internal reliability for the two domains and the Total Stress scale reported as excellent (>.96), though test retest reliabilities were mixed and ranged from poor to good. Validation in families of children with autism were not reported (Abidin, 2012). The Hospital and Depression Scale (HADS; Zigmond & Snaith, 1983), Questionnaire on Resources and Stress- Short Form and Kansas Inventory of Parental Perceptions were reported once, though psychometrics for these instruments could not be found. Frequencies are reported below in table 3.8.

[Insert Table 3.8 here]

Criterion-based or Direct Observation Measures

Two manualized, criterion-based or direct-observation and 3 non-manualized direct observation (Ben-Itzhak & Zachor, 2007; MacDonald et al., 2014; Vivanti et al., 2019) measures were reported across 5 of the 43 articles. The Verbal Behavior-Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008) is a criterion-referenced assessment and curriculum development tool designed to measure and develop skills in language and related skills. Interrater reliability for the Total Milestones was reported as good (.87), though low to poor (.62) reliability for the Barriers Assessment was reported (Montallana et al., 2019). Content validity of the VBMAPP was recently examined by national experts. Domain relevance, age appropriateness, method of measurement and domain representativeness were considered to be moderate to strong (Padilla & Akers, 2021). The Early Social Communication Scales (ESCS; Mundy et al., 2003) is a manualized, direct-observation measure using video recordings to assess nonverbal communication skills in children with mental ages between 8 and 30 months. Recent, published reliability and validity of the ESCS, could not be found. Reliability and validity of the author-created direct observation tools were not included.

Other Measures

Academic achievement (n=2) was measured by the Wide Range Achievement Test 3rd and 4th edition (WRAT; Jastak, 1984), or the Wechsler Individual Achievement Test-II (WIAT-4; Wechsler, 2020) (n=1). Play was assessed using the The Symbolic Play Test (Lowe & Costello, 1988) and the Test of Pretend Play in one article (Lewis & Boucher, 1997). None of these measures were reported more than once in this review.

Discussion

The purpose of this study was to review the current literature in EIBI and determine the usage, reliability and validity of measures used to assess outcomes of children with ASD. Findings indicate that recommendations set forth by Lord et al. (2005) and Matson & Reiske (2014) are being followed. Outcomes in adaptive functioning and core symptoms are being reported with increasing frequencies, though measures of language functioning, challenging behavior and parental well-being remain low. Considerations for measurement, practical implications, social validity and brief recommendations for practice are discussed below.

Research and Clinical Considerations

Previous research has provided guidelines of what a comprehensive assessment battery should consist of, but lack consistent guidelines for selecting measures. This is reflected in the wide variety of measures found in the current review. “Measures of choice” are indicated in domains of cognitive, adaptive functioning and core symptoms, but remain less salient in areas such as language assessment and challenging behavior. When selecting measures, researchers and practitioners must consider what the instrument intends to measure, its psychometric properties, which scores are sensitive enough to measure change over time, and the required time between sequential administrations. Time, cost and administration qualifications should be considered as well.

Standardized testing is often used to measure treatment effects in children with autism. Norm-referenced measurement compares the child's performance against the performance of a normative group (Sattler, 2018 p. 103). Norm-referenced measurement is helpful in interpreting performance as results are often meaningless without an average. Standardized measures, like the WPPSI-IV or ADOS-2 require standardized administration and scoring to eliminate the possibility of extraneous variables on child performance (Sattler, 2018 p. 104). Rogers and Vismara comment on the logical criticism that standardized measures, such as those that measure intelligence, require a large degree of generalization and measure tasks that are never directly addressed in treatment (Rogers & Vismara, 2014). Although global measures like standardized tests of IQ and diagnostic scales lack the sensitivity to detect small changes, they provide an overall picture of the child's performance relative to children in the population across an extended period of time (Granpeesheh et al., 2009) Alternatively, criterion-referenced assessments measure the performance of an individual against an objective criteria, and are often administered under typical contexts and in the natural environment (Sundberg 1983, 1990 in Powers et al., 2014 p. 702). Benefits of criterion-referenced assessments are that they identify the exact skills the person has in their repertoire, as well as identifying skill deficits. Additionally, they provide a starting point for treatment, and can be used to measure progress over smaller increments in time (Granpeesheh et al., 2009) as opposed to an age-equivalent score (Sundberg & Parington, 1998 in Powers et al., 2014 p. 702). When selecting an outcome measure, consider the goal of the assessment: standardized measures may be important in evaluating large scale

effects of treatment, while criterion-referenced assessments may lead to curriculum development, and detect moderate or specific gains of treatment (Lotfizadeh et al., 2020).

How a measure is scored and score interpretation are important factors to be aware of when evaluating effectiveness of EIBI treatment. Standard scores are considered the preferred method for reporting change (Satler, 2018), and are reported in much of the outcome research in behavioral intervention. Standard scores measure progress in comparison to same-age, typically developing peers and represent statistically robust gains. Individuals vary in their response to treatment (Paynter et al., 2018; Vivanti et al., 2013), and although small changes in standard scores represent meaningful change, some scores may appear to decrease over time. This is often the case when reporting outcomes of adaptive functioning (Klintwall et al., 2013). Decreases or small changes in standard scores may be discouraging for parents and stakeholders. Klintwall, Eldevik and Eikeseth (2013) suggest reporting age-equivalents as an alternative to standard scores, as standard scores may mask intervention effectiveness across individuals with different levels of functioning. Age-equivalents can be converted to learn rates, which may reflect progress of slower learners more accurately, and may aid in communication of outcomes to parents and stakeholders (Klintwall et al., 2013). Raw scores are the total scores achieved before statistical conversion and can reflect dramatic changes (Salkind, 2010). Consumers are cautioned to be made aware of these when interpreting outcomes reporting raw scores, as they typically do not represent the type of change reflected in changes of standard scores.

Ratio IQ's are typically converted when an individual has a chronological age that is older than the normative sample on one test, but is unable to reach a basal on an age-appropriate test. As seen in Table 3.1, reporting ratio IQ's for at least one participant was somewhat common in this literature review. Ratio IQs can be calculated when standard scores are unavailable and intelligence approximations warranted, but are not recommended as Ratio IQs are not comparable across ages, and likely have different meanings at different ages (Satler, 2018 p. 108).

Another consideration when selecting assessment tools are the available resources. Several standardized and diagnostic assessments require intensive training, are time-consuming and costly, or require administration by a licensed psychologist. Agencies or centres providing ABA services typically employ masters-level Behavior Analysts who meet Pearson qualifications at the B Level (*Qualifications Policy*, n.d.). Measures of intelligence and the

diagnostic instruments such as the ADI-R or ADOS-2 require additional qualifications or licensing and administration is restricted to clinical psychologists. Psychologists and Doctoral level BCBA's may only be available on a contractual basis and therefore may be impractical and costly when conducting these assessments for multiple individuals and at regular intervals.

Core Findings by Domain

Adaptive functioning represents an individual's personal independence and functioning within their environment relative to same-aged peers. Children with autism commonly demonstrate lower levels of adaptive functioning than intellectual functioning (Klintwall et al., 2013). Ozonoff et al. (2005) recommend measures of intellectual functioning always be accompanied by measures of adaptive functioning. Only 3 studies failed to report measures of AF accompanied by IQ, suggesting that these recommendations are being followed in the current literature. The clear choice for reporting outcomes in AF was the use of the Vineland Adaptive Behavior Scales (39/43, 91%). Due to its strong psychometric properties, the VABS is considered the measure of choice in EIBI outcome research, though no data is available for its current use in clinical practice. Standards scores for the Vineland were reported most frequently, though age equivalents, raw scores and ratio scores were also reported. Cost and qualifications to administer the Vineland compare with other standardized measures of adaptive functioning, such as the Adaptive Behavior Assessment System (ABAS-3; Harrison & Oakland, 2015), or the Scales of Independent Behavior-Revised (Bruininks et al., 1996).

Although it may be unreasonable to expect changes in diagnostic status over time (Reichow et al., 2018; Vivanti & Dissanayake, 2016), measures of core symptoms of ASD are a critical component of a comprehensive assessment. In this review, the Autism Diagnostic Observation Schedule was most frequently reported to evaluate outcomes in core symptoms of ASD. The ADI-R was used to compare outcomes in some articles, but was used primarily to confirm an autism diagnosis. Both the ADOS and ADI-R are considered to be the gold-standard in autism diagnostic measurement, given their excellent sensitivity and specificity. The ADOS is particularly valuable as it requires direct testing and observation, rather than reliance on parent-report. Calculating calibrated scores for the ADOS Total Severity Score, and domain-level scores have been shown to decrease the influence of child characteristics on autism severity than raw totals. These findings indicate that calibrating raw scores may help examine trajectories in

core symptoms over time (Gotham et al., 2009; Hus et al., 2014). However, there are some practical constraints to administering these measures; specifically that they require a licensed professional to administer, are time consuming and costly.

Like diagnostic measures, instruments measuring full scale intelligence present similar challenges to measurement in clinical practice. Lengthy assessment times and stringent qualifications create practical challenges to widespread administration. Some research supports higher intellectual functioning at intake are solid predictors of later outcomes (Smith et al., 2015) and therefore, is an important component to comprehensive assessment. Due to characteristically uneven profiles, intelligence functioning can be difficult to assess. Selecting measures of intellectual functioning are impacted by the individual's chronological and the individual's current level of performance and motivation levels (Ozonoff, 2005). Non-Verbal Intelligence Tests such as the Merrill-Palmer-Revised (Roid & Sampers, 2004) have attractive stimuli which may retain the interests of some children with autism, but do not provide a measure of verbal functioning. Additionally, use of exclusively NV measures has been said to inflate intelligence scores in young children (Eldevik et al., 2006). Thus, full scale measures of intelligence with verbal and non-verbal components are recommended (Ozonoff, 2005). Measures of FSIQ were reported in 74% of articles, suggesting these recommendations are being followed to an extent. Because full scale intelligence testing requires significant time and high levels of qualifications to administer, these instruments may not be feasible or practical for applications at the agency level.

Language ability was primarily measured by standardized assessments of receptive and expressive language, though measures of language pragmatics were absent. Benefits of these measures include quick administration time, low cost and administration qualifications commensurate with the qualifications of a behavior analyst. Alternatively, one study used the Verbal Behavior Milestone Assessment and Placement Program as a measure of language ability (Lotfizadeh et al., 2020). The VB-MAPP is a criterion-referenced assessment using direct observations by trained observers of language and related skills such as play, social and motor skills. The VB-MAPP is divided into developmental milestones and is scored as the number of milestones mastered (Sundberg, 2008). Direct-observation measures like the VB-MAPP are useful in that they provide very fine-grained measures of progress over time. Additionally, they can be re-administered in shorter intervals and help guide moment-to-moment treatment

decisions (Granpeesheh et al., 2009). Though the VB-MAPP shows positive preliminary psychometrics, and has been shown to correlate with other behavioral measures, the Barriers Assessment was found to have poor reliability and should be used with caution. As is the recommendation for assessment in general, use of the VB-MAPP should be used in conjunction with other measurement tools (Montanalla et al., 2019; Padilla & Akers, 2021).

Measures of parent/caregiver well being and challenging behavior were present in 6 and 13 articles respectively. Parental outcomes were primarily assessed by the Parental Stress Index. Parents of children receiving EIBI make a considerable time, financial and emotional contribution (Matson & Rieske, 2014) thus, stress and parents' perceived relationships with their children are good indicators of the family's well-being. More research to determine the validity of the PSI-4 and PSI-4 SF is needed in families of children with autism. Repetitive and maladaptive behavior was largely measured by informant-based checklists and rating scales. While measures like the Maladaptive Behavior domain on the Vineland-3, or the Child Behavior Checklist (CBCL 1.5-5;) may give some indication of frequency an/or severity of the behavior occurring, they do not provide an accurate description of the function or context of the behavior, and may primarily serve as screeners to a more extensive assessment such as a functional analysis. Repetitive behaviors were assessed by the Repetitive Behavior Scale -Revised, a continuous measurement tool rating the frequency and severity of common behaviors of asd (Lam & Aman, 2007). Although classified in this review as a measure of challenging behavior, RBS-R might better reflect changes in core symptoms of asd, though further research is necessary.

Though reporting measures of familial wellbeing and challenging behavior has improved, measures of social validity were missing from the review. Social validity can be defined as the social significance of the goals, appropriateness of the procedures and importance of the effects of the intervention (Wolf, 1978). Measures of social validity may consist of measures of acceptability of the intervention and address parent perceived outcomes for their child and the family. No standardized measures of intervention acceptability specific to EIBI currently exist. Grey et al. (2019) addressed this area of need by creating their own parental satisfaction questionnaire, additionally they solidify the need for measures of acceptability in the field. Quality of life measures were also missing from the literature. A critical review by Ikeda et al., (2013) identified the Pediatric Quality of Life Inventory (PedsQL) as the most used measure of

QoL in children and youth with ASD. Similarly, Tavernor et al., (2012) investigated two QoL measures in children with autism (PedsQL and Kidscreen). They highlight the need for careful consideration of content and face validity of general QoL measures as their results indicated that parents felt the constructs on both tests did not adequately address QoL indicators important to children with autism (Tavernor et al., 2012). Thus, construction of valid QoL measures for children with ASD warrants further research. Finally, Matson and Reiske suggest the inclusion of measures of treatment side effects alongside measures of social validity. Though EIBI interventions are considered well established and evidenced based, treatments seldom come without side effects. Interestingly, no measures of side effects were found in this review. This leaves much room for improvement for both researchers and practitioners in the domain of social validity.

Limitations and Future Research

This paper reviewed 43 articles reporting outcomes for children who received early and intensive behavioral intervention. The aim of the review was to determine the measures in use in outcome research for these interventions in children with autism. The majority of outcome measures represented domains of adaptive (91%) and intellectual functioning (86%), and core symptoms of ASD (77%). This review extends the existing body of knowledge by pooling together both standard and criterion-referenced measures towards standardization of measurement selection in outcome research.

However, there were some limitations to the current study. Although efforts were made to ensure as much of the published EIBI outcome literature was captured, due to the timing of the search, some relevant papers may have been missed. Single case designs, which are frequently used in educational and behavior analytic research (citation) were excluded, and therefore it is possible some measures, especially criterion-referenced measures may be under represented. This review touched on the intervals at which measures are administered, but more research into the sensitivity of these instruments to detect change over shorter periods of time is warranted. Additionally, criterion-referenced assessments as measures of treatment outcome should be explored. Measures of social validity including measures of quality of life, acceptability of the intervention and treatment side effects also warrant use in research. Finally, future research may

be able to discern the frequency to which the identified measures are being used in clinical practice, and whether or not a gap between research and practice exists.

Conclusion and Brief Recommendations

This review attempted to search the EIBI literature in an attempt to identify assessment tools being used to measure treatment outcomes in young children with autism. No longer considered “experimental” treatments, EIBI interventions are now required to be funded through private insurance in almost all states (Zhang & Cummings, 2020). Mandates to provide documentation and measures of treatment outcomes is certainly considered by many to be a positive movement in the field. Insurance providers likely want measures that are sensitive to change over relatively small periods of time (eg. 3-6 month intervals), are inexpensive, easy to administer, and psychometrically strong. Informed by these factors and in keeping with current suggestions from the literature (measures should have representative norms, strong psychometrics, multiple measure should be use and address core symptomatology of ASD) the following recommendations are provided: Vineland-3 provides a representative measure of adaptive functioning , has been validated for use in ASD populations and can be administered by service providers (behavior analysts), therefore it should be considered the gold-standard for this domain. Core symptoms may be accurately represented by the CARS2-ST as it reflects both informed report and observation of the child. SRS-2 or SCQ may be considered as supplementary or additional measures when necessary. A newer measure, the Autism Impact Measure has recently gained interest as a measure of core symptoms (Kanne et al., 2014), though more research is necessary to determine if it is both sensitive and psychometrically valid. Finally, direct observation or criterion-based measures may be a useful and sensitive measure of treatment outcomes as a function of treatment objectives mastered (Granpeesheh et al., 2009).

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Tables and Figures

Table 3.1

Matrix of Reported Scores in Included Articles for Intellectual and Adaptive Functioning.

Domain		Standard Scores	Ratio Score	Raw Scores	Age Equivalent
Cognitive	Composite	37	14	0	4
	Subscale	7	5	1	3
Adaptive	Composite	27	1	2	7
	Subscale	20	1	3	8

Note. Cognitive and adaptive functioning are categorized into composite and subscale as many articles reported both composite scores and subscale scores.

Table 3.2.*Measures Used in Intervals of One Year or Less.*

Author	3-6 months	9 months	1 year
<i>Colombi et al., 2018</i>	GMDS, VABS		
<i>Cohen et al., 2006</i>			BSID, WPPSI, NRDLs, M-P-R, VABS,
<i>Dawson et al., 2010</i>			MSEL, VABS, ADOS, RBS
<i>Rogers et al., 2019</i>			MSEL, VABS, ADOS
<i>Eikeseth et al., 2012</i>			VABS, CARS
<i>Fava et al., 2011</i>	ADOS, GMDS, CDI, VABS, CBCL, PSI, DO		
<i>Howard et al., 2014</i>			VABS, M-P-R, WPPSI, WISC, SB, DAS, NRDLs, ROWPVT, EOWPVT, SICDT, PPVT, EVT
<i>Macdonald et al., 2014</i>			ESAT
<i>Peters-Scheffer et al., 2010</i>		BSID, SON 2.5-7, VABS, CBCL, PDD-MRS	

Table 3.2 *Continued*

Author	3-6 months	9 months	1 year
<i>Reed et al., 2007a</i>		GARS, PEP-R, BAS-EY, VABS	
<i>Reed, P., and Osborne, L., 2012</i>		GARS, PEP-R, BAS-EY, VABS	
<i>Remington et al., 2007</i>			BSID, SB, NRDLs, VABS, NCBRF, DBC, ASQ, ESCS, HADS, QRS, KIPP
<i>Smith et al., 2019</i>			VABS, SRS, SIB-R
<i>Strauss et al., 2012</i>	ADOS, GMDS, VABS, CDI, DO		
<i>Vivanti et al., 2019</i>		LENA, M-COSMIC, MSEL, VABS, PSI	
<i>Waters et al., 2020</i>			WPPSI, WISC, BSCID, DP-2, PEP-R, Leiter, SB, M-P-R, VABS, WIAT, WRAT
<i>Zachor et al., 2007</i>			ADOS, BSID, SB
<i>Zachor, A. Ben-Itzhak, E., 2010</i>			ADOS, VABS, MSEL
<i>Lin et al., 2020</i>	MSEL, ADOS		

Table 3.2 Continued

Author	3-6 months	9 months	1 year
<i>Paynter et al., 2018</i>			MSEL, SCQ, VABS
<i>Smith et al., 2015</i>	PLS, CELF, PPVT, M-P-R, WPPSI, VABS, SRS, CBCL, PSI-SF		
<i>Fossum et al., 2018</i>			PLS, CELF, VABS, SRS, M-P-R
<i>Ben-Izchak, E., and Zachor, D. A., 2007</i>			ADOS, BSID, SB
<i>Smith, T., et al., 2015</i>			MSEL, VABS, ADOS, ADI-R
<i>Vivanti et al., 2016</i>			MSEL, ADOS, VABS
<i>Vivanti et al., 2013</i>			MSEL, ADOS
<i>Eldevik et al., 2019</i>			VABS, BSID, SB, CARS
<i>Lotfzadeh et al., 2018</i>	VB-MAPP		VABS

Note. Measure abbreviations used. ADOS: Autism Diagnostic Observation Schedule, ADI-R: Autism Diagnostic Interview-Revised, ASQ: Autism Spectrum Questionnaire, BAS-EY: British Abilities Scales-Early Years, BSID: Bayley Scales of Infant Development, CARS: Childhood Autism Rating Scale, CDI: Macarthur Bates Communicative Development Inventory, CBCL: Child Behavior Checklist, CELF: Clinical Evaluation of Language Fundamentals, DAS: Differential Abilities Scale, DP-2: Developmental Profile-2, DO: Direct Observation Measure (author), EOWPVT: Expressive One Word Picture Vocabulary

Test, ESAT: Early Skills Assessment Tool, ESCS: Early Social Communication Scales, EVT: Expressive Vocabulary Test, GARS: Gilliam Autism Rating Scales, GMDS: Griffith Mental Development Scales, HADS: Hospital Anxiety and Depression Scale, KIPP: Kansas Inventory of Parental Perceptions, LENA: Language ENvironment Assessment, Leiter: Leiter International Performance Scale, M-COSMIC: Modified Classroom Observation Schedule to Measure Intentional Communication, M-P-R: Merrill Palmer Scale of Mental Tests- Revised, MSEL: Mullen Scales of Early Learning, NRDLs: New Reynell Developmental Language Scales, NCBRF: Nisonger Child Behavior Rating Form, QRS: Questionnaire on Resources and Stress, PEP-R: Psychoeducational Profile- Revised, PDD-MRS: Scale of Pervasive Developmental Disorder in Mentally Retarded Persons, PLS: Preschool Language Scales, PPVT: Peabody Picture Vocabulary Test PSI/PSI-SF: Parental Stress Index/ Short Form, RBS: Repetitive Behavior Scales, ROWPVT: Receptive One Word Picture Vocabulary Test, SB: Stanford Binet Intelligence Scales, SCQ: Social Communication Questionnaire, SIB-R: Scales of Independent Behavior- Revised, SICDT: Sequenced Inventory of Communication Development-Revised, SON 2.5-7: Snijders-Oomen Nonverbal Intelligence Test, SRS: Social Responsiveness Scale, VABS: Vineland Adaptive Behavior Scale, VB-MAPP: Verbal Behavior- Milestones Assessment and Placement Program, WIAT: Wechsler Individual Achievement Test, WISC: Wechsler Intelligence Test for Children, WPPSI: Wechsler Preschool and Primary Scales of Intelligence, WRAT: Wide Range Achievement Test

Table 3.3.*Measures of Intellectual Functioning: Frequency and Percentage of Use.*

Measure	Frequency / Total Articles
Bayley Scales of Infant Development	
BSID (first edition or not specified)	6/43 (14%)
Bayley-R	4/43 (9%)
Bayley-2	6/43 (14%)
Bayley-3	1/43 (2%)
Totals	17/43 (40%)
Wechsler Preschool and Primary Scale	
WPPSI (first edition or not specified)	3/43 (7%)
WPPSI-R	6/43 (14%)
WPPSI-III	5/43 (12%)
Totals	14/43 (33%)
Wechsler Intelligence Scale for Children	
WISC (first edition or not specified)	1/43 (2%)
WISC-R	2/43 (5%)
WISC-III	2/43 (5%)
WISC-IV	4/43 (9%)
Totals	9/43 (21%)
Wechsler Abbreviated Scale of Intelligence	1/43 (2%)
Wechsler Adult Intelligence Scale	1/43 (2%)
Stanford Binet Intelligence Scales	

Table 3.3 *Continued*

	SB (first edition or non-specified)	3/43 (7%)
	SB-IV	7/43 (16%)
	SB-V	1/43 (2%)
Totals		11/43 (26%)
Mullen Scales of Early Learning		12/43 (28%)
Merrill - Palmer Scales of Mental Tests		
	M-P	4/43 (9%)
	M-P-R	3/43 (7%)
Totals		7/43 (16%)
Griffith Mental Development Scales		3/43 (7%)
British Abilities Scales		
	BAS	1/43 (2%)
	BAS-EY	1/43 (2%)
	BAS-2	1/43 (2%)
Totals		3/43 (7%)
Psychoeducational Profile		
	PEP	1/43 (2%)
	PEP-R	2/43 (5%)
Totals		3/43 (7%)
Differential Abilities Scale		2/43 (5%)
Developmental Profile-2		1/43 (2%)
Leiter International Scales		1/43 (2%)
Woodcock-Johnson		1/43 (2%)
Slosson		1/43 (2%)
SON 2.5-7		1/43 (2%)

Table 3.4

Measures of Adaptive Functioning: Frequency and Percentage of Use.

Measure	Frequency/ Total Articles
Vineland Adaptive Behavior Scales	25/43 (58%)
Vineland Adaptive Behavior Scales -2	15/43 (35%)
Child Behavior Checklist	3/43 (7%)
Developmental Profile 1&2	1/43 (2%)

Table 3.5*Measures of ASD Core Symptoms: Frequency and Percentage of Use.*

Measure	Frequency/ Total Articles
Autism Diagnostic Interview	1/43 (2%)
ADI-R	5/43 (21%)
ADI-R (items 61-65)	1/43 (2%)
Totals	7/43 (16%)
Autism Diagnostic Observation Schedule	10/43 (23%)
ADOS-2	2/43 (5%)
Totals	12/43 (28%)
Childhood Autism Rating Scale	4/43 (9%)
CARS2-ST	2/43 (5%)
Totals	6/43 (14%)
Gilliam Autism Rating Scale	3/43 (7%)
Social Responsiveness Scale	3/43 (7%)
SRS-2	1/43 (2%)
Totals	4/43 (9%)
Lovaas measure	1/43 (2%)

Table 3.5 *Continued*

Scale of Pervasive Developmental Disorder in Mentally Retarded Persons (PDD-MRS)	1/43 (2%)
Developmental Behavior Checklist	1/43 (2%)
Social Communication Questionnaire	2/43 (5%)
Autism Screening Questionnaire	1/43 (2%)

Table 3.6*Measures of Challenging or Repetitive Behavior: Frequency and Percentage of Use.*

Measure	Frequency/ Total Articles
The Aberrant Behavior Checklist	1/43 (2%)
The Developmental Behavior Checklist	1/43 (2%)
Nisonger Child Behavior Rating Form- Positive Social Subscale	2/43 (5%)
Conners' Rating Scales–Revised	1/43 (2%)
Child Behavior Checklist (1.5-5)	4/43 (9%)
SIB-R, Maladaptive Behavior Domain	1/43 (2%)
Autism Spectrum Disorder-Behaviors Problems for Children	1/43 (2%)
Questions About Behavior Function	1/43 (2%)
Measure adapted from Fava et al., 2010	1/43 (2%)
VABS (Maladaptive Behavior domain)	2/43 (5%)
Repetitive Behavior Scale	3/43 (7%)

Table 3.7*Measures of Language: Frequency and Percentage of Use.*

Measure	Frequency/ Total Articles
Reynell Developmental Language Scales	3/43 (7%)
RDLS-3	2/43 (5%)
Totals	5/43(12%)
Macarthur Communicative Developmental Inventories	3/43 (7%)
Receptive One-Word Picture Vocabulary Test	1/43 (3%)
Expressive One Word Vocabulary Test	2/43 (5%)
EOWPVT-R	1/43 (3%)
Totals	3/43 (8%)
Expressive Vocabulary Test	1/43 (3%)
Sequenced Inventory of Communication Development-Revised	1/43 (3%)
Peabody Picture Vocabulary Test - 3rd Edition	3/43 (7%)
PPVT-IV	1/43 (3%)
Totals	4/43(9%)
British Picture Vocabulary Scales (BPVS-II)	2/43 (5%)

Table 3.7 *Continued*

Preschool Language Scale (PLS-IV)	3/43 (7%)
Clinical Evaluation of Language Fundamentals (CELF-IV)	2/43 (5%)
Vineland-2 (receptive/expressive)	1/43 (3%)

Table 3.8.

Measures of Parent/Caregiver Well Being: Frequency and Percentage of Use.

Measure	Frequency and Percentage of Total Articles
Parenting Stress Index	1/43 (2%)
PSI-SF	3/43 (7%)
Totals	4/43 (9%)
Questionnaire on Resources and Stress- FSF	1/43 (2%)
Hospital Anxiety and Depression Scale	1/43 (2%)
Kansas Inventory of Parental Perceptions	1/43 (2%)

Appendix

Appendix A.

Descriptive Table Outlining Cost and Administration Qualifications, Psychometrics and Administration Details.

Measures of Intellectual Functioning

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Bayley Scales of Infant Development (Bayley-4; Bayley and Aylward, 2019)	1-42months	Administration: Direct testing. Measures strengths of young children in the areas of cognitive, motor, language, social-emotional, and adaptive behavior. Administration time: about 50 minutes for children <12 months, approximately 90 minutes for children >13 months.	\$1350 B (Pearson)	Good-Excellent	Good
Differential Abilities Scale (DAS-II; Elliot, 2007) *US adaptation of the former British Abilities Scales	2years 6 months- 17 years 11 months	Administration: Direct testing. Offers lower and higher level test batteries aimed at capturing individual cognitive strengths and deficits. DAS-II offers flexibility to administrators and individuals in that it does not require absolute ordering of subtests during administration. Administration time: approximately 30-40 minutes.	\$1375 C (Pearson)	Excellent	Good
Mullen Scales of Early Learning (MSEL; Mullen 1995)	Birth -5 years, 8 months	Administration: child observation. Measures early cognitive, gross and fine motor development, receptive and expressive language abilities and visual reception. Administration time: 15-60 minutes (depending on age).	\$1030 B (Pearson)	Good	Good

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
PsychoEducational Profile (PEP-3; Schopler et al., 2005)	2-7.5 years	Administration: Child observation and parent report. Measures cognition and behavior in children with ASD. Identifies learning strengths, emerging skills and uneven development. Administration time: 45-90 minutes	\$586 C (WPS)	Good	Good
Stanford Binet Intelligence Scales (SB-5; Roid, 2003)	2-85 years	Administration: Observation of child performance. Measures non-verbal and verbal IQ and offers a factor score in fluid reasoning, knowledge, quantitative reasoning, visual-spatial processing and working memory. Administration time: on average, 45-75 minutes.	\$1205 C (WPS)	Excellent	Good
Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV; Weshler, 2012)	2.6 years-7.7 years	Administration: observation of child performance. Measure of cognitive development in young children (2.6-3.11 years) and preschoolers (4.0 years-7.7 years). Young children are assessed in verbal comprehension, visual spatial skills and working memory. The older children include two additional components, fluid reasoning and processing speed. Administration time: about 30-60 minutes.	\$1375 C (Pearson)	Excellent	Satisfactory

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Wechsler Intelligence Scale for Children(WISC-V; Weschler, 2014)	6 years- 16 years, 11 months	Administration: observation of child performance. Measures cognitive strengths and weaknesses in five primary index scales: verbal comprehension, visual spatial, fluid reasoning, working memory and processing speed. Timed tests and necessary verbal understanding may lead to underestimation of non-verbal capabilities in some children. Administration time: approximately 55-65 minutes.	\$1,475 C (Pearson)	Excellent	Satisfactory
Wechsler Abbreviated Scale of Intelligence (WASI-II; Weschler, 2011)	6 years-90 years	An abbreviated measure appropriate for clinical, psychoeducational and research settings designed to measure verbal comprehension, perceptual reasoning and full scale intelligence. Administration of the two-subtest form can be completed in 15 minutes and the four-subtest form can be completed in 30 minutes.	396/ C (Pearson)	Unknown	Unknown
Woodcock -Johnson III (WJ-III; Woodcock et al., 2001)	2-90+ years	Administration: Child performance. Consists of cognitive and academic battery. Unknown assessment time.	Unknown	Poor-Excellent	Satisfactory

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Leiter International Performance Scale-3 (Leiter-3; Roid et al., 2013)	3-75+ years	Administration: Child performance. Measures non-verbal intelligence in children. Consists of cognitive and attention/memory battery. Appropriate for older children with minimal verbal skills, modifications can be made for impairments with fine motor. Administration time: about 30 minutes/subscale.	\$1185 C (WPS)	Unavailable	Unavailable
Merrill-Palmer Scale of Mental Tests (M-P-R; Roid and Sampers, 2004)	1month-6 years, 5 months	Administration: child observation and caregiver report. Measures cognitive, language/communication, self-help/adaptive, motor development, social-emotional. Administration time: 45 min.	\$1000 C (WPS)	Excellent	Satisfactory
Developmental Profile (DP-2; Alpern, 2006)	0-13 years	Measures early strengths and abilities in development across cognitive, communication, adaptive functioning, psychical and social-emotional. Can be used for routine assessments or focussed treatments. Administration time: about 20-40 minutes.	\$125 B (WPS)	Unavailable	Unavailable
Griffith Mental Development Scales (GMDS;)	0-6 years	Administration: Child Performance. Provides an overall picture of child development across scales of early learning, language and communication, hand/eye coordination, fine motor skills and social-emotional development. Administration time: approximately 1 hour.	\$2000 N (WPS)	Unavailable	Unavailable

Appendix A. Continued

Language Functioning

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Reynell Developmental Language Scales (Reynell NRDLs; Edwards et al., 2011)	3-7years	Assessment of both comprehension of vocabulary and the child's speech production in a play-based format. Administration time: about 35-60 minutes.	\$1295 Speech Pathology	Unavailable	Unavailable
Macarthur Communicative Developmental Inventories (MB-CDI; Fenson et al., 2006)	8-37 months	Administration: Parent report. Measures expressive and receptive vocabulary as well as play and gesture based communication. Later levels assess expressive vocabulary and syntax. Administration time: 20-40 minutes to complete, 10-20 minutes to score.	\$124 No Information	Unavailable	Unavailable
Receptive /Expressive One-Word Picture Vocabulary Test (ROWPVT/EOWPVT-4; Martin & Brownell, 2011)	2-80+ years	Administration: Direct. The individual demonstrates the ability to point, match or say the correct colored picture to the spoken word of the administrator. The 190 items are presented in a developmental sequence and the ROWPVT-4 is co-normed with the EOWPVT-4 to give a complete profile of a learners receptive and expressive language abilities. Administration time: about 20 minutes, with 5 minutes scoring time.	\$195 B (Pearson)	Good-Excellent	Good

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Expressive Vocabulary Test (EVT-3; Williams, 2018)	2 years, 6 months- 90+ years	EVT-3 is administered directly to the individual to assess expressive vocabulary without requiring the individual to read or write. The measure can be used as part of an overall cognitive battery or as a stand alone measure of expressive vocabulary. It is co-normed with PPVT-V and can be used to measure progress over time. Administration time: 10-15 minutes.	\$230 B (Pearson)	Good- Excellent	Moderate- Strong
Peabody Picture Vocabulary Test (PPVT-V; Dunn, 2018)	2 years, 6 months- 90+ years	PPVT-V uses age-based standard scores to measure receptive vocabulary across the lifespan. Can be used with EVT-3 to provide a complete assessment of receptive and expressive language. Administration time: 5-10 minutes.	\$230 B (Pearson)	Good- Excellent	Moderate- Strong
Sequenced Inventory of Communication Development-Revised (SICD-R; Hedrick et al., 1978)	4months- 48months	Administration: paper and pencil. Measures Receptive and Expressive communication skills in very young children. Administration time: about 70 minutes.	No Pricing Info C (WPS)	Unavailable	Unavailable

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
British Picture Vocabulary Scales (BPVS-III; GL Assessment, 2009)	3-16 years	BPVT-3 measures receptive vocabulary development, suitable for young children as it requires no reading or spoken responses. Administration time: 5-10 minutes.	No information/ No info	Unavailable	Unavailable
Preschool Language Scale (PLS-V; Zimmerman, Steiner & Pond, 2011)	Birth-8 years	Administration: Child observation. Measures developmental language profile ranging from pre-verbal to early literacy. Administration time: 45-60 minutes.	\$349 B (Pearson)	Unavailable	Unavailable
Clinical Evaluation of Language Fundamentals - Preschool (CELF-3 Wigg et al., 2020)	3-7 years	Administration: Child observation. Measures receptive/expressive language skills necessary to meet the expectations of preschool classrooms. Administration time: variable.	\$128 B (Pearson)	Unavailable	Unavailable

Measures of Adaptive Functioning

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Vineland Adaptive Behavior Scales (Vineland-3; Sparrow et al., 2016)	Birth-90 years	Administration: interview, parent/caregiver report and teacher report. Measures communication, daily living skills and socialization with an optional motor skills and maladaptive behavior component. Can be scored comprehensively or at the domain-level. Administration time: varies by child age and format; approximately 10 minutes (domain), 40-50 minutes (comprehensive interview).	\$200-500/ B (Pearson)	Excellent	Satisfactory

Appendix A. Continued

Measures of Autism Core Symptoms

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Autism Diagnostic Interview- Revised (ADI-R; Rutter et. al, 2003)	2 years-adulthood	Administration: Parent/caregiver interview. Measures language and communication, reciprocal social interactions, restricted/repetitive and stereotyped behaviors and interests. The ADI-R includes two algorithms, Diagnostic and Current Behavior. The Current Behavior algorithm can be used to assess symptoms at the time of administration and can be used for treatment and/or educational planning. Administration time: approximately 90-120 minutes.	\$320 C (WPS)	Excellent	Good
Autism Diagnostic Observation Schedule (ADOS-2; Lord, Rutter, et al., 2012)	12 months-adulthood	Administration: Semi Structured assessment. Measures social interaction, communication, RRB and play and imagination in individuals suspected of having ASD. Assessment modules are used according to developmental and expressive language level. Administration time: 40-60 minutes.	\$2,495 C (WPS)	Excellent	Good
Childhood Autism Rating Scale (CARS2-ST; Schopeler et al., 2010)	6 years and younger (standard form)	Administration: Observation or parent interview. 15-item rating scale designed to distinguish children with ASD from children with other developmental disorders. CARS2-ST is also used to identify varying degrees of severity for ASDs. Administration time: 5-10 minutes.	\$237 C (WPS)	Excellent	Good

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
The Developmental Behavior Checklist (DBC-2; Gray et al., 2018)	4-18 years	Administration: Parent or teacher report. Uses rating scale to measure social and emotional difficulties in individuals who have intellectual or developmental disabilities. Administration time: less than 20 minutes.	\$129 C (WPS)	Unavailable	Unavailable
Gilliam Autism Rating Scale (GARS; Gilliam, 2013)	3-22 years	Administration: Parent/ teacher report. Based on the 2013 ASD diagnostic criteria, GARS-3 estimates symptom severity across six subscales: Restrictive/Repetitive Behaviors, Social Interaction, Social Communication, Emotional Responses, Cognitive Style, and Maladaptive Speech. Administration time: 5-10 min.	\$175 B (Pearson)	Good-Excellent	Good
Scale of Pervasive Developmental Disorder in Mentally Retarded Persons (PDD-MRS;)		No Information Available			

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Social Communication Questionnaire (Rutter, Bailey, et al., 2003)** Formerly Autism Screening Questionnaire (Berument et al., 1999)	>4 years	SCQ is a 40-item rating scale used to measure ASD symptom severity by parent/caregiver questionnaire. The SCQ comes in two forms: Lifetime or Current Behavior. Wording of the SCQ is identical to the ADI-R, and is used in a "yes/no" format. The Lifetime format may be used as a screener or diagnostic tool as it measures the entire developmental history. The Current Behavior form measures behavior in the previous 3 months and can be used in developing treatment plans, or measure changes in symptoms over time. Administration time: Less than 10 minutes.	\$175 C (WPS)	Good	Satisfactory
Social Responsiveness Scale (SRS-2; Constantino & Gruber, 2012)	2.6 years -adulthood	SRS-2 is a 65-item likert type questionnaire designed to measure the individual's interpersonal behavior, communication and repetitive/stereotypic behavior. SRS-2 comes in age-based formats: Preschool, School-Age, Adult Self-Report and Adult Relative/Other-Report and results can be used and interpreted in different ways depending on the goals and intent of the assessment. Administration time: 15 minutes with 5-10 minutes scoring time.	\$334 C (WPS)	Good	Good

Appendix A. Continued

Measures of Challenging Behavior

Measure	Age	About	Cost & Qualifications	Reliability	Validity
The Aberrant Behavior Checklist (Aman & Singh, 1994)	6 years-adulthood	Administration: Parent/teacher report. The ABC-2 is a symptom checklist used to assess problem behaviors in children and adults in home, residential or educational settings. The 58 checklist components can be divided into 5 subscales: Irritability/Agitation, Lethargy/Social Withdrawal, Stereotypic Behavior, Hyperactivity/Noncompliance, Inappropriate Speech. Administration time: 10-15 minutes.	\$180 No Info	Unavailable	Unavailable
The Developmental Behavior Checklist (DBC2; Gray et al., 2018)	4-18 years	Rating scales in three forms: Parent Report, Teacher Report, or Adult Report. Measures emotional and behavioral difficulties in individuals with intellectual and/or developmental disabilities. Administration time: Less than 20 minutes	\$129 C (WPS)	Unavailable	Unavailable
Nisonger Child Behavior Rating Form (NCBRF; Aman et al., 1996)	3-16 years	The NCBRF is an informant-based rating scale designed to measure behavior of children with intellectual disability, autism spectrum disorders and other related disorders. The measure has two forms, parent/caregiver report and teacher report. The Nisonger CBRF contains 76 items divided into two sections: the positive/social subscales (10 items) and the problem behavior subscales (66 items). Items are scored on a likert type scale. Administration time is about 15 minutes.	Available Online/ No information	Unavailable	Unavailable

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Conners' Rating Scales–Revised (CRS-R; Conners, 1997)	3-17 years	A cross-informant assessment of externalizing behaviors in children and adolescents. Report can be completed by parents and teachers for children ages 3-17 years and includes a self-report component for children 12-17 years. All versions are scored on a 4-point likert scale. Administration takes 5-10 minutes (short form) and 10-15 minutes (long-form).		Unavailable	
Child Behavior Checklist (CBCL 1.5-5, C-TRF; Achenbach & Rescorla, 2001).	1.5-5 years	CBCL 1.5-5 is to be completed by parents or caregivers and is designed to measure internalizing-externalizing problems in children. Parents rate 99 questions and provide descriptions of problems, concerns, strengths and disabilities related to the child. Includes a multicultural Teacher Report Form.	\$45 (Manual) CBCL- online	Low-Good	Satisfactory
Scales of Independent Behavior-Revised. Maladaptive Behavior Domain (SIB-R; Bruininks et al., 1996)	Birth -80 years+	SIB-R is a norm-referenced measure of adaptive and problem behavior in individuals. It is administered to the individual and is available in two formats: interview and checklist. The problem behavior scale is rated on the frequency and severity of the behavior and includes 8 areas of problem behavior. Administration time: 45-60 minutes (full scale), 15-20 minutes (short or early years form).	\$446	Unavailable	Unavailable

Appendix A. Continued

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Autism Spectrum Disorder-Behaviors Problems for Children (ASD-BPC; Matson, Gonzalez, & Rivet, 2008)	NA	Part of a larger assessment battery designed by Matson and colleagues (2008) to measure behaviors commonly observed in individuals with ASD and is rated by parent or caregiver from 0-2 (not a problem, severe problem). Consists of 18 items divided into two subscales. Administration time: not reported.	Available Online	Low-Moderate	Unavailable
Questions About Behavior Function (QABF; Matson et al., 1999)	NA	A 25- item, likert scale questionnaire designed for the functional assessment of problem behavior in individuals with developmental disabilities.	NA	Unavailable	Unavailable

Measures of Parent/ Caregiver Well Being

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Parental Stress Index (PSI; Abidin, 2012)	Parents of children ages 1-12 years	The PSI-4 provides a measure of 120 items designed to quantify parent and child characteristics, as well as situational and demographic information which may be influencing familial stress	\$ 314, \$192 (Short Form)	Excellent	Unavailable

Appendix A. Continued

Manualized Criterion -Based Measures

Measure	Age	About	Cost & Qualifications	Reliability	Validity
Verbal Behavior Assessment and Placement Program (VB-MAPP; Sundberg, 2008)	Developmental milestones up to 48 months	Administration: Direct testing/ child observation. Assesses functional and topographical language and related skills (e.g motor, pre-academic, play skills). Milestones are broken up into 3 developmental sequences. Includes Milestones, Barriers and Transitions Assessments.	\$70 (kit)	Good (Milestones), Low (Barriers)	Satisfactory
Early Social Communication Scales (ESCS; Mundy et al., 2003)	Mental ages 8-30 months	Administration: Video-taped, structured assessment. Measures non-verbal communication skills in young children through task presentations. Videos are observed and scored after the assessment. Administration time: 15-25 minutes.	NA	Unavailable	Unavailable

Note. Descriptive Information retrieved from *Assessment of Autism Spectrum Disorders (Second Edition)* (eds. Goldstein and Ozonoff , 2018), *Assessment of Children: Cognitive Foundations* (Sattler, 2018), and publishing websites: wpspublishing.com, pearsonassessments.com.

Information about cost and qualifications retrieved from publishing websites.