Journal of Intellectual & Developmental Disability, June 2015; 40(2): 1–23

Manuscript ID: CJID-2013-0080.R3

Running header: *Autism screening using the ADEC*

Approximate word count: 6,236 words

Keywords: *autism, early detection, screening, ADEC*

ORIGINAL ARTICLE

Effectiveness of the ADEC as a Level 2 screening test for young children with suspected autism spectrum disorders in a clinical setting

LEIGH DIX[1], RACHAEL FALLOWS[1] & GLYNIS MURPHY[2]

[1]*Child and Adolescent Community Health, WA Health, Perth, Australia, and* [2]*Tizard Centre, University of Kent, Canterbury, Kent, UK*

Correspondence: Leigh Dix, Bentley Child Development Service, corner Andrea Way and Treasure Road, Queens Park, WA 6107, Australia. Email: leigh.dix@health.wa.gov.au

Abstract

Background The Autism Detection in Early Childhood (ADEC) is a clinician-administered, Level 2 screening tool. A retrospective file audit was used to investigate its clinical effectiveness.

Method Toddlers referred to an Australian child development service between 2008 and 2010 (N = 53, M age = 32.2 months) were screened with the ADEC. Their medical records were reviewed in 2013 when their mean age was 74.5 months, and the original ADEC screening results were compared with later diagnostic outcomes.

Results The ADEC had good sensitivity (87.5%) and moderate specificity (62%). Three behaviours predicted autism spectrum disorders (ASDs): response to name, gaze switching, and gaze monitoring ($p \leq .001$).

Conclusions The ADEC shows promise as a screening tool that can discriminate between young children with ASDs and those who have specific communication disorders or developmental delays that persist into middle childhood but who do not meet the criteria for ASDs.

Introduction

Given that autism spectrum disorders (ASDs)[1] are now thought to occur in around 1 in 88 births (Centres for Disease Control and Prevention, 2012), there is a clear need for reliable and valid screening tools. If reliable screening tools can lead to earlier diagnosis, a number of early interventions that have been found to be effective in reducing symptoms of ASDs and improving function could be implemented (Darrou et al., 2010; Dawson et al., 2010). In an effort to improve early detection, a number of autism-specific screening tools for toddlers have been developed, including an Australian tool, the Autism Detection in Early Childhood ADEC (Young, 2007).

Screening tests are typically classified as either Level 1 or Level 2 (Filipek et al., 1999; Stone, Coonrod, Turner, & Pozdol, 2004). Level 1 tests are usually delivered in primary care settings and are designed to identify "at-risk" children from the general population of typically developing peers. Level 2 screening tests are used to assess children already identified as at risk and aim to distinguish children with a specific condition (in this case, ASDs) from those with other developmental problems, such as communication disorders, sensory-motor difficulties, or intellectual disability. Level 2 screening tests are usually performed in specialised settings, such as child development centres or early intervention programs. They generally require more time and clinical expertise to administer, because, as Lord (1995) points out, this is "the hardest test, and the one most typical of that faced by clinicians, … to determine the behaviors that discriminate autistic children from children with overlapping communicative and cognitive deficits at early ages" (p. 1368). In Perth, Western Australia, the task of differentiating young children with ASDs from those with other developmental delays often falls to front-line clinicians working in local child development services. Community-based child development services provide a key community reference point for families with children identified as having developmental

concerns. Services are provided by paediatricians, specialist nurses, and allied health professionals.

As in the rest of the world, over the past 20 years, the number of children being referred for an autism assessment in Western Australia has increased significantly, and each year approximately 200 children are newly diagnosed as being on the autism spectrum (Glasson et al., 2008). In addition, a further 200 children go through the lengthy and expensive process of diagnostic assessment but do not receive a formal diagnosis because they do not meet the criteria for ASDs (Glasson et al., 2008).

The increasing number of families seeking a diagnostic assessment has put pressure on an already overstretched system, resulting in lengthy waiting times for assessment, stress for families, and lost time for much needed early intervention. The fact that approximately half of these referrals do not result in an autism spectrum diagnosis highlights the need for better screening services.

Although there is a number of autism screening tests for toddlers, most rely on caregiver report alone. Whereas parents have generally been found to accurately report developmental concerns in their children (Glascoe & Marks, 2011), it has also been found that parents are more accurate at identifying delays in the typical developmental milestones (or negative features characteristic of autism) than noticing atypical behavioural features (or positive features characteristic of autism) in young children (Stone et al., 1999). For this reason, particularly when screening children with more complex presentations, a combination of interaction with a skilled clinician together with a parental report is more effective than parent report measures alone (Chawarska et al., 2007; Robson, 2010; Stone, McMahon, & Henderson, 2008).

In light of this evidence, a number of clinician-administered autism screening tools designed for use with referred samples of young children have been investigated. For

example, the Screening Tool for Autism in Toddlers and Young Children (STAT; Stone, Coonrod, & Ousley, 2000; Stone, Coonrod, Turner, & Pozdol, 2004) is a 12-item, clinician-administered play-based tool. It is suitable for young children aged 24–35 months, and has a simple pass or fail scoring system that provides for high- and low-risk classification of children. A 2004 paper reported good psychometric properties (including sensitivity of 92% and specificity of 85%) in a university-based clinic sample of 104 children (Stone et al., 2004), but this test requires further investigation with larger community-based samples.

Another tool, the ADEC, was developed for use with children aged 18 months to 3 years, but can be used with children as young as 12 months. The ADEC consists of 16 items and targets a lack of, or presence of atypical, behaviour in social-communication skills, play skills, sensory-motor skills, and regulation. The ADEC was designed to specifically detect autistic disorder as defined in the fourth edition, text revision, of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR*; American Psychiatric Association [APA], 2000). Initial validation of the ADEC was carried out with 269 Australian children across four university-based research samples, and the statistical analyses reported in the ADEC manual demonstrated good psychometric properties (Young, 2007). ANOVA results and Tukey's post hoc analysis of total ADEC scores showed that the ADEC was able to reliably discriminate children with autistic disorder from both typically developing children and those with other developmental disability ($p < .001$). Sensitivity and specificity of around 70% were reported when used with a referred population. Good internal consistency was reported (Cronbach's $\alpha = .90$ and .94) with test–retest reliability ($r = .83$) and interrater reliability (intraclass correlation coefficient = .83) was also high.

A second study used a Spanish translation of the ADEC in Mexico (Hedley, Young, Angelica, Gallegos, & Marcin Salazar, 2010) with referred children in three diagnostic groups based on *DSM-IV-TR* (APA, 2000) criteria: typically developing children, children

who had been diagnosed with a pervasive developmental disorder (autistic disorder and pervasive developmental disorder not otherwise specified) and children with a non-pervasive developmental disorder (APA, 2000). Results of the analysis revealed specificity of 88–100%, sensitivity of 76–94%, positive predictive value of .75–1.00, and negative predictive value of .71–.93.

A recent study (Nah, Young, Brewer, & Berlingeri, 2014) examined the psychometric properties of the ADEC in a sample of 201 young children across three diagnostic groups: autistic disorder, as defined in *DSM-IV-TR* (APA, 2000), other developmental disorders, and typically developing children. Again, the ADEC was reported to have excellent sensitivity (100%) and good specificity (74–90%), as well as high positive and negative predictive values (.84 and 1.00, respectively). Statistically significant between-group differences in the mean total ADEC score ($p < .001$) were also reported. Table 1 presents findings from the three ADEC studies reported in the literature.

<<PLEASE INSERT TABLE 1 ABOUT HERE>>

Although the ADEC was developed in Australia, normed with Australian children, and can be used with a wider age range than the STAT, the psychometric properties of the ADEC reported in the literature compared favourably to the STAT. Furthermore, unlike the STAT, no formal training is required to administer the ADEC (although a detailed administration manual and training DVD are provided with purchase of the ADEC kit). After considering all these factors, we decided to examine the clinical effectiveness and diagnostic validity of the ADEC as a Level 2 autism screening tool in a community setting.

The study was designed as a retrospective file audit, following up a group of children with developmental concerns who had been screened with the ADEC as toddlers. The aim was to replicate previous studies and evaluate whether the ADEC could be a useful screening tool for clinicians faced with the difficult task of screening toddlers and young children who

have been referred to a clinical service with complex presentations. A secondary aim was to determine if there were any predictors of diagnostic prognosis among the ADEC's 16 core deficit behavioural items that could be used to differentiate children at risk of later ASDs from children with other developmental delays.

Method

Participants

Participants were from a child development service in Perth, Western Australia, which services a wide range of inner mixed-class suburbs. Children who had been referred to the service due to developmental concerns and who were considered to be at risk for ASDs were screened with the ADEC as toddlers during their participation in an early intervention "Play and Learning" home visiting program. Children were originally screened with the ADEC if they were aged from 1 to 3 years and there was a family history of autism or parental concern about autism in addition to the presenting language or developmental delay; or a clinician concern about significant social, communication, or behavioural difficulties.

Ethical approval

Ethics approval for this study was obtained from the University of Kent Ethics Board (UK) and the Child and Adolescent Health Services (WA) Ethics and Research Governance Team. Informed consent was sought to review the medical records of all children in the study.

Procedure

The ADEC was administered in each child's home by the principal researcher with the toddler's parent present and in accordance with the guidelines outlined in the ADEC manual (Young, 2007). Depending on the results, children were fast-tracked to see a paediatrician for consideration of differential diagnosis or remained on their current waitlists for therapy and paediatric services. Some parents chose to see a private paediatrician or seek a private

diagnostic assessment, which in a few cases reduced the wait time between screening and assessment.

A total of 60 children were identified who had received an ADEC screen as toddlers between January 2008 and December 2010. Of these, parental informed consent was obtained for 53 children to be included in the 2013 file audit (one parent declined to give consent and six families could not be contacted). The medical records of the 53 children were reviewed in 2013 when the children were aged between 4 and 8 years old. Original ADEC screening results were analysed in light of later developmental status and diagnostic outcomes documented in the files. Basic demographic and background information was collected (e.g., gender, ethnicity, original developmental concerns that resulted in referral to the child development service, age when screened, and ADEC scores). Information relating to current developmental and diagnostic status, including the results of any autism assessments, was also collected. Only existing clinical data documented in the files were used, and no new or additional information was collected from parents or children.

Measure

The ADEC is a clinician-administered Level 2 screening test. It relies on clinician interaction and observation during a short (15–30 minute) semistructured play session. The ADEC assesses a lack of, or presence of atypical, behaviours in social-communication skills, play skills, sensory-motor skills, and regulation. The 16 ADEC items are nestling into caregiver; response to name; stereotypical behaviour; gaze switching; gaze monitoring (following a point/pointing); eye-contact in peek-a-boo game; functional play; pretend (symbolic) play using a wooden block as a phone; reciprocity of a smile; sensory response to everyday sounds; imitation; response to a verbal command; demonstrated use of words; anticipatory posture when picked up; use of gestures; and ability to switch (transition) to a new task.

The ADEC scoring is criterion referenced, based on a 3-point system. Each item is scored as 0, 1, or 2 (with higher scores indicating more atypical performance). Item scores are then summed to give a total score, which is interpreted based on cut-off scores published in the ADEC manual (Young, 2007). A score of 10 or below falls within the low-risk range; a score from 11 to 13 falls in the moderate-risk range; a score of 14 to 19 is considered high risk; and a score greater than 19 indicates a very high risk for autistic disorder, as defined in *DSM-IV-TR* (APA, 2000). Although the ADEC was originally developed to detect autistic disorder, in the present study the ADEC (using existing cut-off scores) was used to screen for the broader range of ASDs (i.e., autistic disorder and pervasive developmental disorder not otherwise specified; APA, 2000).

Data analyses

All the data analyses were performed using SPSS Version 19.0. Descriptive statistics were used to describe demographic and background information, and as a result of non-normal distributions, non-parametric tests were used to compare the total ADEC scores of children later diagnosed with ASDs using *DSM-IV-TR* (APA 2000) criteria with the ADEC scores of children with no ASD diagnoses at follow-up. Further analysis using chi-square tests for association examined whether children with ADEC scores of 10 or below (and considered at low risk) were less frequently diagnosed as having ASDs at follow-up (compared with those considered at moderate to very high risk). Associations between ADEC scores and age when screened, gender, and cognitive functioning were also examined. Fisher's exact test was used to analyse specific test items to determine whether any items were reliable predictors of diagnostic outcome. Psychometric properties of sensitivity, specificity, and positive and negative predictive values were also calculated.

Results

Demographic and background information

Analysis of the 53 children recruited to the study found that 83% were male and 17% were female; 78% of children were from English-speaking backgrounds and 19% of the sample were from families where English was an additional language (with diverse backgrounds including Australian Aboriginal, Turkish, Hindi, Indonesian, African, and Arabic). The majority of the children's parents (51%) expressed initial concerns related only to speech and language delays, with 11% of parents having initial concerns related to delayed or atypical motor development, and a further 38% presenting with multiple developmental concerns (including sensory and behavioural issues). At the time of being screened with the ADEC, the mean age of the children was 32.2 months (*SD* = 8.4 months). At follow-up, the mean age of children was 74.5 months (*SD* = 11.9 months), with ages ranging from 49 to 97 months. Demographic characteristics of the children are presented in Table 2.

<<PLEASE INSERT TABLE 2 ABOUT HERE>>

Screening results and diagnostic outcomes at follow-up

A summary of screening results and diagnostic outcomes is provided in Figure 1. Of the sample of 53 children, 66.8% (*N* = 35) had been referred for an autism assessment following review by a paediatrician, with 24 receiving a diagnosis of autistic disorder and eight receiving a diagnosis of pervasive developmental disorder not otherwise specified.[2] Twelve children were also diagnosed with co-occurring intellectual disability (IQ ≤ 70) after being assessed with standardised developmental or cognitive tests, most commonly the Griffiths Mental Developmental Scales – Extended Revised (Luiz et al., 2006). Three children did not receive an autism spectrum diagnosis following assessment but were diagnosed with communication disorders. At follow-up, they continued to receive clinical services, displaying ongoing language and developmental difficulties.

<<PLEASE INSERT FIGURE 1 ABOUT HERE>>

The remaining 18 children, apart from one child,[3] had received a developmental assessment by a paediatrician with experience in autism diagnosis but were considered not to have sufficient features to warrant a full autism diagnostic team assessment. At follow-up, 16 children were still engaged with child development or private therapy services; 12 had received significant speech and language therapy, with most also receiving at least one additional therapy (most notably occupational therapy, but also physiotherapy and clinical psychology services). Two children had been diagnosed with an intellectual disability (IQ ≤ 70), and two children were receiving ongoing clinical psychology services to assist with behavioural difficulties, which appeared to be resolving with age and support.

In summary, 60% of the sample received an ASD diagnosis, and 36% did not but continued to have developmental delays at follow-up. Only two children (4%) were no longer accessing therapy services at follow-up, as their developmental concerns had resolved with intervention over time (see Figure 1).

Group differences

Statistically significant group differences in total ADEC scores were found between children who received an ASD diagnosis, and those children who did not (two-tailed Mann–Whitney test: $U = 144.00$, $n = 53$, $p < .001$). The mean total ADEC score for those children who later received ASD diagnoses ($N = 32$) was 15.06 ($SD = 5.03$), whereas the mean for those children not receiving ASD diagnoses ($N = 21$) was 10.29 ($SD = 3.38$).

More children whose ADEC test scores were above 10 (the moderate- or high-risk groups) were diagnosed with ASDs than those who scored 10 or below and were categorised as low risk ($N = 53$, $\chi^2 = 12.11$, $df = 1$, $p = .001$). This suggested that a cut-off score of 11 did discriminate between those children who went on to get ASD diagnoses and those who did not.

Discriminatory ability of individual ADEC items

Individual ADEC items were analysed using Fisher's exact test. Scores on three items were statistically significantly associated with a later ASD diagnosis: Item 1 (response to name), Item 4 (gaze switching) and Item 10 (gaze monitoring); all $p \leq .001$. Of these, Item 1 (response to name) was the strongest discriminator, with no children in the ASDs group having shown typical behaviour (i.e., a score of 0) and no children in the non-ASDs group having shown definite evidence of inappropriate behaviour (i.e., a score of 2) at the time of screening.

Correlation between ADEC scores and age, gender, and intellectual disability

No statistically significant correlation was found between ADEC scores and age or gender. However, data analysis indicated that those children diagnosed with an intellectual disability (IQ ≤ 70 after being assessed with standardised developmental or cognitive tests) had significantly higher ADEC scores (N = 14, M = 18.4, SD = 4.68), than those children without an intellectual disability (N = 39, M = 11.28, SD = 3.59), using a two-tailed Mann–Whitney test (U = 61.50, N = 53, $p < .001$). This suggests that the ADEC may be over-identifying children with an intellectual disability. However, these results should be treated with caution in view of the small numbers involved.

Sensitivity, specificity and predictive values

Using the cut-off score of 11 as specified in the ADEC Manual, the ADEC correctly classified 27 of 32 children with an ASD (sensitivity = 87.5%) and 13 of 21 children without an ASD (specificity = 62%). In other words, five children had a false-negative screening result and eight children without an ASD had a false-positive screening result. This equates to a positive predictive value of 0.77 and a negative predictive value of 0.72.

Discussion

Findings from the current research are comparable with other studies of the ADEC, although the mean scores in this study were slightly higher than previous studies. Due to the clinical

nature of the file review where all children were referred with developmental concerns, there was no typically developing comparison group. Significant between-group differences were found for the total ADEC scores in all four studies (including this one), implying that in all four studies, the ADEC was able to discriminate between children with ASDs and children with other non-pervasive developmental disability. When comparing the sensitivity and specificity across studies, the sensitivity in the current study was similar to that in previous ADEC studies, but the specificity of 62% reported here was lower than that previously reported in the literature (which ranged from 70% to 94%). Specificity may have been affected as a result of using a referred clinical sample where typically developing children were not included. Positive and negative predictive values were comparable.

In terms of the discriminatory ability of individual ADEC items, the identification of the three early ASD markers found in this study (response to name, gaze monitoring, and gaze switching) is consistent with other research that found these same behavioural deficits in young children with ASDs in samples that included high-risk children (siblings) or children with developmental delays (Barbaro & Dissanayake, 2012; Saint-Georges et al., 2010). Other behaviours such as lack of pretend play, reduced imitation, delayed language, sensory responses to sounds, and poor eye contact were not found to be sufficiently sensitive discriminators of ASDs in this referred clinical sample.

The association between ADEC scores and intellectual disability was also seen in a study by Robson (2010), who used the ADEC as an outcome measure to rate symptom severity in infants at risk of ASDs (Robson, 2010). She found that children with poorer cognitive skills at 12 months were more likely to have greater ASD symptomology later in development. Stone and colleagues (2004) also found group differences for mental age using the STAT (Stone et al., 2004). Other research has documented a lack of delays in general cognitive development as one of the early signs of ASDs in toddlers (Dereu, Roeyers,

Raymaekers, Meirsschaut, & Warreyn, 2012; Zwaigenbaum et al., 2009), suggesting that it is difficult to separate delayed cognitive skills and early autism-specific behaviours because they appear to have an impact on each other.

The overlap in symptomatology between ASDs and intellectual disability (particularly severe and profound intellectual disability) can add to the complexity of differential diagnosis. Ahmad and Mohmood found in their 2011 study that language and speech delays (lack of age appropriate language, poor expressive and receptive language skills, delayed language development), stereotyped movements (rocking, flapping, spinning, lining up), and behavioural issues (high activity levels, lack of attention to task, self-harm, poor ability to learn, interest in adults only to get needs met) were common to both autism and intellectual disability. The involvement of cognitive factors in symptom expression may account for the association found here between higher ADEC scores and intellectual disability.

Of the 32 children diagnosed with ASDs, 27 (84%) were male and 5 (16%) were female, resulting in a ratio of 5.4:1 for male to female, which is higher than the usual 2.5–4.1:1 male to female gender ratios currently reported in the literature (Zwaigenbaum et al., 2012). However, caution is advised in interpreting these results in view of the small numbers involved.

Sensitivity and specificity: Difficulties of screening complex children

Although the ADEC was found to have high sensitivity (87.5%) in this study, lower specificity was recorded (62%) than in previous studies, with five children who were diagnosed with ASDs recording false-negative screens and eight children without ASDs recording false-positive screens. Positive and negative predictive values were comparable.

Of particular interest is the group of eight false-positive children. Although two of these children were diagnosed with an intellectual disability, it is not clear why the developmental trajectory of the other six children differed from those in the group who went

on to be diagnosed with an ASD. At the time of early screening, this subgroup of false-positive children were only 2 years old (*M* age = 32.2 months) and presented with high scores on the ADEC, indicating atypical development and behaviours consistent with ASDs. At follow-up, these children were around six years old (*M* age = 69.8 months), and although they continued to have a variety of difficulties (language, sensory, fine and gross motor, anxiety and behavioural), they had also improved in some areas. Behaviours indicative of autism were either not present or were present at a milder level, such that it was felt they did not or would not meet the criteria for ASD diagnoses.

Further research and developmental surveillance of this subgroup would be worthwhile to explore the variables associated with better developmental outcomes. It seems unlikely that treatment effects influenced their development, given that intensive autism-specific behavioural intervention was not available until after a formal autism diagnosis was made. Between screening and diagnostic assessment (a mean difference of 9.0 months), participants continued their standard therapy services, which involved short weekly or fortnightly clinic-based individual or group treatment sessions.

Were their higher screening scores a reflection of the ADEC being a brief snapshot of development on a particular day? Could this also account for the five false-positive cases? Should the ADEC be used routinely with parent report measures such as the M-CHAT (Robins, Fein, Barton, & Green, 2001) or the Autism Spectrum Rating Scale (Goldstein & Naglieri, 2010) to get the more comprehensive picture of child development that is recommended in the literature? Although reasons for the variable results are not clear, these findings support the instability of *some* early markers in *some* children who are identified as being at risk for autism as toddlers and highlight the complexity of diagnosing autism at a young age.

The problem of achieving optimal sensitivity and specificity when screening this young age group has been frequently discussed in the literature (Barton, Dumont-Mathieu, & Fein, 2012; Dereu et al., 2012; Turner-Brown, Baranek, Reznick, Watson, & Crais, 2013). The difficulty for many screening tools is that the behaviours they target lack sufficient specificity for autism. Many children who end up with a false-positive screening result often have, as this study has shown, subclinical social-communication deficits indicative of a broader autism phenotype (Sasson et al., 2013) or other developmental issues that persist into early childhood.

This question of whether we can or should be screening infants and toddlers for autism has generated considerable debate in the last couple of years. Some researchers believe that the moderate levels of sensitivity and specificity found in most early autism screening tools makes their use questionable (Al-Qabandi, Gorter, & Rosenbaum, 2011). Others argue that there are many potential benefits from earlier intervention when significant risk markers are present (Crais & Watson, 2014). The blurring of diagnostic boundaries, especially in children under 5 years, has led some to call for a less rigid and more holistic approach to screening, diagnosis, and early intervention (Gillberg, 2010).

Limitations

There are several limitations to this research. First, the small sample size means that the results should be interpreted with caution. Further research with a larger sample size is necessary to validate the findings.

It is also possible that the time between the initial ADEC screening and follow-up was not long enough for some of the children in the study to have received a definitive diagnosis. At follow-up, children's ages ranged from 4 to 8 years, and not all children had been formally assessed for ASDs. They had, however, all been reviewed by a paediatrician experienced in autism diagnosis who felt that they did not have sufficient features to warrant a full autism

diagnostic team assessment and that their difficulties were better accounted for by other diagnoses (e.g., intellectual disability or communication disorder). As such, it is possible, given that all but two children were still engaged with services and receiving ongoing therapy and paediatric reviews, that children might yet cross diagnostic boundaries as they age and this may alter ADEC sensitivity and specificity calculations.

Another limitation is that although cognitive testing was administered to all children undergoing a formal autism assessment, some children in the developmental delay group were not administered an IQ test. Where the paediatrician felt there were no indications on informal observations that a child was likely to have intellectual disability, formal cognitive testing was, in some cases, not undertaken. As a result, a comparison of mean IQ scores for the two groups (those with and without ASDs) was not possible at the time of writing.

Although the literature recommends a combination of interaction with a skilled clinician together with parental report when screening children for ASDs, it was found that although a number of parent measures had been completed and were found in the children's records, there was no consistency across all 53 participants, which meant parental report of early traits associated with ASDs could not be compared with ADEC results.

Conclusion

The principal research question this study aimed to address was whether the ADEC could be a useful screening tool to assist early intervention clinicians who are faced with the difficult task of screening toddlers and young children with complex presentations in a clinical setting. Specifically, could the ADEC help clinicians discriminate between children with ASDs and those with differential diagnoses (e.g., intellectual disability, communication disorders)?

This study, as a replication of previous research, supported a cut-off score of 11 on the ADEC (resulting in 87.5% sensitivity), but specificity (62%) was lower than that reported in other papers. Positive and negative predictive values were comparable. Three social-

communication behaviours were strongly predictive of an ASD diagnosis: response to name, gaze switching, and gaze monitoring. These behaviours could serve as possible indicators in a referred sample of young children presenting with language and developmental delays.

Notwithstanding lower specificity levels, the ADEC *has* proved to be a valuable tool for assisting clinicians in the present study to make decisions about referring children for paediatric evaluation or autism-specific assessments. As reported, more than 60% of cases were listed for speech pathology or physiotherapy services only before their ADEC screening. A positive ADEC score ensured that they were referred to a paediatrician more quickly and evaluated more thoroughly, ensuring earlier multidisciplinary assessment and access to autism-specific interventions as required.

Notes

1 The term autism spectrum disorders (ASDs) is used throughout this paper to encompass diagnoses made using *DSM-IV-TR* (APA, 2000) criteria; that is, autistic disorder, pervasive developmental disorder not otherwise specified, and Asperger's disorder. This decision was taken because the studies discussed here were completed before the *DSM-5* (APA 2013) changes were introduced.

2 Diagnoses were made jointly by a multidisciplinary team of a paediatrician or psychiatrist, a clinical psychologist, and a speech pathologist using *DSM-IV-TR* (APA, 2000) behaviourally defined criteria and included use of the Autism Spectrum Disorder Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999) and the Autism Spectrum Disorder Diagnostic Interview – Revised (ADI-R; Lord, Rutter, & Le Couteur, 2003). Glasson et al. (2008) provides a detailed description of the assessment model used in Western Australia.

3 One child was not seen by a paediatrician because the only concern was chronic toe-walking and a developmental assessment was not considered warranted.

Author note

Funding was not obtained for this research. Additionally, there are no conflicts of interests for the authors.

References

Al-Qabandi, M., Gorter, J. W., & Rosenbaum, P. (2011). Early autism detection: Are we ready for routine screening? *Pediatrics, 128*, e211–e217. doi:10.1542/peds.2010-1881

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Barbaro, J., & Dissanayake, C. (2012). Early markers of autism spectrum disorders in infants and toddlers prospectively identified in the Social Attention and Communication Study. *Autism, 17*, 64–86. doi:10.1177/1362361312442597

Barton, M. L., Dumont-Mathieu, T., & Fein, D. (2012). Screening young children for autism spectrum disorders in primary practice. *Journal of Autism and Developmental Disorders, 42*, 1165–1174. doi:10.1007/s10803-011-1343-5

Centres for Disease Control and Prevention. (2012). Prevalence of autism spectrum disorders — Autism and Developmental Disabilities Monitoring Network, 14 Sites, United States, 2008. *Morbidity and Mortality Weekly Report (MMWR) Series, Surveillance Summaries, 61*(SS03), 1–19. Retrieved from Centres for Disease Control and Prevention website: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6103a1.htm?s_cid=ss6103a1_w

Chawarska, K., Paul, R., Klin, A., Hannigen, S., Dichtel, L. E., & Volkmar, F. (2007). Parental recognition of developmental problems in toddlers with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37*, 62–72. doi:10.1007/s10803-006-0330-8

Crais, E. R., & Watson, L. R. (2014). Challenges and opportunities in early identification and intervention for children at-risk for autism spectrum disorders. *International Journal of Speech-Language Pathology, 16*, 23–29. doi:10.3109/17549507.2013.862860

Darrou, C., Pry, R., Pernon, E., Michelon, C., Aussilloux, C., & Baghdadli, A. (2010). Outcome of young children with autism: Does the amount of intervention influence developmental trajectories? *Autism, 14*, 663–677. doi:10.1177/1362361310374156

Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J., … Varley, J. (2010). Randomized, controlled trial of an intervention for toddlers with autism: The Early Start Denver Model. *Pediatrics, 125*, e17–e23. doi:10.1542/peds.2009-0958

Dereu, M., Roeyers, H., Raymaekers, R., Meirsschaut, M., & Warreyn, P. (2012). How useful are screening instruments for toddlers to predict outcome at age 4? General development, language skills, and symptom severity in children with a false positive screen for autism spectrum disorder. *European Child & Adolescent Psychiatry, 21*, 541–551. doi:10.1007/s00787-012-0280-y

Gillberg, C. (2010). The ESSENCE in child psychiatry: Early symptomatic syndromes eliciting neurodevelopmental clinical examinations. *Research in Developmental Disabilities, 31*, 1543–1551. doi:10.1016/j.ridd.2010.06.002

Glascoe, F. P., & Marks, K. P. (2011). Detecting children with developmental-behavioral problems: The value of collaborating with parents. *Psychological Test and Assessment Modeling, 53*, 258–279.

Glasson, E. J., MacDermott, S., Dixon, G., Cook, H., Chauvel, P., Maley-Berg, A., & Wray, J. (2008). Management of assessments and diagnoses for children with autism spectrum disorders: The Western Australian model. *The Medical Journal of Australia, 188*, 288–291.

Goldstein, S., & Naglieri, J. A. (2010). *Autism Spectrum Rating Scales (ASRS): Technical manual*. Toronto, Canada: Multi-Health Systems, Inc.

Hedley, D., Young, R., Angelica, M., Gallegos, J., & Marcin Salazar, C. (2010). Cross-cultural evaluation of the Autism Detection in Early Childhood (ADEC) in Mexico. *Autism*, *14*, 93–112. doi:10.1177/1362361309347676

Lord, C. (1995). Follow-up of two-year-olds referred for possible autism. *The Journal of Child Psychology and Psychiatry*, *36*, 1365–1382. doi:10.1111/j.1469-7610.1995.tb01669.x

Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (1999). *Autism Diagnostic Observation Schedule (ADOS)*. Los Angeles, CA: Western Psycological Services.

Lord, C., Rutter, M., & Le Couteur, A. (2003). *Autism Diagnostic Interview – Revised (ADI-R)*. Los Angeles, CA: Western Psychological Services.

Luiz, D. M., Barnard, A., Knoesen, N., Kotras, N., Horrocks, S., McAlinden, P., … O'Connell, R. (2006). *Griffiths Mental Developmental Scales – Extended Revised: Two to Eight Years. Analysis manual.* Oxford, UK: Hogrefe.

Nah, Y.-H., Young, R. L., Brewer, N., & Berlingeri, G. (2014). Autism Detection in Early Childhood (ADEC): Reliability and validity data for a Level 2 screening tool for autistic disorder. *Psychological Assessment, 26*, 215–226. doi:10.1037/a0034472

Robins, D. L., Fein, D., Barton, M. L., & Green, J. A. (2001). The Modified Checklist for Autism in Toddlers: An initial study investigating the early detection of autism and pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, *31*, 131–144. doi:10.1023/A:1010738829569

Robson, D. C. (2010). *The development of infants with an increased risk of autism spectrum disorders* (Doctoral dissertation). Retrieved from

http://www.autismsa.org.au/uploads/ProfessionalPractice/Research%20Attachments/Completed/PP200703%20-%20Thesis%20-%20Robson.pdf

Saint-Georges, C., Cassel, R.S., Cohen, D., Chetouani, M., Laznik, M.-C., Maestro, S., & Muratori, F. (2010). What studies of family home movies can teach us about autistic infants: A literature review. *Research in Autism Spectrum Disorders*, *4*, 355–366. doi:10.1016/j.rasd.2009.10.017

Sasson, N. J., Lam, K. S. L., Childress, D., Parlier, M., Daniels, J. L., & Piven, J. (2013). The Broad Autism Phenotype Questionnaire: Prevalence and diagnostic classification. *Autism Research*, *6*, 134–143. doi:10.1002/aur.1272

Stone, W. L., Coonrod, E. E., & Ousley, O. Y. (2000). Brief report: Screening Tool for Autism in Two-Year-Olds (STAT): Development and preliminary data. *Journal of Autism and Developmental Disorders*, *30*, 607–612. doi:10.1023/A:1005647629002

Stone, W. L., Coonrod, E. E., Turner, L. M., & Pozdol, S. L. (2004). Psychometric properties of the STAT for early autism screening. *Journal of Autism and Developmental Disorders*, *34*, 691–701. doi:10.1007/s10803-004-5289-8

Stone, W. L., Lee, E. B., Ashford, L., Brissie, J., Hepburn, S. L., Coonrod, E. E., & Weiss, B. H. (1999). Can autism be diagnosed accurately in children under 3 years? *The Journal of Child Psychology and Psychiatry*, *40*, 219–226. doi:10.1111/1469-7610.00435

Stone, W. L., McMahon, C. R., & Henderson, L. M. (2008). Use of the Screening Tool for Autism in Two-Year-Olds (STAT) for children under 24 months: An exploratory study. *Autism*, *12*, 557–573. doi:10.1177/1362361308096403

Turner-Brown, L. M., Baranek, G. T., Reznick, J. S., Watson, L. R., & Crais, E. R. (2013). The First Year Inventory: A longitudinal follow-up of 12-month-old to 3-year-old children. *Autism*, *17*, 527–540. doi:10.1177/1362361312439633

Young, R. (2007). *Autism Detection in Early Childhood (ADEC) manual*. Camberwell, Australia: ACER Press.

Zwaigenbaum, L., Bryson, S., Lord, C., Rogers, S., Carter, A., Carver, L., … Yirmiya, N. (2009). Clinical assessment and management of toddlers with suspected autism spectrum disorder: Insights from studies of high-risk infants. *Pediatrics*, *123*, 1383–1391. doi:10.1542/peds.2008-1606

Zwaigenbaum, L., Bryson, S. E., Szatmari, P., Brian, J., Smith, I. M., Roberts, W., … Roncadin, C. (2012). Sex differences in children with autism spectrum disorder identified within a high-risk infant cohort. *Journal of Autism and Developmental Disorders*, *42*, 2585–2596. doi:10.1007/s10803-012-1515-y

Table 1. The differences in total ADEC scores across different diagnostic categories in the three reported ADEC studies

Study	Diagnostic category[a]	Total ADEC score *M* (*SD*)	*p*
Young, 2007 ADEC Manual	Autistic disorder (*n* = 149)	15.32 (6.76)	$p < .001$
	Non-PDD disability (*n* = 60)	9.00 (6.68)	
	Typically developing (*n* = 60)	4.54 (4.27)	
Hedley et al., 2010 ADEC in Mexico (Phase 1)	Autistic disorder (*n* = 19)	15.84 (4.98)	$p < .001$
	Non-PDD disability (*n* = 13)	7.54 (4.81)	
	Typically developing (*n* = 29)	4.34 (3.22)	
Hedley et al., 2010 ADEC in Mexico (Phase 2)	PDD (AD and PDD-NOS) (*n* = 34)	14.35 (4.13)	$p < .001$
	Non-PDD disability (*n* = 5)	4.2 (0.84)	
	Typically developing (*n* = 15)	5.53 (3.16)	
Nah, Young, Brewer, & Berlingeri, 2014 Validation of the ADEC	Autistic disorder (*n* = 70)	19.0 (5.4)	$p < .001$
	Non-PDD disability (*n* = 57)	8.5 (6.1)	
	Typically developing (*n* = 64)	2.7 (3.0)	

[a]Assigned using *DSM-IV-TR* (APA, 2000) behaviourally defined criteria.

Table 2. Demographic characteristics of the research sample

	Age (months)			Male gender	English as first language
Participants	*M*	*SD*	Range		
At referral (*N* = 53)	23.8	9.2	4–45	83%	78%
Initial ADEC screen (*N* = 53)	32.2	8.4	18–47	83%	78%
ASD[a] diagnosis (*N* = 32)	41.18	9.2	22–65	84%	84%
At follow-up (*N* = 53)	74.5	11.9	48–97	83%	78%

[a]Assigned using *DSM-IV-TR* (APA, 2000) behaviourally defined criteria.

FIGURE CAPTION

Figure 1. Flow chart showing ADEC screening results and diagnostic outcomes at follow-up.