Evaluating autism in a Chinese population: the Clinical Autism Diagnostic Scale

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Original article

Background: **The purpose of this study was to report on the psychometric measures and discriminatory function of a new diagnostic test for autism spectrum disorders, the Clinical Autism Diagnostic Scale (CADS).**

Methods: **The CADS was used to test 216 children in the study, including 86 with low-functioning autism specturm disorders (ASD), 16 children with high-functioning ASD, 16 with pervasive developmental disorder, not otherwise specified, 7 with Asperger syndrome, 65 with typical development, 11 children with language impairments and 15 with intellectual disabilities. Ages ranged from 38-73 months. Behaviors for the groups were compared across seven domains.**

Results: **The results indicated the instrument was reliable, valid, and successfully differentiated the different groups of children with and without autism. All ASD groups were found to display difficulties in the domains of sensory behaviors and stereotyped behaviors. The play and social domains were found to measure similar underlying concepts of behaviors, while the receptive language and expressive language domains were also found to measure similar underlying-language concepts. The group of children diagnosed as having low-functioning autism performed less well on all tested domains in the instrument than did the other three groups of children with ASD, and these other three groups each also presented unique patterns of behaviors and differed on individual domains.**

Conclusions: **CADS is a reliable and valid test. It successfully differentiates the abilities of children with ASD at different levels of functioning.**

World J Pediatr 2014;10(2):160-163

Key words: **autism spectrum disorders;**
diagnosis;
rating scale

Introduction

There are a few autistic-diagnostic tests that have been directly translated into Mandarin for use in China without standardization data.[1] The problem with directly translating diagnostic tests from one language to another is that many of the items are culturally and linguistically inappropriate.[2] Furthermore, the standardization population for these tests contains exclusively English speaking children, specifically American children, and not Chinese children, which can lead to misdiagnosis, unreliable results, and invalid conclusion.[3] A preferred approach is to standardize the diagnostic instrument for Chinese children, by Chinese professionals, in China.

The Clinical Autism Diagnostic Scale (CADS)[4] is the first instrument designed, developed, and standardized in China for diagnosing Chinese children with autism spectrum disorder (ASD). In its development, we took into account both cultural and linguistic variations, and selected items and questions appropriate for use with young Chinese children. We also addressed the needs and frequently asked questions proposed by professionals in China regarding how to evaluate children with ASD. The CADS has gone through an intensive study with children who were previously diagnosed as low functioning ASD (LFASD), high functioning ASD (HFASD), pervasive developmental disorder, not otherwise specified (PDD-NOS), and Asperger syndrome along with three matched control groups of children without autism, including typically developing children, children with specific language impairments-no autism, and children with intellectual disabilities-no autism. The purpose of this study was to report on the psychometric and

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doi: 10.1007/s12519-014-0466-0

discriminatory characteristics of the CADS across all of the groups of children, with and without autism, and to provide a valuable resource for further research on Chinese children.

Methods

Subjects

There were 216 children (175 males and 41 females) in the study across seven different groups of children: LFASD (*n*=86), HFASD (*n*=16), PDD-NOS (*n*=16), Asperger's (*n*=7), typical development (TD, *n*=65), language impairments (LI, *n*=11), and intellectual disability (ID, *n*=15). Table presents the background information for the groups, their mean ages, gender, and mean-scores for the total CADS, along with the standard deviations for the CADS scores.

All of the children spoke Mandarin as their primary language. They were divided within six age groups: 18-23 months, 24-36 months, 37-48 months, 49-60 months, 61-72 months, and 73 months or older.

All of the children were recruited from the Third Affiliated Hospital of Sun Yat-sen University. Children with ASD and ID had been previously diagnosed. All typical developing children were recruited from the Well baby care clinic in the same hospital without any known developmental disorders.

Instrument

The CADS[4] was designed and developed with seven broad domains. Play and social interactive domains,were designed to evaluate social behaviors; three other domains, motor behaviors, stereotyped behaviors, and sensory behavior, evaluated the area of repetitive/restrictive behaviors; while two domains, receptive language, and expressive language, evaluated the language area.

Individual behavior-items were assigned scores depending upon the severity of the involvement: 1 for no problem, 2 for symptoms sometimes present, and 3 for symptoms frequently present. On a few items, there were only two choices: either 1 for no problem or 3 for symptoms present.

Procedures

The evaluation took place in the Center for Developmental Disorders at the Third Affiliated Hospital of Sun Yat-sen University. A parent or caretaker was present throughout the testing session. Each child was administered the CADS. Testing was completed in a single setting. Breaks were provided when necessary. Total assessment time for the complete assessment was approximately one hour. ADI-R[5] and PEP-2[6] were administered to a randomly selected subject group of 54 subjects, along with a thirty-minute clinical protocol.

Each examiner was required to score ten children independently on the CADS before testing subjects for the study. Inter-scorer reliability was obtained by a simple percent agreement of the CADS test items between the senior examiner's re-scoring of the trained examiner's scores for the ten children. A criterion of 90 percent agreement was established on individual items.

Statistical analysis

Group comparisons were made using MANOVA and ANOVA first for the robust combined (i.e., total) scores and for individual domain scores. Post-hoc analyses, using Tukey B, were used to explore contrasts between separate groups.

Results

Group comparisons

Mean CADS scores were 193.80 for the males and 188.44 for the females with a non-significant difference in the gender (t=0.657, df =26.42, P=0.517) (Table). Therefore, the two gender-groups were combined for all other statistical analyses. Mean ages for the children were between 38 months to 50 months. A One-Way-ANOVA across ages by groups indicated no statistical differences in ages for total CADS scores (F=1.961, df=6.215, P=0.073) (Table).

Table. Background information of different age groups

Groups	*n*	Group18-23 mon	Group 24-36 mon	Group 37-48 mon	Group 49-60 mon	Group 61-72 mon	Group >73 mon	Mean age, mon	Gender Male	Gender Female	Mean total CADS score	Standard deviation
LFASD	86	17	15	9	16	14	15	48.4	77	9	203.5	36.6
HFASD	16	0	0	7	4	3	2	48.7	11	5	162.4	12.9
PDD-NOS	16	0	3	1	2	6	4	59.1	15	1	174.4	29.3
Aspgerger's	7	0	0	2	1	2	2	60.7	4	3	169.9	20.2
Typical developing	65	15	12	10	10	9	9	44.6	50	15	133.9	33.9
Language impaired	11	1	3	4	3	0	0	38.9	8	3	186.9	44.9
Intellectually disabled	15	1	3	3	3	2	3	50.5	10	5	173.5	18.9

LFASD: low functioning autism spectrum disorder; HFASD: high functioning autism spectrum disorder; PDD-NOS: pervasive developmental disorder, not otherwise specified; CADS: Clinical Autism Diagnostic Scale.

Reliability measures on the CADS

The CADS total scores were found to have high inter-reliability for all groups (inter-correlation matrix across domains ranged from r=0.363 to r=0.911, P=0.001). The internal consistency reliability coefficients were also high with the lowest being in the sensory behavior domain (alpha coefficient was 0.705) with an r^2 value of 0.497. This indicates a strong coefficient in this domain.

Also, the results of test-retest reliability measures were calculated on a subset of children with ASD (n=54). The range of test-retest reliability scores varied from 0.820 to 0.987. All were statistically significant at the 0.01 level. Furthermore, the inter-rater examiner reliability score, on the same set of children, was found to be high (r=0.945), indicating the CADS is a reliable instrument.

Validity measures on the CADS

Validity measures were determined by comparing the CADS domain scores with PEP-2 broad categories in a randomly selected group of children with ASD (n=54). All contrasts were found to be highly correlated. The CADS visual motor domain compared to the PEP-2 visual motor was significant (r=-0.814, P=0.001), the CADS receptive language domain compared to the PEP-2 Receptive language was significant (r=-0.809, P=0.001), the CADS expressive language domain compared to the PEP-2 expressive language was significant (r=-0.804, P=0.001), and the CADS sensory, stereotype, social, and play domains compared to the PEP-2 maladaptive behavior was significant (r=-0.750, P=0.001). These findings indicated the CADS was highly correlated to the PEP-2 broad categories.

Similar findings were found when the CADS domains were compared to the ADI-R with the same group of children (n=54). The ADI-R social subtest compared to the CADS social interaction domain was significant (r=0.864, P=0.001), the ADI-R sommunication subtest compared to the CADS receptive language and expressive language domains was significant (r=0.464, P=0.017), and the ADI-R repetitive behavior subtest compared to the CADS stereotyped behavior domain was significant (r=0.786, P= 0.001). The CADS was found to be highly correlated to the ADI-R.

Total CADS scores across seven groups

ANOVA statistics, for total CADS scores, across the seven groups, were found to be statistically different (F=27.67, df=6209, P=0.0001). Post-hoc mean comparisons (Tukey B, P=0.05) indicated the children with HFASD and the children who were TD were similar on the CADS total scores. The other groups of children, i.e., PDD-NOS, Asperger's, LI, and ID, scored similarly on the CADS total scores. The children with LFASD had the highest mean CADS score, therefore, yielding the poorest performance (Table) This indicated the children with LFASD differed from the PDD-NOS, Asperger's, LI and ID groups.

Cut-off points, sensitivity and specificity

A series of receiver operating characteristic (ROC) curves were analyzed to determine cutoff values on the CADS total scores across the different groups. For instance, when the HFASD group was compared to the TD group, the ROC curve showed the total CADS score to be 283 with a sensitivity and specificity of 0.65 and 0.80, respectfully. Similarly, two of the ASD groups, i.e., PDD-NOS and Asperger's, compared to the TD group yielded a ROC curve cut-off of 283 with a 0.79 score for both sensitivity and specificity. And, the LFASD group compared to the ID group yielded a ROC curve cut-off score of 283 with only a 0.50 score for both sensitivity and specificity.

Between-group analysis for combined scores and domain scores

A series of multivariate analysis of variances were computed on just the children diagnosed with ASD. The multivariate tests were computed for the total combined CADS scores and the individual seven domain scores.

Each of the analyses was statistically significant for the total combined scores (F=10.63, P=0.001, Eta^2=0.209) and all seven Domains: motor/vocal imitation (F=6.93, P=0.001, Eta^2=0.2147), stereotyped behaviors (F=12.59, P=0.001, Eta^2=0.238), sensory behavior (F=6.45, P=0.001, Eta^2=0.138), play behavior (F=5.83, P=0.001, Eta^2=0.126), social interactive behavior (F=7.77, P=0.001, Eta^2=0.161), receptive language (F=8.55, P=0.001, Eta^2=0.175), and expressive language (F=10.42, P=0.001, Eta^2=0.205).

Tukey B post-hoc mean comparisons indicated the children with LFASD differed from the other high-functioning ASD groups on the total domain and on the seven individual domains. In comparison, the three high-functioning ASD groups did not differ on the combined scores and on the expressive language domain. However, unique patterns of domain presentation were observed when comparing the subdomains among the three groups of high-functioning ASD. The PDD-NOS group differed from the Asperger's group on the motor/vocal imitation domain, play behavior domain, social interactive domain, and receptive language skills domain, and stereotyped behaviors domain; the Asperger's group differed from both HFASD and PDD-NOS groups on stereotyped behaviors domain; and the HFASD group also differed

from the PDD-NOS group on stereotyped behaviors domain. Finally, the three high-functioning ASD groups all differed from each other on the sensory domain.

Discussion

The purpose of this study was to report psychometric characteristics of a new Chinese diagnostic scale across different groups of Chinese children with ASD and across matched control groups of typically developing children, language impaired children-no autism, and intellectually disabled children-no autism. The seven groups were found to differ on the scores from all CADS domains, but the children with HFASD and the children with typical development were found to be quite similar in behaviors. Further analysis indicated that the children with LFASD differed on the CADS compared to the other three groups of children with ASD. The other three groups of children with ASD were found to be similar in most domains, except in the sensory domain where they all differed.

The current findings found the CADS was both reliable and valid. It was reliable on several dimensions including test-retest administration, inter-examiner reliability, split-half reliability, and item analysis. This indicated the CADS can be administered with confidence knowing that over time and between examiners reliable scores will be obtained. The CADS was also found to be valid when compared to two other commonly used diagnostic tests, PEP-2[6] and ADI-R.[5] This finding indicated the CADS measures common behaviors found in children with ASD that are routinely measured in other ASD tests.

The CADS was also found to have inter-domain relationships. For instance, the motor/vocal imitation domain had a moderate relationship with the two language domains (i.e., receptive language and expressive language) but a low relationship with the rest of the domains. This suggests that performance on the motor/vocal imitation domain is related to performances in language skills and, thus, can be regrouped under one common domain. Similarly, the domains for play and social behavior were highly related but not so with the other domains. Therefore, play and social behaviors were evidently measuring similar attributes and could be regrouped under one common domain. Thus, the original seven behavior domains can be regrouped into three broad categories: 1) stereotyped sensory behaviors; 2) play and social behaviors, and 3) motor, receptive and expressive language skills.

The CADS was found to have relatively high sensitivity and specificity scores for diagnosing the HFASD, PDD-NOS, and Asperger's syndrome groups, but low-to-moderate sensitivity and specificity scores for the LFASD group. Another important finding was the ability of the CADS to differentiate three groups of higher-functioning children across seven domains and the ability to differentiate the three groups of higher-functioning children to that of lower-functioning children with ASD. This indicates the CADS can diagnose and differentiate children with ASD at four different levels of functioning.

Funding: None.
Ethical approval: This research project was by the Institutional Review Board at North Carolina Central University.
Competing interest: None.
Contributors: Hao G and Layton TL proposed the project and wrote the first draft of the manuscript. All authors jointly developed the structure and arguments for the paper. Li DY collected the data. Hao G, Layton TL and Li DY analyzed the data. Hao G and Layton TL made critical revisions and approved the final version. Hao G is the guarantor.

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Accepted after revision August 7, 2012