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Clinical Validity of the ADI-R in a US-Based Latino Population

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Abstract

The Autism Diagnostic Interview-Revised has been validated as a tool to aid in the diagnosis of Autism; however, given the growing diversity in the United States, the ADI-R must be validated for different languages and cultures. This study evaluates the validity of the ADI-R in a U.S.-based Latino, Spanish-speaking population of 50 children and adolescents with ASD and developmental disability. Sensitivity and specificity of the ADI-R as a diagnostic tool were moderate, but lower than previously reported values. Validity of the social reciprocity and restrictive and repetitive behaviors domains was high, but low in the communication domain. Findings suggest that language discordance between caregiver and child may influence reporting of communication symptoms and contribute to lower sensitivity and specificity.

Keywords

ADI-R; Latino; Spanish version; autism

The use of standard diagnostic tools in assessing Autism Spectrum Disorder (ASD) is critical to the advancement of research and clinical practice for individuals with ASD. One standard instrument that is often used in combination with an observation tool, the Autism Diagnostic Interview – Revised (ADI-R; Lord et al. 1994) has been characterized as a 'gold-standard' parent interview in the assessment of children and adults with ASD (Risi et al. 2006). Initially developed as a research tool, the ADI-R has become more widely used in clinical settings to aid in the diagnostic evaluation of individuals with suspected ASD. The transition of the ADI-R into clinical practice, along with its extensive use across research studies, creates a strong demand for a comprehensive evaluation of its psychometric properties extending beyond the norming sample. To date, several studies have evaluated the validity of the ADI-R in identifying individuals with ASD. However, research on the use of the ADI-R and its applicability in accurately identifying individuals with ASD across non-English speaking populations is significantly lacking. The current study will evaluate the

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validity of the ADI-R in a U.S.-based Latino population to determine its efficacy in identifying children and adolescents with ASD who have Spanish-speaking parents.

The ADI-R is a semi-structured investigator-based interview administered by trained examiners to parents and/or caregivers of children and adults with suspected ASD. The interview is guided by the examiner, who solicits information from parents, records their responses, and codes the information provided. The comprehensive interview contains 93 items that tap into an individual's early developmental history and queries the individual's behavioral repertoire along three dimensions: social interactions, communication, and restricted, repetitive, and stereotyped behaviors. Parent/caregivers are asked to give examples for each item and this information is coded by the examiner for current and past behavior. Specific behaviors are coded based on their level of severity, with codes including 0 (no abnormality), 1(possible abnormality), 2 (definite autistic type abnormality), and 3 (severe autistic type abnormality). Higher item and domain scores indicate greater impairment. Up to 42 of the items are combined to create an algorithm to diagnose autism based on criteria from the ICD-10 (World Health Organization 1992) and the Diagnostic and Statistical Manual of Mental Disorders -IV (DSM-IV; American Psychiatric Association [APA] 1994). Although the DSM-5 (APA, 2013) has now been published with updated ASD criteria (social communication and restricted, repetitive patterns of behavior), to date, most children have had diagnoses based on the DSM-IV and this criteria continues to be the underlying basis of the ADI-R.

Validity of the ADI-R

Studies have explored the psychometric properties among individuals with and without ASD across specific age groups and across levels of intellectual ability. The original validation study on the English-language ADI-R was conducted by Lord et al. (1994), who compared children with Autistic Disorder/PDD to children with mental handicaps or language impairment. The results of this study suggested that the ADI-R had a high sensitivity (96%), and high specificity (92%). Several studies have now shown the validity and reliability of the ADI-R in toddlers and preschoolers may be lower than with older children with ASD (Chawarska et al. 2007; Cox et al. 1999). These individual findings are supported by a recent systematic review showing on average, the sensitivity of the ADI-R is much lower for children under 3 years of age (82%) than children over 3 years of age (91%; Falkmer et al. 2013). Furthermore, other studies have also found the individual's intellectual ability may have undue influence on the ADI-R, with higher false positive rates when used to assess individuals with intellectual disability (ID; Lord et al. 1997). However, other studies have reported adequate sensitivity and specificity of the ADI-R in identifying ASD in children and adults with ID (de Bildt et al. 2005; Sappok et al. 2013).

In summary, the validity of the English-language ADI-R has been challenging to discern as many studies vary in terms of the ASD severity (Autistic Disorder, Pervasive Developmental Disorder – Not Otherwise Specified), ages of inclusion (toddlers, preschoolers, youth), and points of comparison (algorithm item scores, domain scores, diagnostic classification). Studies to date have demonstrated individual (child's IQ; Falkmer et al. 2013) and administration factors (sequence of questions regarding current and past behaviors; Jones et

al. 2015) may influence the resulting outcomes of the ADI-R. These studies suggest that the utility of the English-language ADI-R may be inconsistent under certain conditions; however, it is even less clear how linguistic and cultural factors may influence the effectiveness of the ADI-R. Thus, it is critical to determine how these issues may be augmented when additional sociocultural factors come into play.

Validity of the ADI-R Across Cultures

Thus far, the ADI-R has been translated into 17 languages (Western Psychological Services 2015); however, the process by which the English-language ADI-R is translated and adapted to different cultures and languages is quite variable. To determine if the use of the ADI-R across cultures is valid, studies should evaluate not only the use of the ADI-R as a diagnostic tool, but also evaluate the equivalence of the tool within the culture (Magaña and Smith 2013). Studies of the ADI-R in Latino populations is rather limited, with many of these studies using the ADI-R to validate other tools, such as the M-CHAT (Albores-Gallo et al. 2012) or the Autism Detection in Early Childhood (ADEC; Hedley et al. 2010) in Latino populations. Even fewer have specifically investigated the properties of the ADI-R and its utility in assessing ASD in Latino populations.

Blacher et al. (2014) evaluated Latino and White children referred to an ASD screening clinic and compared information collected from their comprehensive intake form, the ADI-R and the Autism Diagnostic Observation Schedule (ADOS). The authors found that White mothers reported higher levels of communication symptoms than Latina mothers did on the ADI-R, however, regardless of diagnostic status, Latina mothers reported more developmental concerns prior to age 3 than White mothers. Other studies have also reported significant differences on other domains of the ADI-R. For example, Overton et al. (2007) found that Latino parents underreported difficulties in social interaction for their children; whereas Magaña and Smith (2006, 2013) showed that Latina mothers reported lower levels of restricted, repetitive, and stereotyped behaviors for youth with ASD when compared to White mothers. These findings suggest that ASD behaviors as reported on the ADI-R may vary significantly between Latino and White cultures, possibly resulting in significant discrepancies in the diagnostic process. It is unclear, however, whether these differences are associated with cultural perceptions of ASD or if these differences are tied to the cultural and linguistic equivalence of the content of the ADI-R.

Evaluations of other translated versions of the ADI-R in their respective cultures have also yielded useful, but somewhat inconsistent information. In Brazil, Becker at al. (2012) reported high sensitivity (100%) and specificity (100%) in a clinical sample of children and adolescents with diagnoses of ASD or moderate ID. These rates may be due to a more homogeneous control group than those in other studies, and differences in the way the ADI-R was administered and scored. Tsuchiya et al. (2013) found that the sensitivity and specificity of the Japanese version of the ADI-R was lower than Becker et al. but still high (92%, 89%, respectively) in a mixed clinical and community sample of children and adolescents. In a Greek clinical sample of children and youth, sensitivity was high (88%); however specificity was much lower (69%) in identifying autism with the Greek version of the ADI-R (Papanikolaou et al. 2009). These latter findings are similar to those reported in a

Finnish sample of registry-based diagnoses of autism, with high sensitivity of 95%, however, much lower specificity of 74% (Lampi et al. 2010). These findings highlight a need to further investigate the use of the ADI-R across cultures and languages.

Influence of Sociocultural Factors on ASD Assessment

Sociocultural factors may play a significant role in the use of the diagnostic tools in ASD. Recent work on cultural adaptations of diagnostic and educational tools have found that cultural perceptions of disabilities and autism may vary greatly and these variations in perceptions may alter how the parent reports and understands their child's development (Albores-Gallo et al. 2012; Grinker et al. 2015). For example, Latino families may perceive delayed language development to be within the norm and this in turn may influence when they seek out services for their child with ASD (Garcia et al. 2000). One issue unique to Latino families in the U.S. is that parents may be predominantly Spanish-speaking while their children may be bilingual or predominantly English-speaking (Block 2012; Kohnert and Bates 2002). This may lead to under reporting of communication symptoms as in the study by Blacher et al. (2014). In this study, Latina mothers reported fewer communication symptoms than White mothers, although direct observations indicated that Latino children exhibited greater impairment than White children. However, studies of the ADI-R in Latino families have not systematically investigated the role of parent-child language match in the reporting of communication symptoms. Additionally, behavior that is deemed acceptable and expected from young children may vary significantly across cultures and even within cultures. For example, one of the key items on the ADI-R asks about a child's use of eye contact. In many Asian and Latin American cultures, this behavior is not deemed appropriate for a child and therefore, the lack of eye contact may not be indicative of an underlying ASD symptomatology, but rather the child's observance of social norms. Therefore, past studies comparing the ADI-R in Latino populations with that of the majority culture in the U.S., may have been inherently biased as the equivalence of individual items, domains, and total scores have not been confirmed. However, as a diagnostic tool, the ADI-R should discriminate between children with ASD from other disabilities or impairments within a specified culture or population. Therefore, the present study will evaluate the validity of the ADI-R in distinguishing between Latino children with ASD and Latino children with DD, thereby holding cultural expectations and biases constant.

The Present Study

The goal of the present study was to evaluate the clinical validity of the ADI-R in a U.S.-based Latino, Spanish-speaking population in a sample of children and adolescents with ASD and other developmental disability or delay (DD). Our research questions are: 1) Are there significant differences in domain scores and diagnostic algorithm items of the ADI-R between the ASD and DD groups? It is expected that children and adolescents with ASD will receive higher item, domain, and total ADI-R scores when compared to children and adolescents with DD. 2) What are the sensitivity and specificity rates of the Spanish language ADI-R in identifying ASD within a clinical sample of children and adolescents with ASD or DD? Due to the limited research on the Spanish language ADI-R and its sensitivity and specificity in a U.S.-based Latino population, no predictions are made.

Rather, these findings will be explored as a comparison to other translated or adapted ADI-R studies across various cultures. 3) Does language discordance between parent and child contribute to lower validity in the communication domains? It is possible that if the parent speaks mostly Spanish and the child is more likely to speak English with peers and at school, the verbal communication questions may be less valid.

Methods

Participants

The present study consisted of 50 Spanish-speaking parents of children with either ASD or other developmental disability or delay (DD). Parents were recruited from developmental clinics and support groups in two Midwestern cities. Recruitment criteria included being a parent of Latin American descent whose primary language was Spanish and who had a child between the ages of 4 and 16 years with a clinically diagnosed developmental or neurological disability (e.g., communication disorder, intellectual disability, Down syndrome, or ADHD) or Autism Spectrum Disorder. One child was excluded from analyses due to unavailability of medical records to confirm clinical diagnosis. It was also required that the participating parent be the primary caregiver of the child. Only one father was interviewed, the remainder of parents were mothers.

Demographic information is presented for the ASD and the DD groups in Table 1. More than 77% of the parents had a high school education or less, and more than 65% had incomes under $30,000. The majority of families in our sample were of Mexican descent and the majority of parents were foreign born. All parents were fluent in Spanish and only 10% of the parents reported themselves to be fully bilingual in English and Spanish. In contrast, the majority of children in our study were born in the U.S. and the majority of children who were verbal were either fully bilingual or predominantly English-speaking. There were no significant differences in any of the demographic variables between the two groups.

Measures

The ADI-R is a standardized, investigator-based interview conducted with a primary caregiver, and is based on the International Classification of Diseases criteria for autism (ICD-10; World Health Organization 1992), and closely parallels the DSM-IV criteria (American Psychiatric Association 1994). It is investigator-based in that the structure and probes of the questions, recording and coding of responses is led by the examiner and their evaluation of the information provided by the caregiver. The interviewer codes behavioral descriptions given by the caregiver as 0 (no abnormality), 1(possible abnormality), 2 (definite autistic type abnormality), and 3 (severe autistic type abnormality). In the present study, scores of 3 were recoded to 2, as recommended by Lord et al. (1994). The 36 ADI-R items that comprise the ADI-R lifetime diagnostic algorithm were used in the present study. Items within each of the three domains, impairments in social reciprocity, impairments in communication, and restricted, repetitive, and stereotyped behaviors were summed to create summary scores for each domain. Age of first concern is also included in the overall algorithm and the score is based on whether there were any developmental concerns present

prior to 3 years of age. The Spanish version of the ADI-R used in the present study was originally translated and back translated by Vrancic et al. (2002) and is now the official Spanish version obtained through Western Psychological Services.

To confirm the diagnosis of the children, medical records were obtained for the children with the consent of the parents. Two clinicians who were not involved in administering the ADI-R for our study (a developmental psychologist and a speech and language pathologist) independently reviewed the medical records. Using methods similar to those used in the Autism and Developmental Disability Monitoring (ADDM) Network (Centers for Disease Control and Prevention 2014), the clinicians reviewed the records using a coding scheme based on the DSM-IV (American Psychiatric Association 1994) criteria for ASD including Autistic Disorder, PDD-NOS, or Asperger Disorder. The DSM-IV was used for criteria because the DSM-5 was published in 2013, after most of the obtained medical records were created. The clinical reviewers determined the child to have Autistic Disorder, PDD-NOS, or Asperger Disorder if the diagnosis was written in the record by a qualified professional or if symptoms that met DSM-IV criteria were documented in the record. Children who were included in the DD group did not meet criteria for ASD based on review of their clinical records and symptoms reported. After independently coding the cases, the reviewers met to determine consensus. For cases in which there was disagreement, the two reviewers and the principal investigator (PI, second author) made a final determination of the diagnosis. In all cases in which the child did not have an ASD diagnosis, the child had another developmental or neurological disability and were classified as DD for the purposes of the study. This classification was chosen as not all children had an accompanying diagnosis of Intellectual Disability (ID), however, they all demonstrated clinical symptoms characteristic of developmental or neurological disability. Out of the 50 children in the study, 29 had an ASD diagnosis (19 with Autistic Disorder and 10 with PDD-NOS or Asperger Disorder) and 21 had a diagnosis of another developmental or neurological disorder (e.g., communication disorder, intellectual disability, Down syndrome, or ADHD).

A child language assessment instrument was developed to be administered before the language questions of the ADI-R in order to determine whether the child was bilingual and/or more likely to speak English. If the child was verbal and 5 years old or older, parents were asked 1) if their child only understands and uses Spanish, 2) understands and uses both, but Spanish is stronger, 3) understands and uses both but English is stronger, and 4) is bilingual, and can use both languages equally. The variable was recoded, collapsing values 3 and 4 into 1 to indicate fluency in English, and all else into 0. This was done to capture whether there was a match in dominant language between parent and child.

Sociodemographic variables included the following parent characteristics: parent age, marital status, level of education, annual household income, employment status, place of birth, ethnicity, and language use (good or excellent English versus poor or fair English); and child characteristics: presence of an intellectual disability, verbal status, gender, age and place of birth.

Procedures

The interviews were conducted in office space at the University by bilingual interviewers and lasted on average 3 hours. All interviews were conducted in Spanish and only the parent was required to be present (not the child). First, the interviewer reviewed the Institutional Review Board (IRB) approved informed consent with the parent, which asked for consent to participate in the interview and for parental consent to obtain their child's medical record. Parents also signed an IRB approved Health Insurance Portability and Accountability Act (HIPAA) form outlining the information needed from the child's medical record. In order to ensure that interviewers were blinded to the child's diagnosis while administering the ADI-R, they were instructed to complete page 6 of the ADI-R (questions about child's education, diagnoses, and medication use) and the demographics questionnaire, after the remainder of the ADI-R was administered. All procedures were conducted in Spanish. Lastly, parents received $25 each for their participation.

Four bilingual graduate level interviewers conducted the ADI-R interviews. One had a master's degree in social work, two were graduate students (counseling psychology and special education), and one was a licensed clinical psychologist. Two of the interviewers were trained to achieve research reliability by a Certified Independent Trainer and two were trained by researchers who were certified in using the ADI-R for research purposes and monitored by the PI who is also research certified in using the ADI-R. Inter-rater reliabilities between interviewers and certified researchers were .90 and above.

Analyses

Analyses of Variance (ANOVA) were conducted on the individual diagnostic algorithm items and summary scores for the three domains of the ADI-R (social reciprocity, communication, and repetitive behaviors and restricted interests). Rates of sensitivity, specificity, positive predictive value, and negative predictive value were measured across overall domain criteria and across each domain and age of first concern. These analyses would allow us to further evaluate how each individual domain criteria contributes to the identification of ASD in our sample. Sensitivity was categorized as the percentage of children with clinical diagnoses of ASD who were identified as having ASD on the ADI-R. Specificity was determined by the percentage of children with clinical diagnoses of DD who did not meet criteria for ASD on the ADI-R. The positive predictive value represented the percentage of children with clinical diagnoses of ASD from all children who were classified as having ASD on the ADI-R. The negative predictive value indicated the percentage of children with clinical diagnoses of DD from all children who were classified as non-ASD on the ADI-R. Finally, to assess the role of language discordance between parent and child, an ANOVA was conducted on the individual diagnostic algorithm items and summary scores for the communication domain within each clinical group.

Demographic variables (e.g., presence of ID, age, gender) were not included in any of the analyses as no significant differences were found between groups (all p's > .05, see Table 1).

Results

Research Question 1: Group Differences across ADI-R Lifetime Domain and Item Scores

Mean scores for the three domains and algorithm items were analyzed in a one-way ANOVA to identify any significant differences between the ASD and DD groups based on clinical diagnosis from medical records. Overall, significant differences were found on the social interaction domain, $F(1, 48) = 10.06$, $p = .003$, partial $\eta^2 = .17$, and the restricted, repetitive, and stereotyped behavior domain, $F(1, 48) = 14.31$, $p < .001$, partial $\eta^2 = .23$. There were no significant differences for the verbal communication domain, $F(1, 31) = 3.53$, $p = .070$, partial $\eta^2 = .10$, or nonverbal communication, $F(1, 48) = 1.59$, $p = .214$, partial $\eta^2 = .03$ between the ASD and DD groups. Thus, at the domain level, only difficulties in social reciprocity and restricted, repetitive, and stereotyped behaviors were distinct between children with ASD and children with DD.

Further analyses were conducted on the individual items within the social reciprocity (15 items), nonverbal communication (7 items), verbal communication (6 items), and the restricted, repetitive, and stereotyped behavior (8 items) domains to identify the specific impairments that distinguish between children with ASD and children with DD. Within the social reciprocity domain, eight items were significantly different between children with ASD and children with DD (see Table 2). The largest differences were observed in the range of facial expressions, showing and directing attention, and offering comfort. Within the communication items, differences were found between children with ASD and children with DD on three nonverbal items (pointing to express interest, nodding head, shaking head) among all children and only one verbal item (stereotyped utterances/echolalia) among all verbal children (see Table 3). Finally, among the restricted, repetitive, and stereotyped behavior items, significant differences between children with ASD and children with DD were observed for six items, with the largest differences seen for circumscribed interests, repetitive use of objects, and unusual sensory interests (see Table 4). No differences were observed for unusual preoccupations between children with ASD and children with DD.

Research Question 2: Clinical Validity: ADI-R Consensus with Clinical Diagnoses

Children’s clinical diagnoses were compared to their classification based on the diagnostic algorithm cutoff scores for social reciprocity, communication, restricted, repetitive and stereotyped behaviors, and age of first concern. Overall, the Spanish ADI-R showed moderate sensitivity (69.0%), moderate specificity (76.2%), high positive predictive value (80.0 %,), and moderate negative predictive value (64.0%; see Table 5). At the individual domain level, social reciprocity had the highest sensitivity (93.1), yet the lowest specificity (33%).

Further comparisons were made to evaluate the clinical validity across domains and age of concern to determine which ADI-R lifetime domain cutoffs were most effective in correctly classifying children with ASD. Overall, the combination that resulted in the highest sensitivity, specificity, positive predictive value, and negative predictive value was the restricted, repetitive, and stereotyped behavior domain and age of first concern (sensitivity = 79.3%, specificity = 76.2%, positive predictive value = 82.1%, negative predictive value =

72.7%). Adding the social reciprocity cutoff to this combination did not contribute to the sensitivity, specificity, positive predictive value, or negative predictive value, whereas adding the communication cutoff decreased the sensitivity by 10%, decreased the positive predictive value by 2%, and decreased the negative predictive value by 8%.

Additional comparisons were conducted to determine if the clinical validity of the ADI-R improved in the detection of Autism among children with a clinical diagnosis of Autistic Disorder or DD. These analyses excluded children with clinical diagnoses of PDD-NOS and Asperger Disorder. These analyses found overall sensitivity was higher (78.9%), specificity remained the same (76.2%), the positive predictive value decreased (75.0%), and the negative predictive value increased (80.0%) when compared to the clinical validity of the ADI-R in detecting ASD (see Table 6). The overall combination that produced the best clinical identification of autism was the restricted, repetitive, and stereotyped behavior domain and age of first concern (sensitivity = 89.5%, specificity = 76.2%, positive predictive value = 77.3%, negative predictive value = 88.9%). Adding the social reciprocity domain did not result in any change in the clinical validity. These analyses revealed the sensitivity of the Spanish ADI-R improves when it is used to detect autism specifically and the best clinical discrimination between autism and DD is associated with the restricted, repetitive, and stereotyped behavior domain and age of first concern cutoff scores.

Research Question 3: Role of Parent and Child Language on Validity of Spanish ADI-R

To investigate the influence of parent and child language experience on the validity of the Spanish ADI-R, an additional ANOVA was conducted across language concordant (parent and child speak predominantly Spanish) and language discordant groups (parent was predominantly Spanish-speaking and child was bilingual or predominantly English-speaking) on the communication domain and items within each clinical group. It was not expected that parent-child language match would affect the ASD symptoms children within each clinical group presented, but rather, the parent-child language match might influence the *report* of communication difficulties. These analyses were conducted only for children who were reported be verbal at the time of the ADI-R interview and were age 5 or older (ASD $n = 18$, DD $n = 13$).

Results of the ANOVA showed parents of children with ASD reported lower impairments in spontaneous imitation of actions, $F(1, 16) = 9.44$, $p = .007$, partial $\eta^2 = 0.37$, and imitative social play, $F(1, 16) = 25.86$, $p < .001$, partial $\eta^2 = 0.62$, when their language proficiencies did not match their child's. No other significant differences were observed on individual verbal items or overall nonverbal and verbal communication scores for children with ASD (see Table 7). Because the sample sizes are very small in these comparisons, effect sizes based on the partial η^2 were examined. The general pattern in the overall scores shows the ASD concordant group reported more impairment than the ASD discordant group in nonverbal and verbal communication and the partial η^2 of .06 for each of these domains suggests moderate effect sizes (Cohen 1988). The results for children with DD showed a more distinct but opposite pattern, with parents reporting greater impairments in pointing to express interest, $F(1, 11) = 7.69$, $p = .018$, partial $\eta^2 = 0.41$, and pronominal reversal, $F(1, 11) = 5.30$, $p = .042$, partial $\eta^2 = 0.33$, when the parent's language proficiencies did not

match their child's. No other differences were found within the DD group on items or overall domain scores. These differences between ASD and DD groups suggest that when parents' language differs from their child's, the parent may interpret communicative behaviors in ways that are not accurately reflected on structured interviews.

Discussion

This is the first study to examine the validity of the Spanish version of the ADI-R in a U.S.-based Latino population. It is important that diagnostic instruments are not only translated into other languages, but are also culturally validated for specific populations (Bravo et al. 1993; Sánchez et al. 2006). This is particularly true given the increased racial and ethnic diversity in the United States and the need to use standardized instruments throughout the world (Lord and Jones 2012). The purpose of this study was to determine the clinical validity of the Spanish ADI-R in a sample of Latino parents of children with either an ASD or DD in the United States. The U.S. Spanish-speaking population is distinct from populations within Spanish-speaking countries because while Latino immigrant parents may be predominantly Spanish-speaking, their children may be bilingual or predominantly English-speaking. These dynamics present unique challenges when diagnosing U.S. based Latino children (Block 2012; Kohnert and Bates 2002).

For our first research question, differences between the ASD and the DD clinical groups across the ADI-R lifetime domain and item scores were examined. The results showed significant differences between the ASD and DD groups in the social reciprocity domain. In this domain, the majority items were significantly different with the ASD group showing greater impairment than the DD group. These findings suggest good discrimination between ASD and DD on social reciprocity, although validity was not as strong as findings from the original ADI-R validation study (Lord et al. 1994). In the original study, researchers found significant differences in all social reciprocity items between the autistic group (n=25) and the DD group (n=25) in a predominantly white (82%) sample (Lord et al. 1994). The total domain score for social reciprocity among children with ASD in our study was similar to the original study, 20.7 in our study compared to 19.0 in the original study (Lord et al. 1994). However, the score for the DD group in our study was higher, 14.0 compared to 4.2 in the original study. It may be that differences in the validity of the ADI-R reflect a lack of consistency of clinical diagnosis across clinical settings.

No differences were found between the two groups on the nonverbal communication domain, and a borderline difference in the verbal communication domain. These results suggest questionable discrimination between the two groups on the communication domains and contrasts the results in the original validation study in which both of these domains were significantly different between the two groups (Lord et al. 1994). The implications of language will be discussed in more detail later.

With respect to the restrictive and repetitive behavior domain, the two groups were significantly different, with the ASD group reporting greater impairment. The majority of items in this domain were significantly different with the exception of unusual

preoccupations. These findings are consistent with findings from the Lord et al. study in this domain and suggest good validity.

In our second research question, the clinical validity of the Spanish ADI-R was assessed by comparing the children's clinical diagnosis to their autism classification based on the diagnostic algorithms cutoff scores for social reciprocity, communication, restricted, repetitive and stereotyped behaviors, and age of first concern. Using the clinical diagnosis of ASD, a sensitivity rate of 69.0% and a specificity rate of 76.2% was found among the Latino children in our sample. These rates are much lower than those in the original validation study, which reported rates of 96% and 92% respectively (Lord et al., 1994). They are also lower than those found in international validation studies from Japan, 92% and 89% respectively (Tsuchiya et al. 2013); and Brazil, 100% for both sensitivity and specificity (Becker et al. 2012). The sensitivity rate in our study is lower than reported in the validation study conducted in Greece (88%); however, the Greek study reported lower specificity (69%) than ours (Papanikolaou et al. 2009). Because the ADI-R was originally intended to aid in the diagnosis of Autistic Disorder, additional analyses were conducted using only those children with a clinical diagnosis of Autism or Autistic Disorder compared to children with other developmental disabilities or delay. In these analyses, the overall sensitivity increased to 78.9%, however, the specificity stayed the same. It is important to note the specificity of any of the three domains separately is relatively low, with the exception of restrictive and repetitive behaviors. Therefore, the presence of restrictive and repetitive behaviors may be a stronger indicator of ASD than the other two domains independently. This suggests that additional information regarding children's social reciprocity and communication should be solicited in addition to using the ADI-R in clinical evaluations (Mazefsky et al. 2013).

As mentioned earlier, a unique feature of Spanish-speaking families in the U.S. is that parents may be predominantly Spanish-speaking, yet their children may be bilingual or predominantly English-speaking. This dynamic may especially impact the communication domains and items. Therefore, in research question 3, parents and verbal children who were language concordant (both parent and child spoke predominantly Spanish) were compared with parents and children who were language discordant (parent was predominantly Spanish-speaking and child was bilingual or predominantly English speaking). The analyses showed that the parents in the language discordant ASD group reported lower levels of impairment on communication items than parents in the concordant group. In other words, if the children spoke more English, Spanish-speaking parents reported lower impairments than if the children spoke more Spanish, suggesting that parents may not fully know the language abilities of their children when they speak English and may underreport impairment. This is in line with research suggesting that parents may accommodate or compensate for their child's delays when asked open-ended questions (Coonrod and Stone 2004). The opposite effect was found among parents and children in the DD group—when there was language discordance between parent and child, parents reported more impairment in the communication items. These findings suggest that language discordance may be contributing to the lower discriminate validity in the communication domain and items, and may contribute to lower sensitivity and specificity ratings overall. Thus, the Spanish instrument may not be valid when the parent and child's Spanish language proficiencies

differ. Clinicians and researchers should be cautious in interpreting the communication domain within U.S.-based Latino populations. This research suggests that clinicians and researchers should use a language measure of the children similar to the one used in our study to help interpret results when using the Spanish version of the ADI-R in the United States.

This study has several limitations. First, the clinical diagnosis was based on medical record review and not assessed by the research team. While record review methods similar to those used by CDC in the autism surveillance studies (Centers for Disease Control and Prevention 2014) were employed in the current study, methods of diagnosis by medical professionals can vary across clinical settings, making it difficult to verify the accuracy of the diagnosis and consistency of the diagnostic process. It is possible these results reflect on the validity of the clinical diagnosis in addition to the validity of the ADI-R. Second, the sample size of children who were verbal was very small, making the detection of effects more challenging in the language validity analysis. A larger sample of verbal children would allow researchers to determine whether sensitivity and specificity is improved among those families with language concordance. Third, this study is only representative of Spanish-speaking Latinos residing in the Midwestern region of the United States, and predominantly of Mexican descent, limiting the generalizability of the findings.

Despite the limitations, the present results suggest the ADI-R can be a useful tool in the diagnosis of Latino children of Spanish-speaking parents in the United States. Both the social reciprocity and restrictive and repetitive behavior domains discriminate well between children with ASD and children with other DD. The restrictive and repetitive behavior domain is a stronger indicator of ASD as the specificity rate is the highest for this domain. The current study found the validity of the communication domain is questionable and suggests extra caution should be taken in cases in which the parent speaks predominantly Spanish and the child is more likely to speak English, as parents may underreport impairment. It is recommended that clinicians consider direct child observations in both languages (if child is bilingual) to determine the presence or absence of communication difficulties characteristic of ASD.

Future research is needed with a larger sample to explore the language issue in more depth among this population. Larger studies could adequately assess the factor structure of the Spanish ADI-R to identify the convergence of symptoms within a Latino population. Studies of factor analyses have been conducted on the English ADI-R (Lecavalier et al. 2006; Tadevosyan-Leyfer et al. 2003), and have reported distinct factors in number and type from the original validation study (Lord et al. 1994). Additional studies could evaluate how parents interpret children’s communicative development and compare their reports with observations of children’s communication skills. It would also be important to evaluate whether similar patterns are observed in the communication reported by other non-English speaking families in the United States. This would yield crucial information for clinicians to consider in the assessment of children from culturally and linguistically diverse populations. In addition, because the DSM-5 has changed some of the criteria for diagnosis to encompass the spectrum of autism disorders, future research is needed to determine the validity of the ADI-R compared to the DSM-5 classification.

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Table 1

Demographic Characteristics by ASD and DD Groups

	ASD ***n*** **= 29**	**DD** ***n*** **= 21**	**Total** ***n*** **= 50**
Parent characteristics			
Mean age (SD)	40.01 (6.32)	39.69 (5.50)	39.87 (5.93)
Married or living together (%)	78.6%	81.0%	79.6%
Level of education			
High School or Less (%)	71.4%	85.7%	77.6%
Annual Household Income			
Less than $30,000 (%)	60.7%	71.4%	65.3%
Employed (%)	21.4%	33.3%	26.5%
Foreign-born (%)	96.6%	95.2%	96.0%
Ethnicity			
Mexican (%)	79.3%	95.2%	86.0%
Language use			
Good/excellent English (%)	10.7%	9.5%	10.2%
Child characteristics			
Mean age (SD)	9.12 (3.40)	8.79 (3.46)	8.98 (3.39)
Male (%)	75.9%	81.0%	78.0%
Where child born			
United States (%)	100%	95.2%	98.0%
Intellectual Disability (%)	20.7%	14.3%	18.0%
Language			
Verbal (%)	65.5%	66.7%	66.0%
Bilingual or more English (%) *	55.2%	47.6%	52.0%

Note:

* based on who were verbal; No group comparisons were significantly different, all *p*'s > .05.

Table 2

Impairments in Social Reciprocity Domain and Items

	ASD (*n* = 29)		DD (*n* = 21)		*F*	Partial η^2
	M	*SD*	*M*	*SD*		
Social Reciprocity Domain	20.72	6.50	14.00	8.50	10.06**	.17
Direct gaze	1.59	0.63	1.14	0.79	4.87*	.09
Social smiling	1.55	0.74	1.05	0.86	4.93*	.09
Range of facial expressions	1.48	0.78	0.81	0.87	8.16**	.15
Interest in children	1.59	0.78	1.14	0.91	3.42†	.07
Response to approaches	1.31	0.81	1.05	0.86	1.22	.02
Showing and directing attention	1.66	0.67	1.10	0.77	7.52**	.14
Offering to share	1.66	0.67	1.29	0.85	2.97†	.06
Seeking to share enjoyment	1.55	0.69	1.00	0.89	6.10*	.11
Use of other's body	1.10	0.82	0.62	0.74	4.63*	.09
Offers comfort	1.62	0.73	0.90	0.83	10.46**	.18
Quality of social overtures	1.38	0.82	0.76	0.89	6.43*	.12
Inappropriate facial expressions	1.03	0.68	0.67	0.66	3.66†	.07
Appropriateness of social overtures	1.55	0.78	1.19	0.93	2.22	.04
Friendships	1.03	0.94	0.81	0.98	0.67	.01
Imaginative play with peers	0.62	0.90	0.48	0.81	0.34	.01

** $p < .01$;

* $p < .05$;

† $p < .10$

Table 3

Impairments in Nonverbal and Verbal Communication Domain and Items

	ASD (*n* = 29)		DD (*n* = 21)		*F*	Partial η^2
	M	*SD*	*M*	*SD*		
Nonverbal Communication Domain	6.55	4.19	5.00	4.45	1.59	.03
Pointing to express interest	1.41	0.78	0.90	0.89	4.61*	.09
Conventional gestures	1.31	0.93	1.14	0.96	0.38	.01
Nodding head	1.10	0.98	0.43	0.81	6.68*	.12
Head shaking	1.03	0.98	0.38	0.74	6.59*	.12
Spontaneous imitation of actions	0.59	0.87	0.86	0.91	1.14	.02
Imaginative play	0.69	0.93	0.62	0.80	0.08	.00
Imitative social play	0.41	0.73	0.67	0.91	1.18	.02
Verbal Communication Domain [a]	11.63	5.77	8.00	5.08	3.53†	.10
Stereotyped utterances/echolalia	1.26	0.81	0.57	0.76	6.26*	.17
Social verbalization/chat	1.42	0.77	1.14	0.86	0.95	.03
Reciprocal conversation	1.37	0.76	1.14	0.86	0.63	.02
Inappropriate questions/statements	0.95	0.78	0.64	0.84	1.15	.04
Pronominal reversal	1.32	0.89	1.07	0.92	0.60	.02
Neologisms/idiosyncratic language	0.63	0.76	0.50	0.85	0.22	.01

*p <05;

†p < .10

[a]Verbal communication items are for verbal participants only, ASD *n* = 19, DD *n* = 14

Table 4

Impairments in Restricted Interests and Repetitive Behaviors Domain and Items

	ASD (*n* = 29)		DD (*n* = 21)		*F*	Partial η^2
	M	*SD*	*M*	*SD*		
Restricted, Repetitive, and Stereotyped Behaviors Domain	5.55	2.91	2.48	2.73	14.31**	.23
Circumscribed interests	1.10	0.98	0.38	0.67	8.56**	.15
Unusual preoccupations	0.21	0.49	0.29	0.64	0.24	.01
Compulsions/rituals	0.86	0.95	0.29	0.64	5.76*	.11
Hand/finger mannerisms	1.00	0.93	0.48	0.81	4.31*	.08
Other complex mannerisms	0.93	0.92	0.38	0.74	5.08*	.10
Repetitive use of objects	1.38	0.82	0.48	0.75	15.86**	.25
Unusual sensory interests	1.10	0.77	0.24	0.44	21.36**	.31
Verbal rituals [a]	0.79	0.92	0.29	0.61	3.17†	.09

** $p < .01$;

* $p < .05$;

† $p < .10$

[a] Verbal communication items are for verbal participants only, ASD $n = 19$, DD $n = 14$

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Table 5

Clinical Validity of Spanish-ADI-R with Clinical Diagnosis of ASD

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
All Domains and Age of Concern	69.0%	76.2%	80.0%	64.0%
By Individual Domain without Age of First Concern				
Social Reciprocity	93.1%	33.3%	65.9%	77.8%
Communication	65.5%	61.9%	70.4%	56.5%
Restricted Interests, Repetitive Behaviors	79.3%	66.7%	76.7%	70.0%
By Individual Domain with Age of First Concern				
Social Reciprocity	93.1%	38.1%	67.5%	80.0%
Communication	79.3%	52.4%	69.7%	64.7%
Restricted Interests, Repetitive Behaviors	79.3%	76.2%	82.1%	72.7%

Table 6

Clinical Validity of Spanish-ADI-R with Clinical Diagnosis of Autism

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
All Domains and Age of Concern	78.9%	76.2%	75.0%	80.0%
By Individual Domain				
Social Reciprocity	100.0%	33.3%	57.6%	100.0%
Communication	84.2%	47.6%	59.3%	76.9%
Restricted Interests, Repetitive Behaviors	89.5%	66.7%	70.8%	87.5%
By Individual Domain & Age of First Concern				
Social Reciprocity	100.0%	38.1%	59.4%	100.0%
Communication	84.2%	52.4%	61.5%	78.6%
Restricted Interests, Repetitive Behaviors	89.5%	76.2%	77.3%	88.9%

Table 7

Impairments in Nonverbal and Verbal Communication Domain and Items by Parent-Child Language Agreement

ASD Group	**Concordant (*n* = 4)**		**Discordant (*n* = 14)**		***F***	**Partial η^2**
	M	***SD***	***M***	***SD***		
Nonverbal Communication Domain	7.25	6.13	4.79	3.77	1.02	.06
Pointing to express interest	1.25	0.96	1.43	0.76	0.16	.01
Conventional gestures	0.75	0.96	1.21	0.97	0.71	.04
Nodding head	0.50	0.93	0.79	0.97	0.27	.02
Head shaking	1.00	1.15	0.79	0.97	0.14	.01
Spontaneous imitation of actions	1.25	0.96	0.14	0.53	9.44**	.37
Imaginative play	1.00	1.15	0.36	0.74	1.83	.10
Imitative social play	1.50	1.00	0.07	0.27	25.86**	.62
Verbal Communication	14.50	5.80	11.29	5.68	0.99	.06
Stereotyped utterances/echolalia	1.25	0.96	1.36	0.74	0.06	.00
Social verbalization/chat	1.25	0.96	1.50	0.76	0.30	.02
Reciprocal conversation	1.75	0.50	1.21	0.80	1.57	.09
Inappropriate questions/statements	1.50	1.00	0.86	0.66	2.36	.13
Pronominal reversal	1.50	1.00	1.29	0.91	0.17	.01
Neologisms/idiosyncratic language	0.25	0.50	0.79	0.80	1.60	.09
DD Group	Concordant (*n* = 4)		Discordant (*n* = 9)		*F*	Partial η^2
	M	*SD*	*M*	*SD*		
Nonverbal Communication Domain	2.25	2.63	3.89	3.76	0.61	.05
Pointing to express interest	0.00	0.00	1.11	0.78	7.69*	.41
Conventional gestures	1.25	0.96	1.11	1.05	0.05	.01
Nodding head	0.00	0.00	0.00	0.00	*a*	*a*
Head shaking	0.00	0.00	0.11	0.33	0.42	.04
Spontaneous imitation of actions	0.50	1.00	0.89	0.93	0.47	.04
Imaginative play	0.25	0.50	0.33	0.71	0.05	.00
Imitative social play	0.25	0.50	0.33	0.71	0.05	.00

ASD Group	Concordant (*n* = 4)		Discordant (*n* = 14)		*F*	Partial η^2
	M	*SD*	*M*	*SD*		
Verbal Communication	6.00	3.92	9.33	5.50	1.18	.10
Stereotyped utterances/echolalia	0.50	0.58	0.67	0.87	0.12	.01
Social verbalization/chat	1.50	0.58	1.11	0.93	0.58	.05
Reciprocal conversation	1.25	0.96	1.11	0.93	0.06	.01
Inappropriate questions/statements	0.25	0.50	0.89	0.93	1.63	.13
Pronominal reversal	0.25	0.50	1.33	0.87	5.30*	.33
Neologisms/idiosyncratic language	0.25	0.50	0.67	1.00	0.60	.05

** $p < .01$;

* $p < .05$;

[a] analyses were not run due to no variation between language concordance groups