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A review of methodological issues in the differential diagnosis of autism spectrum disorders in children

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Abstract

The development of standardized tests to assess autism, particularly in young children, is a topic of considerable interest in the research community. Recent years have seen an exponential growth in scales for differential diagnosis. Particular emphasis has been placed on defining and better delineating the symptoms of the disorder relative to other forms of autism spectrum disorder (ASD) and intellectual disability (ID), and identifying the condition at the earliest possible age. The general consensus is that scaling methods are the core means of establishing a diagnosis. Thus, analyzing the research activity in the area for strengths and weaknesses in methodology would appear to be in order. A critical overview of existing psychometric properties of these tests is presented with suggestions for future research on the topic.

Keywords: Methodology; Differential diagnosis; Autism

Differential diagnosis of autism has been at the center of debate and research since it was first described by Kanner. In one early paper he notes that the primary referral was because the children were assumed to be ''severely feeble minded'' (Kanner, 1944). A considerable amount of research has been published over the ensuing 60 years on the topic. Autistic children are no longer assumed to always or never to have an intellectual disability (ID). However, considerable overlap between the two conditions appears to

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exist (La Malfa, Lassi, Bertelli, Salvini, & Placidi, 2004). Furthermore, some debate about which symptoms are core features of one conditions versus the other and where they overlap is still occurring (Matson & Minshawi, 2006).

It is generally argued that Asperger's syndrome and autism intersect on the other end of the I.Q. continuum (Volkmar & Klin, 1998). However, after the original description of the condition by Asperger in 1944, little attention was paid to this potential diagnosis until popularized by Wing (1981). She argued that Asperger's syndrome was not a separate condition at all, but rather a variant of autism. The person with Asperger's evinces a high degree of intellectual ability versus being ID or borderline ID as was the situation with most identified cases of autism. Asperger's syndrome, later seen as a separate autism spectrum disorder (ASD), was placed in DSM-IV as a distinct condition. Now the popular view of Asperger's syndrome, once again, appears to favor the idea that it is a variant of autism. This view may be reflected in updates of ICD and DSM (Mayes & Calhoun, 2004).

Given the many opinions and rapid changes in notions about how best to label various disorders relative to core symptoms of autism, it is no wonder that a number of scaling methods have been developed to help clarify these major controversies in definition and diagnosis. Perhaps equally challenging has been the recent efforts to diagnose children with autism under the age of two. The primary reason for these efforts has been the belief that treatment programs based on applied behavior analysis can dramatically help afflicted children, and that the earliest possible recognition of those at risk will result in the best long term treatment results. Early intervention has proven successful in remediating many symptoms of autism and has allowed many of these children to be integrated into regular same age classroom (Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996; Smith, 1999).

Autism versus other autism spectrum disorders has proven to be the fulcrum for differential diagnosis research to date. PDD-NOS, autism, and Asperger's syndrome are much more frequently occurring than Rett's syndrome and Childhood Degenerative Disorder and have many more symptoms in common than the latter two conditions. For these and other reasons, differential diagnosis in autism has primarily involved teasing out the diagnostic patterns of the three former conditions. Because autism has received the majority of the attention in symptom description and scale development, PDD-NOS and Asperger's syndrome are often defined largely by the fact that they are not autism. In fact, some authors refer to Asperger's syndrome as ''high functioning autism'' (Mayes & Calhoun, 2004). Given this state of affair, while the present review will be limited to autism, nonetheless this review has implications for the differential diagnosis of PDD-NOS and Asperger's syndrome. Since scaling methods have been the primary means of defining these syndromes, the review will be limited to an overview of these measures in the context of diagnostic schema. At present, the test literature for the other ASDs have similar, and in fact, more limitations than for autism assessment methods. The state of the state in autism test development therefore has value not only for this syndrome but for the entire ASD area. Differential diagnosis of autism is more advanced than for other ASDs and thus sets a model for research with other ASDs, and by defining the features of autism, PDD-NOS, and Asperger's syndrome are at least partially defined as well.

1. Test characteristics

The general value of scales for diagnosing autism can be broken down into several categories. Some methodological questions to be considered are as follows. First, is the test reliable? Various approaches can be used to establish this point. Test-retest reliability for example is two administrations of the same test with the typical interval being 2–3 weeks. This period is long enough to insure that the informant does not remember his/her answers but short enough so that the symptom patterns will probably not have changed very much. For items measuring one construct, split-half and inter-item reliability can be beneficial. Similarly, inter-rater reliability, which has become a hallmark of applied behavior analysis, is a useful means to establish that independent raters observe and score behavior in a similar manner.

A second major methodological concern is validity. Several types of validity should be included. Face validity, that is whether the test appears to be measuring autism based on a cursory review of the items, is essential. Clinicians, parents, teachers, and other concerned adults are unlikely to accept a scale that does not meet this criterion. Another form of validity involves differential diagnosis of the disorders (divergent validity). Can the measure successfully distinguish between symptoms of autism as compared to PDD-NOS, intellectual disability, phobias, and other childhood conditions? The ability of a scale to correctly identify children with autism at very young ages and establish how a symptom pattern will look in later life (predictive validity), is of considerable importance. Finally, does an autism scale measure autism? The gold standard or anchor point would appear to be DSM-IV-TR or ICD-10 criteria, along with observation, interview, and where applicable ''team process'' data. A licensed clinical psychologist or board certified psychiatrist would take this information into account and render a diagnosis.

A third point is perhaps an even more pragmatic one. Are professionals and parents willing to use the test? Several issues go into a decision of this sort. For example, are the directions clear and can the administration of the measure be taught in a brief amount of time, such as 30 min or less? Is the measure intrusive and does it require a considerable amount of specialized testing space? The experimental functional analysis technology has particular problems in this regard (Matson & Minshawi, in press). Can the test be scored easily and rapidly? And, can all of these points be met while still rendering a valid diagnosis? This list of characteristics presents a tall order for the test developer. However, most settings for differential diagnosis are resource and experienced professional poor. These factors create a challenge and an opportunity for those who are interested in enhancing diagnostic accuracy for autism.

2. Early diagnosis

Until very recently, conventional thinking among researchers and clinicians was that the ''clinical gestalt'' of core symptoms that comprises autism could not be adequately recognized to make a reliable and valid diagnosis until 6–10 years of age (Gillberg, Nordin, & Ehlers, 1996). It has also been conventional thinking that no method could accurately diagnose the condition in children 6–12 months of age. It has only been in recent years that

investigators have argued that younger and younger children with autism could be diagnosed at all. The primary reason for this rush to diagnosis is another generally accepted convention that the earlier the diagnosis, the greater the long-term benefits later on in childhood, adolescence, and adulthood (Matson, Laud, & Matson, 2004a, 2004b; Rogers, 1998; Smith, Groen, & Wynn, 2000; Whiteford, 2000). While intuitively this point might appear valid, no long-term follow-up studies are available (e.g., 3–20 years), or will be available for some time. Additionally, while intensive early intervention programs are promising in the short term, many methodological shortcomings exist such as lack of matched controls and outcome measures of core symptoms of autism. Thus, while data are quite promising at present, they are far from conclusive (Matson, in press).

The primary method of making a differential diagnosis is the use of a standardized measure of autism. This approach also holds for children as young as 18 months. The CHAT and STAT are two scaling instruments that have been designed specifically to make a diagnosis in children at 1.5–2 years of age (Baron-Cohen et al., 2000; Stone, Coonrad, & Ousley, 2000). Methodologically, one approach is to differentially diagnose children with ASD as compared to children without ASDs, and to diagnose between ASD conditions. From a practical standpoint, this will be autism and PDD-NOS because Asperger's syndrome does not seem to be diagnosable at these young ages and Childhood Disintegrative Disorder and Rett's syndrome are very rare. A second dimension is to diagnose the children and then follow them up later to determine if they still have the same diagnosis (predictive validity). Stone et al. (1999) tested 65 children under the age of 3 with a mean of 31.4 months. Twenty-five children were diagnosed as having autism and 12 children were diagnosed as having PDD-NOS based on the DSM-IV and the Childhood Autism Rating Scale (CARS) criteria. The general conclusion was that interrater diagnosis was good as was stability of diagnosis over time if ASD versus autism or PDD-NOS criteria were employed.

In a more recent study, Charman et al. (2005) diagnosed 26 children with autism at age 2 with the ADI-R and then followed them up at age 3 and 7. They concluded that standardized assessments used at age 2 did not predict outcome at age 7, but assessments at age 3 were predictive. These studies are among the few, and certainly among the best, to establish the reliability and validity of early diagnosis. While the children in the study by Stone et al. (1999) were 2, most were quite close to being 3 years of age. Also, the five-year follow-up that was employed is a much more rigorous criterion versus a one year follow-up. Thus, Charman et al. (2005) conclusion that predictive validity is best when the child is at least 3 years old appears to be the best bet as of this writing. Milder symptoms which are likely in PDD-NOS may require the child to be a good deal older, since researchers have noted that milder symptoms are more difficult to identify in younger children.

Going back some years and included in the DSM is the statement that autism has an onset before 30 months of age (Short & Schopler, 1988). However, as noted here, as of this writing, there is controversy as to whether an accurate diagnosis of autism can be made prior to age three, particularly if the symptom profile is not of the most extreme form (Baron-Cohen et al., 1996; Charman et al., 2005). In fact, the more recent study from this group seems to be less optimistic about accurate diagnosis in children under the age of three. These data, then, put the clinician in a rather odd bind. Criteria in various major classification systems (e.g., DSM-IV-TR; American Psychiatric Association, 1994) state

that a diagnosis should be made before age 3, yet the science suggests that such a proposition is at best risky and at worst, not possible at present. From a conceptual/methodological perspective then, what are the theories and methods of differential diagnosis and what is their current status?

2.1. Diagnostic classification systems versus empirical subtyping

The diagnosis of autism eventually comes down to symptom definition of the disorder. Two primary methods with some but not total overlap are commonly cited. These approaches include diagnostic systems and empirically derived subtyping. In the first method, experts are consulted and committees formed to determine what symptoms describe the disorder. In the latter case, tests specifically designed to measure autism are administered to a subset of this population. Based on the data obtained and the subsequent derived symptom clusters, differential diagnoses are established as descriptors of the condition.

Two diagnostic classification systems are usually referenced, the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 1994; Kabot, Masi, & Segal, 2003) and the ICD-10 (Kurita, Osada, & Miyake, 2004). At present, these two systems have definitions of autism that are similar, adding a degree of continuity into the picture with respect to definition. In addition to these methods a newer, but far less known system, the Diagnostic is the DC-0-3, has appeared (Zero to Three, 1994). This latter method has gained very little traction in the published literature to date.

As noted earlier, attempts to differentially diagnosing autism at ages younger than three have been mixed (Charman et al., 2005). Additionally, the DC-0-3 is a new system, relatively speaking, and will have a hard time competing with the two existing models. DSM and ICD have large professional organizations that sponsor them and a large momentum from being in place for many years. Also, these system's sponsors have taken the position that autism is a neurodevelopmental disorder while the DC-0-3 emphasizes the environment, particularly with respect to deprivation of stimulation, to a much greater degree (Zero to Three, 1994). The DC-0-3 is modeled after DSM in that an axis approach is used. The five axes are: (1) primary diagnosis (e.g., sleep disorders, adjustment disorders, disorders of relating and communicating including multisystem developmental disorders and pervasive developmental disorders); (2) relationship disorder classification (e.g., overinvolved, underinvolved, abuse); (3) medical and developmental disorders and conditions; (4) psychosocial stressors; and (5) functional emotional developmental level. The developers emphasize the need for multiple assessments over time and in different contexts which is at variance with DSM and ICD. They do follow the other two systems in that it is used not only for classification, but for assessment and clinical case formulation. We believe this is not the most parsimonious model despite the commonality with which such methods are used in everyday practice. Similarly, others have noted that before these classification schemes can be codified, they must be confirmed via extensive empirical study and clinical use (Rutter, 1978). Rather, normed data based assessment scales, published in peer reviewed journals, should constitute the core of any diagnosis. The goal should be a scientific, data-driven approach to differential diagnosis and should influence the diagnostic criteria in these systems. DSM and ICD are following this approach to a large degree.

3. Assessment instruments

Authors of assessment instruments almost uniformly suggest that these tests be used in conjunction with clinical observations, DSM or ICD criteria, team processes and other decision making criteria in a cumulative fashion. Despite this, scales are used as the central feature for group selection and differentiation in assessment research with young autistic children. Furthermore, a goal of many of these studies is expressly the differential diagnosis of autism from other ASDs, other common childhood problems, and ID. Therefore, the data do not always match the argument for more broad-based clinical diagnostic methods. Furthermore, most pediatricians, general practitioners, teachers, social workers, clinical psychologists, and psychiatrists who are in practice on the ''front-line'', are not familiar with the clinical presentation of autism in children. Therefore, these scales may represent not only a diagnostic tool, but the primary means of educating professionals about the symptoms that make up the disorder. Even more than in the research being conducted, where people very knowledgeable of autism are guiding the evaluation process, the ''typical'' clinician is likely to rely very heavily, if not exclusively, on these assessment instrument data. Whether this is optimal is certainly debatable. However, it is a pragmatic fact of clinical practice which is unlikely to go away soon.

A second observation is that the popular media in the form of newspapers, press releases, TV, the internet and so on, present a bewildering and even shocking amount of misinformation and bad advice. From a diagnostic standpoint, some of the more egregious information include suggesting that parents with no formal training diagnose their child by using a hastily put together checklist with no published psychometric data. Additionally, well-meaning advocates will list various diagnostic systems, some with published reliability and validity data, and others with no empirical support, and no guidance as to which scales are methodologically sound. Not all tests have been created equal.

Table 1 is an overview of autism scales that have published psychometric data. Tests which authors state were designed to establish educational goals or assess treatment outcome were not included given the focus on diagnosis. Similarly, studies with questionable methodology were excluded (e.g., tests were sent to large numbers of clinicians who were asked to fill them out and return them versus directly interviewing an informant or observing a child). We located 21 scales within these parameters. Many other scales, some in wide use, do not meet these very minimal criteria. We would argue that any instrument used for diagnosing autism in children should come from this list, unless there is a measure with good published psychometrics (e.g., reliability and validity) that we have missed. And, even within this list many of the scales are outdated or have minimal psychometric support. Even where studies report over several hundred cases, most are children without ASD. Thus, differentiating ASD from normals is quite different than establishing psychometrics within items, and subdomains/diagnoses of the scale itself. Scales using large numbers of ASD children in their psychometric studies are quite important yet rare.

The ADI-R is considered to be the gold standard for assessment scales used in the diagnosis of autism by many at this time (Cohen, 2003; Constantino et al., 2003). It has a broader age range of norms, more published psychometric data, and is a best fit with DSM and ICD criteria relative to other scales. The authors also emphasize the open-ended

Table 1
A list of scales with published psychometric data, developed for the differential diagnosis of autism and in some cases other ASDs

1	Developmental Dimensional and Diagnostic Interview	3di	Skuse et al. (2004)
2	Autism Behavior Checklist	ABC	Krug, Arick, and Almond (1980)
3	Autism Diagnostic Interview	ADI	LeCouteur et al. (1989)
4	Autism Diagnostic Interview- Revised	ADI-R	Lord, Rutter, and Le Couteur (1994)
5	Autism Diagnostic Observation Schedule	ADOS	Lord et al. (1989)
6	Autism Diagnostic Observation Schedule- Generic	ADOS-G	Lord et al. (2000)
7	Autism Spectrum Disorders-Diagnosis	ASD-D	Matson, Terlonge, and Gonzalez (2006)
8	Behavior Function Inventory	BFI	Adrien et al. (2001)
9	Behavior Observation Scale	BOS	Freeman and Schroth (1984)
10	Childhood Autism Rating Scale	CARS	Schopler, Reichler, DeVellis, and Daly (1980)
11	Checklist for Autism in Young Children	CAYC	Mayes and Calhoun (1999)
12	Checklist for Autism in Toddlers	CHAT	Baron-Cohen et al. (2000)
13	Diagnostic Interview for Social and Communication Disorders	DISCO	Wing, Leekam, Libby, Gould, and Larcombe (2002)
14	Diagnostic Checklist, Form E2	E2-DC	Rimland (1971)
15	Gilliam Autism Rating Scale	GARS	Gilliam (1995)
16	Modified Checklist for Autism in Toddlers	M-CHAT	Robins, Fein, Barton, and Green (2001)
17	Pervasive Developmental Disorders Behavior Inventory	PDDBI	Cohen, Schmidt-Lackner, Romanczyk, and Sudhalter (2003)
18	Pervasive Developmental Disorders in Mentally Retarded Persons	PDD-MRS	Kraijer (1997)
19	Pervasive Developmental Disorders Rating Scale	PDDRS	Eaves, Campbell, and Chambers (2000)
20	Pre-Linguistic Autism Diagnosis Observation Schedule	PL-ADOS	DiLavore, Lord, and Rutter (1995)
21	Screening Test for Autism in Two-year-olds	STAT	Stone et al. (2000)

response method versus yes–no or Likert answers. Having said this, the scale also has a number of shortcomings with respect to psychometrics. Table 2 presents the methodological criteria reviewed earlier in the paper and also lists other relevant information for methodology studies of childhood autism scales. The biggest shortcoming with this and other measures of autism is the general lack of adequate norms. Cut-off scores are generally based on how well diagnoses compare to DSM, ICD, or criteria established in existing scales. These data present reliability and differential diagnostic validity at some level. Specifically, all reported studies had face validity. However, without the large group studies to psychometrically define the disorder, it is quite possible that the experts are in agreement but may be at least partially in error with respect to diagnostic criteria. We direct the reader to recent disagreements over diagnostic criteria in various revisions of the DSM with respect to hyperactivity and the debate over whether Asperger's is a separate syndrome or a subset of autism. We argue that carefully constructed empirical studies should be used to answer these questions to the extent possible versus opinions or politics which has often entered into DSM and ICD manuals. Another important methodological approach would be to use a best fit model of diagnostic scales to scaling methods using a

Table 2
A representative list of ASD diagnostic studies, the number, ages, and diagnoses of children tested

Author(s) and year	Children			Test name	Factor analysis	Reliability				Validity			
	No.	Age range	Sample character-istics			Test-retest	Inter-rater	Internal consistency		Diff. diag.	Criterion-related		Match to DSM or ICD
								Alpha coefficient	Split-half		Con-current	Prediction	
Skuse et al. (2004)	149	3–16 years	ASD, non-ASD	3di		X	X			X	X		X
Krug et al., 1980	1111	18 months–35 years	Autism, ID, controls	ABC			X		X	X	X		
Volkmar et al. (1988)	157	19 years	Autism, clinical controls	ABC	X		X		X	X	X		X
Wadden, Bryson, and Rodgers (1991)	123	6–15 years	Autism, learning diabilities, ID	ABC	X					X			X
Szatmari, Archer, Fisman, and Streiner (1994)	83	4–6 years	PDD	ABC			X						
Goodman and Minne (1995)	17	4–11 years	Blind or blind with PDD	ABC		X				X			X
Miranda-Linne and Melin (1997)	383	5–22 years	ASD	ABC	X								
De Bildt et al. (2003)	1059	4–18 years	ID, PDD	ABC, PDD-MRS						X	X		X
Eaves et al. (2000)	139	Mean 8.5 years	Autistim, PDD, ID	ABC, PDDRS						X	X		X
LeCouteur et al. (1989)	47	6–22 years	Autism, ID	ADI			X			X			X
Yirmiya, Sigman, and Freeman (1994)	18	9–16 years	Autism, other dev. disorders	ADI, ABC			X			X			X
Lord et al. (1994)	50	3–5 years	Autism, ID	ADI-R		X	X	X					X
Cox et al. (1999)	17173	20 month then 3.5 years	Autism, PDD, language disorder	ADI-R						X		X	X
Mildenberger, Sitter, Noterdaeme, and Amorosa (2001)	27	Mean 9 years	Autism, receptive language disorder	ADI-R						X			X
Moore and Goodson (2003)	20	2.5 then 4.5 years	At risk for PDD	ADI-R						X		X	X
Cuccaro et al. (2003)	207	3–21 years	Autism	ADI-R	X			X					
Charman et al. (2005)	26	Ages 2, 3, and 7	Autism	ADI-R								X	X
Tadevosyan-Leyfer et al. (2003)	292	2–47 years	ASDs	ADI-R, ADI	X								

Table 2 (*Continued*)

Author(s) and year	Children			Test name	Factor analysis	Reliability				Validity			
	No.	Age range	Sample character-istics			Test-retest	Inter-rater	Internal consistency		Diff. diag.	Criterion-related		Match to DSM or ICD
								Alpha coefficient	Split-half		Con-current	Prediction	
Bishop and Norbury (2002)	74	6–9 years	ASD, language impairment	ADI-R, ADOS-G, SCQ						X			
Saemunden, Magnusson, Smari, and Sigurdardottir (2003)	54	2–9.5 years	At risk for ASD	ADI-R, CARS				X		X			
Lord et al. (1989)	120	6–18 years	Autism, ID, normals	ADOS		X	X			X	X		X
Noterdaeme, Sitter, Mildenberger, and Amorosa (2000)	49	7–12 years	Autism, language disorders	ADOS						X			X
Lord et al. (2000)	223	4–21 years	Autism, PDD-NOS, non-spectrum diagnoses	ADOS-G	X	X	X	X		X			X
Adrien et al. (2001)	131	2–12 years	Autism, PDD-NOS, ID	BFI	X		X						X
Freeman et al. (1981)	114	2.5–5 years	Autism, normal, ID	BOS						X			X
Freeman and Schroth (1984)	118	2–6 years	Autism, normal, ID	BOS			X			X			X
Schopler et al. (1980)	537	2–10 years	Autism, controls	CARS			X	X		X			
Garfin, McGallon, and Cox (1988)	84	6–22 years	Autism	CARS			X	X		X			
Mesibov, Schopler, Schaffer, and Michal (1989)	89	10 then 13	Autism, controls	CARS		X				X			
Van Bourgondien, Marcus, and Schopler (1992)	138	2–34 years	Autism, PDD	CARS			X			X			X
DiLalla and Rogers (1994)	69	2–6 years	Autism, PDD-NOS, non-PDD	CARS	X	X	X			X			X
Kanai et al. (2004)	74	2–22 years	Autism and high-functioning autism	CARS-TV						X			X
Mayes and Calhoun (2004)	157	1.5–14 years	Autism, Asperger's	CAYC						X			X
Baron-Cohen, Allen, and Gillberg (1992)	91	18 months then 30 months	At risk for PDD & random sample	CHAT						X			X

Baron-Cohen et al. (1996)	16000	18 months then 3.5 years	General population	CHAT						X			X
Wing et al. (2002)	82	3–11 years	ASD, LD, language disorder, controls	DISCO			X						
Rimland (1971)	2218	Not available	Psychosis or autism	E2-DC						X			
Hagerman, Jackson, Levitas, and Braden (1986)	50	2.5 years	Fragile X syndrome	E2-DC, ABC						X			X
South et al. (2002)	119	3–10 years	Autism	GARS									X
Robins et al. (2001)	1293	18 months–2.5 years	ASD, at risk for ASD, controls	M-CHAT				X		X		X	X
Cohen (2003)	84	3–6 years	ASD	PDDBI						X		X	
Cohen et al. (2003)	311	1–17 years	ASD	PDDBI	X		X	X					X
DiLavore et al. (1995)	83	1–5.5 years	Autism, DD, normals	PL-ADOS			X						X
Stone et al. (1999)	65	2 then 3 years	ASDs	PL-ADOS, CARS			X			X	X		X
Stone et al. (2000)	73	2–3 years	Autism, other dev. disorders	STAT						X			X
Stone, Coonrod, Turner, and Pozdol (2004)	156	2–3 years	Autism, dev. delay, language impairment	STAT		X	X			X	X		X

Also included are the psychometric characteristics of the tests evaluated. 3di = Developmental, Dimensional, and Diagnostic Interview, ABC = Autism Behavior Checklist, ADI = Autism Diagnostic Interview, ADI-R = Autism Diagnostic Interview-Revised, ADOS = Autism Diagnostic Observation Schedule, ADOS-G = Autism Diagnostic Observation Schedule-Generic, ASD = Autism Spectrum Disorders, BFI = Behavior Function Inventory, BOS = Behavior Observation Scale, CARS = Childhood Autism Rating Scale, CARS-TV = Childhood Autism Rating Scale- Tokyo Version, CAYC = Checklist for Autism in Young Children, CHAT = Checklist for Autism in Toddlers, DD = Developmental Disorders, DISCO = Diagnostic Interview for Social and Communication Disorders, E2-DC = Form E2- Diagnostic Checklist for Behaviorally Disturbed Children, GARS = Gilliam Autism Rating Scale, ID = Intellectual Disabilities, LD = Learning Disabilities, M-CHAT = Modified Checklist for Autism in Toddlers, PDD = Pervasive Developmental Disorder, PDDBI = Pervasive Developmental Disorder Behavior Inventory, PDD-MRS = Pervasive Developmental Disorder in Mentally Retarded Persons, PDD-RS = Pervasive Developmental Disorders Rating Scale, PL-ADOS = Pre-Linguistic Autism Diagnostic Observation Schedule, SCQ = Social Communication Questionnaire, STAT = Screening Tool for Autism in two-year-olds.

Table 3
Administration time for measures of autism spectrum disorders

	Test name	Type of measure	Administrator qualifications	Average administration time
1	3di	Structured interview	Trained examiner	45–90 min
2	ABC	Rating scale	Parent	Under 20 min
3	ADI	Interview	Trained examiner	2–3 h
4	ADI-R	Interview	Trained examiner	1–3 h
5	ADOS	Observation	Trained examiner	20–45 min
6	ADOS-G	Observation	Trained examiner	30–45 min
7	ASD-D	Rating scale	Trained Examiner/Parent	30–45 min
8	BFI	Rating scale	Clinician	20–45 min
9	BOS	Observation	Trained examiner	30 min observations per day over 3 days
10	CARS	Rating scale	Trained examiner	30 min
11	CAYC	Interview	Trained examiner	20–30 min
12	CHAT	Rating scale	Parent, teacher	5–15 min
13	DISCO	Interview	Clinician	2–4 h
14	E2-DC	Rating scale	Parent	Not available
15	GARS	Rating scale	Parent, teacher	20 min
16	M-CHAT	Rating scale	Parent	5–10 min
17	PDDBI	Rating scale	Parent, teacher	45 min
18	PDD-MRS	Rating scale	Clinician, teachers	15 min
19	PDDRS	Rating scale	Parent, teacher	20 min
20	PL-ADOS	Rating scale	Trained examiner	30 min
21	STAT	Rating scale	Trained examiner	Under 20 min

multitrait-multimethod approach versus an a priori ‘‘gold standard’’ (Campbell & Fiske, 1959).

Other measures with multiple studies published on their psychometrics include the CHAT, ABC, CARS, and the ADOS/PL-ADOS/ADOS-G. The remainder of the scales generally have one or two published psychometric studies describing their methodological properties. Some measures received initial attention in past years but largely due to the failure to continue the development of their psychometrics, have fallen from favor. Other papers have sometimes used one of these autism measures as an outcome variable for treatment. These studies were not included because they did not deal with the establishment of test psychometrics. Table 3 identifies the type of measure, administrator qualifications, and the average administration time.

3.1. Practical considerations

Various advantages and disadvantages have been put forward by scale developers. Some of these distinctions are interesting but do not appear to be supported by available data. For example, the fact that a test involves a detailed interview versus yes–no answers may generate more, or more specific information. However, one cannot conclude at this time that such information results in a more accurate diagnosis. The studies that address this hypothesis have not been conducted. A second, related issue is the distinction made that some instruments are for research purposes while others are for clinical use. Absent an

operational definition and empirical verification of such a distinction, which has not occurred, this point at best awaits further verification, or at worst does not exist. Third, most scale developers suggest that these tests should not be used for diagnosis, despite the fact that they have largely been developed for that purpose. These tests are the most systematic, reliable and valid means currently available in the child autism diagnostic literature. Thus, we argue that these scales should be used to make diagnoses, unless or until more scientifically sound means of making such diagnoses become available. The sheer volume of scales developed to diagnose autism in children would seem to suggest at least tacit agreement among researcher-clinicians that this is the most viable approach to differential diagnosis.

Some measures emphasize the fact that they are very detailed. We would argue that detail equals time. From a pragmatic perspective, our view is that a major priority should be to develop the balance between obtaining relevant information to make a diagnosis, while parsing out items that do not enhance that goal. More detailed assessment information that would assist in establishing target behaviors for intervention, variables maintaining problem behaviors, skill deficits that could be identified for education and development, and means of assessing treatment outcome are all worthy but different goals than differential diagnosis. These issues might, for efficiency and clarity be addressed best in separate evaluation packets.

Some additional practical issues may limit the use of particular scales. For example, the ADI-R and variations of the ADOS which are very good scales in many ways require attendance at a workshop or purchasing and viewing lengthy training videotapes. Most clinicians are not going to do that. Additionally, with few exceptions, time and resources are not available outside of university clinics for assessment and scoring of major diagnostic tests that take over an hour to administer. Some test developers have gone to computerized scoring to shorten the amount of time involved. However, it still takes time to enter raw data in the proper format. We are of the opinion that a better method is a brief, easy to score instrument that can be done by hand. This approach provides a valuable opportunity for the clinician to review and reflect on items which should assist in diagnosis and case formulation and adds little additional time to a computerized data entry method.

4. Holes in the literature

Given that differential diagnostic research is only several decades old, it should not be surprising that several areas of development are still in need of exploration. Furthermore, while authors routinely note in the literature that scales alone should not be used for differential diagnosis of autism, there is no doubt that they are and should be the central feature in this process. They are the only means of differential diagnosis with scientific support at present. If and when other data-based methods arrive on the scene (e.g., genetic measures) they may partially supplant or augment these paper and pencil methods. We say this because of the value of genetic markers in early identification. However, because of the binary nature of such diagnoses and the failure to account for environmental factors, scales are likely to be of considerable value in identifying

severity and type of symptom complexes regardless of success with genetic tests. Down syndrome may be a model in that while a clear genetic marker exists, ID and adaptive behavior measures are still of considerable value since these persons can vary markedly along the I.Q. continuum.

At present there is a need for a number of additional developments which could greatly enhance the field. A large normative sample, collected in various settings and geographic areas, with a large number of PDD-NOS, autistic and Asperger syndrome/autistic children from 3 years to 18 years is needed. At present, correlations with small samples of these children to DSM or ICD criteria are used. This approach is better than nothing, but the classification systems have not been adequately studied. Therefore, items are extrapolations from research and clinical practice, and to some extent the reasoning is circular. Most studies are correlated to DSM criteria, but what if they are inaccurate? One could have reliability but no validity. Looking at convergent and discriminant validity is one way to address this issue (Cambell & Fiske, 1959).

Psychopathology and ASD have a developmental course. Nowhere would developmental differences be as evident as in the childhood population. Thus, diagnostic symptoms are likely to vary by age and can only be established via adequate norms. Along these same lines is the need for cut-off scores. The cut-off may vary with age, some symptoms might be *must have*, while other symptoms might be designated as *may have*. Social validity criteria could also be used to establish diagnoses of autism by age. Vignettes presented to parents, students, or others diagnosed by experts as having autism, PDD-NOS, or normal development would be valuable in obtaining another perspective on how or whether symptoms appear unusual or out of the ordinary as compared to the general population. These types of data for same-age peers would be valuable for establishing critical target symptoms that cause the child to ''stand out'' as being different, thus compromising optimal integration in normal settings.

Brief scales that can be used to accurately diagnose autism using the latest empirically established symptoms and data-based cut-offs would be helpful. Along these same lines, designing assessments that do not require terminal degrees, but could be reviewed by a doctoral level clinical psychologist or board certified psychiatrist would be more in line with clinical practice in most applied settings. Comparisons of doctoral versus masters level professionals in test administration might be one method of testing this pragmatic issue.

Specialized methods of autism scaling are emerging, such as efforts to diagnose very young children. Additionally, some initial efforts to identify challenging behaviors in a systematic way have appeared in recent scales. Measures of comorbid psychopathology are needed as well. The field of assessment in ASD has developed rapidly and much has been learned about differentially diagnosing different types of ASD form each other, from normals, and from those with ID, particularly in the context of autism. However, the literature is somewhat scattered and piecemeal at present. As the literature grows more coherent (hopefully), assessment strategies are likely to emerge. For example, the growing belief by many that the ADI-R is presently a good place to start when diagnosing autistic and PDD-NOS children is as near as anything to a consensus view when thinking of autism diagnosis. The literature is still quite fluid, however, and many new developments are likely in the next decade.

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