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Chapter 3

The interrelationship between ADOS, ADI-R and DSM-IV-TR classification in children and adolescents with mental retardation

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Abstract

The interrelationship between the ADI-R, ADOS and clinical classification was studied in 184 children and adolescents with mental retardation. The agreement between the ADI-R and ADOS was fair, with a substantial difference between younger and older children (5-8 vs. 8+). Compared to the DSM-IV-TR classification of AD and PDD, both instruments measure AD or PDD validly and reliably. Even in low functioning children the interrelationship between the instruments and the clinical classification was satisfactory. The combination of ADI-R and ADOS identifies AD or PDD, as described in the DSM-IV-TR, most appropriate. Both instruments seem to be of great value in the diagnostic process of pervasive developmental disorders in children and adolescents with mental retardation.

3.1 Introduction

Diagnosing pervasive developmental disorders is complicated, especially in individuals with mental retardation, and should be based on a diagnostic process involving extensive information from child, parents and school or other important sources. Instruments (e.g. questionnaires, interviews, observation methods, etc.) may be helpful in this process. With instruments information on the behavior of a child can be collected in a standardized way. This means that the same information is collected in the same way in the diagnostic process of each child. The information that is collected can be compared to the information collected on other children with pervasive developmental disorders. However instruments are only valuable if they measure pervasive developmental disorders validly and reliably. Therefore it is important to study the interrelationship between instruments and the clinical diagnosis.

Even with information from all sources and from instruments, differentiation between pervasive developmental disorders and mental retardation is complicated. First, the definition of pervasive developmental disorders includes a broad group of children. Especially children with a diagnosis in the category of Pervasive Developmental Disorder-Not Otherwise Specified are difficult to describe as one homogeneous group (Bailey, Phillips, & Rutter, 1996; Buitelaar, Van der Gaag, Klin, & Volkmar, 1999; Luteijn et al., 2000). But even in the category of core autism, with more stringent criteria in both DSM-IV-TR (APA, 1994) and ICD-10 (WHO, 1992), not all children show the same behavior (Wing & Gould, 1979; Wing, 1997).

Second, since low mental ages may account for less developed social and communicative behavior in itself (Wing, 1997) there is a behavioral overlap between children with mental retardation and children with pervasive developmental disorders (DiLavore, Lord, & Rutter, 1995). Besides that, in young non-verbal children there is a substantial overlap with behavior in typically developing children, because of the large variation in normal behavior. This complicates a diagnosis of both pervasive developmental disorders (DiLavore et al., 1995) and mental retardation. Although present in all levels of functioning, the differentiation issue is most apparent in low functioning children with mental retardation, because of the lack of differentiated social or communicative behavior, and the presence of stereotyped behavior in low functioning children with mental retardation, as well as in children with pervasive developmental disorders.

Instruments developed for the assessment of pervasive developmental disorders may be helpful in differentiating between pervasive developmental disorders and mental retardation, although each instrument has its limitations (Lord, Rutter, & Le Couteur, 1994). These limitations seem not specifically to be related to the instruments. Especially low functioning children with mental retardation show a narrow behavioral repertoire (Kraijer, 1997). Therefore application of the concept of pervasive developmental disorders is difficult in this group, which complicates the differentiation between mental retardation and pervasive developmental disorders, even with instruments. However, to standardize the diagnostic process of children and adults, instruments are needed for clinical and for research purposes.

In recent years, a combination of instruments was developed, for assessing pervasive developmental disorders in children and adolescents: the Autism Diagnostic Interview-Revised (Le Couteur et al., 1989; Lord et al., 1994; Lord, 1997) and the Autism Diagnostic Observation Schedule (Lord et al., 1989; DiLavore et al., 1995; Lord, Rutter, DiLavore & Risi, 1998). Both instruments provide extensive data on the three aspects of pervasive developmental disorders, as mentioned in the DSM-IV-TR and ICD-10: 1) qualities of reciprocal social interaction, 2) communication and language and 3) repetitive, restricted, and stereotyped interests and behaviors. When used together, data are available both on the current behavior (observation with ADOS), and on the history and development of the child (interview with parents/caregivers with ADI-R). The algorithm of the ADI-R differentiates between AD and non-AD and the algorithm of the ADOS differentiates between AD, PDD-NOS and non-PDD.

Since both instruments are relatively new, there is only a limited number of studies that specifically address the psychometric qualities. For the purpose of this paper we reviewed the studies of the ADI-R and the ADOS with respect to children with mental retardation.

Early studies showed that the predecessors of the ADOS (Lord et al., 1989; DiLavore et al., 1995) discriminated well between autism and mental retardation in higher functioning children but less well in low functioning children. Developmental level played a role in outcome on the ADOS (Lord et al., 1989). Currently the ADOS provides a standardized observation for a wider age and developmental range and the role of developmental level was not mentioned anymore (Lord et al., 2000). In this recent study of Lord et al. (2000) reliability and validity of the items, domains and

classifications of each module were reported to be good to excellent. Discrimination between AD versus non-spectrum disorders was better than discrimination between AD and PDD-NOS. The ADOS seems to be a very well developed, standardized observational instrument, which provides the examiner with extensive information on the current social and communicative behavior, and which has good psychometric qualities. The instrument seems to be most applicable for children with mental ages from 15-18 months and higher. The authors stated that it still seems complicated to determine how the ADOS can discriminate between low functioning children with and without autism.

With respect to the ADI-R, the minimal mental age seems to be around 18 months. Accurately discriminating between AD and low functioning mental retardation in non-verbal children seems to be difficult, the ADI-R seems to be over-inclusive in non-verbal children with mental ages of 18 months or less (Fombonne, 1992; Lord et al., 1994; Cox et al., 1999). Although the algorithms of the ADI and ADI-R seem to apply to all individuals with autism, sensitivity is lower for high functioning individuals, whereas specificity is lower for low functioning individuals (Lord et al., 1997). Especially communication items do not seem to be helpful in differentiating between children with autism and low functioning children with mental retardation (Lord, Storoschuk, Rutter, & Pickles, 1993). The ADI-R provides extensive information about the history and development of the child. However, the role in discriminating between AD and non-AD in low functioning individuals seems complex.

According to the literature reviewed here, diagnosing pervasive developmental disorders in children and adolescents with mental retardation is complicated, especially in lower functioning children and adolescents, even with the ADI-R and ADOS. The underlying issues are the definition of pervasive developmental disorders and the behavioral overlap between children with mental retardation, pervasive developmental disorders or young, typically developing children. Further investigation of the ADI-R and ADOS in a population with mental retardation, including the lowest functioning individuals, will contribute to understanding the value of these instruments in the diagnostic process in this population.

The study presented in this paper had two main objectives. The first objective was to describe the interrelationship between the ADI-R and ADOS in children and adolescents with mental retardation. The second objective was to study the criterion

related validity between a clinical DSM-IV-TR classification and the ADOS and ADI-R, in individuals with mental retardation.

3.2 Method

Sample Selection

In this study, 184 children and adolescents with mental retardation between the ages of 5 and 20 years were evaluated. All levels of mental retardation were included. The level of mental retardation was evaluated with standardized intelligence tests, Wechsler Intelligence Scale for Children-Revised, WISC-R (Wechsler, 1974; Vander Steene et al., 1986), Wechsler Preschool and Primary Scale for Intelligence-Revised, WPPSI-R (Wechsler, 1989; Vander Steene & Bos, 1997), Non-verbal intelligence tests, e.g. Snijders-Oomen Niet-verbale intelligentie test-Revisie, SON-R (Snijders, Tellegen, Winkel, & Laros, 1996), Dutch modification of the Bayley scales of Infant Development (Bayley, 1969; Van der Meulen & Smrkovsky, 1983) and adaptive behavior scales, Vineland Adaptive Behavior Scales VABS-Survey Form (Sparrow, Balla, & Cicchetti, 1984), and the Social Functioning Scale for the Mentally Retarded, SRZ, (Kraijer & Kema, 1994), i.e. a modified version of the Cain-Levine Social Competency Scale (Cain, Levine, & Elzey, 1963). The participants were selected from an epidemiological study of pervasive developmental disorders we conducted earlier, in a total population of children and adolescents with mental retardation in the province of Friesland (de Bildt et al., in press). The selection was based on the Scale of Pervasive Developmental Disorder in Mentally Retarded persons, PDD-MRS (Kraijer, 1997). This is a 12-item questionnaire completed by clinicians, with dichotomous items on the three aspects of pervasive developmental disorders, e.g. communication, social behavior and stereotyped behavior. Weight factors 1, 2, or 3 are assigned to the item scores. Children in the PDD category (scores 10 and higher) on this instrument (n=123) were evaluated with ADI-R, ADOS and a clinical classification. A random selection of negative screened participants (scores 9 and lower, n=61) was evaluated as well. In table 3.1 the sample characteristics are presented.

Table 3.1 Sample characteristics

<i>Level of MR</i>	<i>n</i>	Sex				<i>range</i>	Age	
		Male		Female			<i>mean</i>	<i>sd</i>
		<i>n</i>	%	<i>n</i>	%			
Profound	40	22	55.0	18	45.0	6-19	11.31	3.53
Severe	53	33	62.3	20	37.7	5-20	12.60	4.43
Moderate	32	18	56.3	14	43.8	6-16	9.79	2.96
Mild	59	36	61.0	23	39.0	5-19	10.62	3.59
Total	184	109	59.2	75	40.8	5-20	11.19	3.85

Instruments

Autism Diagnostic Interview-Revised

Seven trained interviewers administered the ADI-R in the home of the parents/caregivers. All interviewers had reached 80% reliability in scoring the ADI-R as required. Data analysis involved the recommended algorithm, which provides information on the history and development of the individual (mostly information on 4-5 years of age, or 'ever'). The internal consistency of the ADI-R domains in our sample were slightly lower than described by Lord et al. (1994), but followed the same pattern, with highest alpha's for social (.90) and communication (.76), and lowest for repetitive behavior (.59).

Autism Diagnostic Observation Schedule

Three trained examiners administered the ADOS in the school, day-care facility or institution where the child was during the day. Each examiner had reached 80% reliability as required. All ADOS's were videotaped. Two trained raters coded the ADOS independently, immediately after administration. When raters disagreed on scoring, consensus was reached by discussing the item and reviewing the videotape.

Internal consistency of the domains varied between the different modules. For all modules the pattern of internal consistency corresponded with the pattern of internal consistencies described by Lord et al. (2000), with highest internal consistency for the social domain (.51-.82) and the combination of the social and communication domain (.66-.87), lower for the communication domain (.58-.67) and lowest for stereotyped behavior (.07-.44). In general, the values found for module 1

(n=81) and 2 (n=61) were higher than for module 3 (n=36) and 4 (n=6). This may be due to the number of individuals observed with each module.

Clinical classification

Clinical classifications were assigned by four experienced clinicians, two board certified child and adolescent psychiatrists (R.B.M. and C.E.J.K.), one clinical and developmental psychologist (D.W.K.) and one resident (E.J.M.). When a case was considered difficult to assess, consensus classification was made through reviewing and discussing the available information.

The clinical classification was made according to DSM-IV-TR criteria, based on parent information, collected with the ADI-R and observation of the child on video, during the ADOS. The clinicians were blind for the outcome on the algorithms of the ADI-R and the ADOS. Each combination of two clinicians classified ten children in common. They were unaware of which child, which other clinician or outcome of the other classification. In order to measure the level of agreement of the diagnostic classification (AD, PDD-NOS, non-PDD) between clinicians, a weighted kappa was calculated. The weights we used were 1 for exact agreement, .5 if one rater scored AD and the other PDD-NOS and 0 in all other cases. The percentage of agreement found was 81.2% and the weighted kappa coefficient was .66 (sd .13). Both the percentage of agreement and the weighted kappa values are considered good according to the criteria of Cicchetti (2001), that combine the criteria reported earlier by Cicchetti and Sparrow (1981) for weighted kappa values and the criteria reported by Cicchetti, Volkmar, Klin and Showalter (1995) for percentages of agreement. The clinical classification was AD in 48, PDD-NOS in 48 and non-PDD in 89 cases.

3.3 Results

Interrelationship between ADI-R and ADOS

In table 3.2, the agreement between the classifications based on the cut-offs of the algorithms of the ADI-R and ADOS is presented. The percentage of agreement was 63.6%. When agreement was controlled for chance with kappa statistic, agreement between ADI-R and ADOS AD was .272 for the total population. Agreement between ADI-R and ADOS AD and PDD-NOS was .288. Both values are poor. Agreement was much higher in younger children.

Table 3.2 Agreement between ADI-R and ADOS

Age			ADI-R				Agreement	
			AD		Non-AD		%	κ
			n	%	n	%		
5-8	ADOS	AD	18	42.9	3	7.1	83.4	.667
		Non-AD	4	9.5	17	40.5		
		PDD	22	52.4	8	19.0	81.0	
		Non-PDD	0	0	12	28.6		
8+	ADOS	AD	38	26.8	33	23.2	57.8	.155
		Non-AD	27	19.0	44	31.0		
		PDD	53	37.3	47	33.1	58.5	
		Non-PDD	12	8.5	30	21.1		
Total	ADOS	AD	56	30.4	36	19.6	63.6	.277
		Non-AD	31	16.8	61	33.2		
		PDD	75	40.8	55	29.9	63.6	
		Non-PDD	42	22.8	12	6.5		

The Pearson's r correlation between algorithm total scores of the ADI-R and ADOS was substantial, without a difference between younger and older children (total: .521, 5-8: .539, 8+: .517 ($p < .01$)).

Criterion related validity of ADI-R and ADOS compared to DSM-IV-TR

The sensitivity and specificity of the cut-off criteria of the algorithms for the ADI-R and the ADOS compared to the clinical classification with the DSM-IV-TR are presented in table 3.3.

Table 3.3 Sensitivity and specificity of the ADI-R and ADOS compared to the DSM-IV-TR ($n=184$)

		Sensitivity cut-off	Specificity cut-off	Correctly classified	Positive predictive value	Negative predictive value
DSM-IV-TR PDD	ADOS	.874	.472	.679	.639	.778
	ADI-R	.716	.787	.750	.782	.722
DSM-IV-TR AD	ADOS	.917	.647	.717	.478	.956
	ADI-R	.771	.632	.668	.425	.887

Compared to the DSM-IV-TR PDD-classification, the ADOS had a higher sensitivity and a lower specificity, whereas the ADI-R had a high specificity and a lower sensitivity, which were closer to each other than for the ADOS. The percentage of cases correctly classified was lower for the ADOS than for the ADI-R. Negative predictive values were satisfactorily high for both instruments. Positive predictive value was lower for the ADOS than for the ADI-R.

The variation of agreement on classification between each instrument and the clinical classification over age and level of functioning was tested with a logistic regression. The results are presented in table 3.4.

Table 3.4 Variation of agreement of the ADI-R and ADOS with the DSM-IV-TR for PDD, over IQ and age

	Agreement ADOS/DSM-IV-TR		Agreement ADI-R/DSM-IV-TR	
	Odds ratio	95% CI	Odds ratio	95% CI
Age	1.11*	1.0-1.2	1.06	.97-1.15
Level of MR				
<i>Mild</i>	1		1	
<i>Moderate</i>	6.41**	2.59-15.86	2.13	.91-4.99
<i>Severe</i>	1.45	.64-3.27	1.59	.70-3.58
<i>Profound</i>	2.43	.98-6.05	1.94	.77-4.84

* $p < .05$, ** $p < .001$

The odds ratio's (OR) express the increase or decrease in the probability of agreement between the instrument and the clinical classification, with increasing age and decreasing levels of functioning. For the ADI-R age and level of functioning had no significant effect. For the ADOS the probability of agreement with the DSM-IV-TR increased with increasing age and decreasing levels of functioning.

A Receiver Operating Characteristic (ROC) analysis with the ADOS and ADI-R and criterion DSM-IV-TR classification was applied to further investigate these outcomes, which is presented in table 3.5.

With this method the sensitivity and specificity of the ADOS and ADI-R were studied over their whole range of scores, instead of the cut-off criteria of the algorithms. In clinical practice, single fixed cut-off scores are needed to identify a child or adolescent as AD or PDD. However, we were also interested in how the ranges of scores on the algorithms were related to the classification with the DSM-IV-

TR. The larger the Area under the Curve (AuC), the better the criterion related validity of the ADOS or ADI-R compared to the clinical classification. In the total population, the AuC was good for both the ADOS and the ADI-R. However, the criterion related validity of the ADI-R was significantly higher than of the ADOS, compared to the clinical classification. When the criterion related validity of the instruments compared to the clinical classification was studied per IQ level, all AuC were high, except for children with mild mental retardation in the comparison between the ADOS and the clinical classification. This resembled the pattern as found with the logistic regression. Combined scores of the ADOS and ADI-R resulted in an even higher AuC, which was significantly higher than for the total score of the ADOS alone.

Table 3.5 Sensitivity and specificity of the ADOS and ADI-R compared to the DSM-IV-TR for PDD, tested with ROC analysis

	Level of MR	Obs	DSM-IV-TR PDD ROC analysis		
			Area under the Curve (AuC)	95.0% C.I. for AuC	
				Lower	Upper
ADOS	Profound	40	.930	.849	1
	Severe	53	.823	.707	.940
	Moderate	32	.873	.737	1
	Mild	59	.656 ¹	.514	.798
	Total	184	.808	.746	.870
ADI-R	Profound	40	.818	.638	.998
	Severe	53	.880	.789	.971
	Moderate	32	.935	.858	1
	Mild	59	.860	.768	.952
	Total	184	.883 ²	.835	.930
Combination ADOS/ADI-R	Total	184	.902 ³	.860	.944

¹ $p < .05$, compared with AuC of ADOS other levels of MR, ² $p < .05$, compared with AuC of ADOS Total, ³ $p < .01$, compared with AuC of ADOS Total

3.4 Discussion

The ADI-R and ADOS are the most extensive standardized instruments for diagnosing pervasive developmental disorders at this moment. Since the instruments are rather new, more research is needed, especially in specific subgroups, e.g. older children/adults, children with other pervasive developmental disorders than autism,

language impaired children and low functioning children and adolescents with mental retardation (Fombonne, 1992; Lord et al., 1993; Lord et al., 1994; Cox et al., 1999; Lord et al., 2000). This study examined the interrelationship between the ADI-R and ADOS and between the instruments and a clinical classification with the DSM-IV-TR, in a population with mental retardation.

The level of agreement between the diagnostic classification of the ADI-R and ADOS was not more than fair. We expected the concepts underlying the instruments to play a role in the disagreement, as the ADI-R differentiates between AD and non-AD, whereas the ADOS differentiates PDD-NOS as well. If the concepts played a major role, we would expect the agreement between the ADI-R and the ADOS to be higher for AD than for PDD, including AD and PDD-NOS. However, in our population we found no difference in the level of agreement using the wider PDD classification or the more restrictive AD classification of the ADOS in the comparison with the AD classification of the ADI-R. The PDD classification of the ADOS includes more children than the AD classification of the ADI-R, which makes sense because of the wider concept. On the other hand, the AD classification of the ADOS includes fewer children than the ADI-R, which could be explained by two factors. First, the source of information differs between the instruments: the ADI-R is administered with parents, the ADOS is based on a direct observation of the child. Second, the time period considered for the classification of the instruments differs as well. The ADI-R focuses on age 4-5, whereas the ADOS focuses on current behavior (Robertson, Tanguay, L'Ecuyer, Sims, & Waltrip, 1999). Symptoms existing at age 4-5 may have faded or even vanished at the time the child is observed with the ADOS. As expected according to this explanation, the agreement between the instruments is higher for younger children than for older ones. In younger children, actual differences in behavior measured with the ADI-R and the ADOS may be smaller, because of the smaller amount of time in which the behavior may have changed. Besides that, it may be easier for parents to remember the behavior of their child when answering questions about age 4-5 in the ADI-R.

To our knowledge, no data from other studies are available on the interrelationship between the ADI-R and ADOS. One study (Pilowsky, Yirmiya, Shulman, & Dover, 1998) reported on the interrelationship between the ADI-R and the Childhood Autism Rating Scale, CARS (Schopler, Reichler, De Vellis, & Daly, 1980; Schopler, Reichler, & Renner, 1988). This study supports the finding that

disagreements between the interview and the observation are due to sources of information and time and place limits, e.g. past versus current behavior. Taking these results into consideration, we conclude that the source of information and the time period seem to be the most important factors in the level of agreement between the classifications of the ADI-R and the ADOS in our population.

Besides the agreement between the instruments, the validity of the instruments compared with the current classification systems is important as well. To investigate this, we compared each of the instruments with the clinical classification of PDD-NOS and AD on the DSM-IV-TR. Compared to this clinical classification of PDD-NOS and AD, the ADOS seems to be more inclined to identify a child as PDD-NOS/AD than the ADI-R and even seems to be over-inclusive. On the other hand, the ADI-R seems to better identify children and adolescents who actually have PDD-NOS/AD according to the clinical classification. Age and level of functioning have no significant effect on the probability of agreement in classification between the ADI-R and DSM-IV-TR classification. For the ADOS the probability of agreement with the clinical classification increases when children get older, and is higher in the lower levels of functioning.

The same pattern is found when the criterion related validity of the instruments compared with the clinical classification of PDD was studied in more detail with a ROC analysis. This revealed that the overall interrelationship between both instruments and the clinical classification is very good. Both instruments seem to measure PDD/AD as described in the DSM-IV-TR validly. Nevertheless, again the interrelationship between ADOS and clinical classification is more pronounced in the lower levels of functioning than in the mild level of mental retardation.

One factor that may play a role in the very good relationship is the fact that in our study the clinical classification was based on information from the ADI-R and the ADOS and does not totally reflect the course in clinical practice. Hence, the agreement between the instruments and the clinical classification may be inflated, due to the fact that the only information available for the clinician was the information used for the classification of the instruments. However, we emphasize the fact that no algorithm information was available to the clinicians, which kept the independence as large as possible. The factor that plays a far greater role in our opinion, is the combination of information from various sources and time periods. This results in a more complete picture of the history, development and current behavior of the

individual, which is required for a diagnosis of a pervasive developmental disorder, as is known from clinical practice.

With respect to the interrelationship between the ADI-R, ADOS and clinical classification, we expected disagreement between the instruments and the clinical classification in the lower levels of functioning. Based on the literature on identifying pervasive developmental disorders in low functioning children, the instruments were expected to be over-inclusive in low levels of functioning compared to the clinical classification (Wing et al., 1979; Lord et al., 1993; Lord et al., 1994; DiLavore et al., 1995; Wing, 1997; Kraijer, 1997). Although this seems to be partially true for the ADOS, the ROC analyses for the different levels of functioning show a high criterion related validity for both instruments compared to the clinical classification in the low levels of mental retardation. This means that the interrelationship between the instruments and the clinical classification is very good even in these groups.

A very important factor to be considered in this issue is that the absolute number of individuals with a mental age of less than 18 months was only 26, with 20 individuals clinically classified as PDD. This means that the proportion of individuals with a pervasive developmental disorder is high, and the variance within the group is very small. Besides this, as mentioned before, the main issue seems the fact that limitations in differentiating pervasive developmental disorders and mental retardation in low functioning children, are not related to the instruments, but probably more so to the narrow behavioral repertoire of the children and to the concept of pervasive developmental disorders in general.

To conclude, the ADI-R and the ADOS provide the investigator with a lot of information on the social, communicative and stereotyped behavior of a child or adolescent and therefore can have great value for assessing autism and pervasive developmental disorders in children with moderate and mild mental retardation. With respect to very low functioning children however, diagnosing a pervasive developmental disorder is still difficult. With respect to the other levels of functioning, we see that the combination of both instruments is the best way to measure pervasive developmental disorders. This corresponds to the recommendations of the authors, to use the interview in combination with the observation, to collect complete information on the behavior of the child. As described by Robertson et al. (1999), the ADI-R and the ADOS measure slightly different aspects or manifestations of behavior that plays a role in pervasive developmental disorders. These aspects are valuably

united in the combination of the instruments, which would therefore be the most conservative approach to assigning a diagnosis. However, we would like to emphasize that the cut-off scores for these instruments are not recommended as the sole criteria, nor should be given undue weight when determining diagnoses. The instruments are intended as tools to facilitate a diagnosis in the context of a larger assessment.

Apart from that, one issue has to be raised from the experience in clinical practice. Filipek et al., (1999) wrote that 'the clinical time abroad is not as limited as with managed care in the US'. This certainly does not apply to the Netherlands, and we are afraid that the situation is no different in many other countries. The ADOS takes at least 45 minutes to administer and score, for the ADI-R the time needed is, in our experience and that of Poustka et al. (1996), 2.5 hours or even more. The time consuming aspect of the administration of the instruments, and of the useful training needed before using the instruments, are factors that complicate the use of the ADI-R and the ADOS in clinical practice, however great their value in the diagnostic process.

