Autism

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What is This?

Comparison of a broad-based screen versus disorder-specific screen in detecting young children with an autism spectrum disorder

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Abstract

The goals of our study were to (a) compare agreement between autism spectrum disorder diagnosis and outcome of the Modified Checklist for Autism in Toddlers and Parents Evaluation of Developmental Status in a sample of toddlers and (b) examine specific concerns noted for toddlers who screened negative on the Modified Checklist for Autism in Toddlers or Parents Evaluation of Developmental Status but were later diagnosed with autism spectrum disorder. Participants were administered the Modified Checklist for Autism in Toddlers and Parents Evaluation of Developmental Status during well-child visits. Families were invited for a clinical evaluation if autism spectrum disorder symptoms were noted on the Modified Checklist for Autism in Toddlers and Modified Checklist for Autism in Toddlers Follow-Up Interview or if autism spectrum disorder concerns were noted by the pediatrician. Fifty-two children completed the Modified Checklist for Autism in Toddlers, Parents Evaluation of Developmental Status, and a clinical evaluation, and 30 of these children were diagnosed with an autism spectrum disorder. Modified Checklist for Autism in Toddlers results showed higher agreement with autism spectrum disorder diagnosis than any individual Parents Evaluation of Developmental Status screen result, although the latter detected many children with other developmental concerns. Children who screened negative on the Modified Checklist for Autism in Toddlers or Parents Evaluation of Developmental Status but were diagnosed

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with autism spectrum disorder had concerns noted in sensory response and proto-declarative pointing that can be considered in the context of screen results. In sum, our findings support universal autism spectrum disorder–specific screening in addition to general developmental screening and offer considerations to encourage early identification of toddlers with autism spectrum disorder.

Keywords

Autism spectrum disorders (ASDs) are behaviorally defined disorders that involve social, communication, and behavioral deficits that present in early childhood and can last throughout life (American Psychiatric Association, 1994). Early intervention for children with ASDs can improve social, communication, and cognitive functioning and decrease maladaptive behaviors (Landa, 2007; Rogers and Vismara, 2008), yet many children with ASDs are not identified until several years after symptoms first appear (Howlin and Asgharian, 1999; Wiggins et al., 2006). The Centers for Disease Control and Prevention (Autism and Developmental Disabilities Monitoring Network, 2012) report that about 1 in 88 children are currently suspected of having an ASD, which is more common than previously suspected (Fombonne, 1996; Gillberg et al., 1991; Rutter, 2005). Consequently, the American Academy of Pediatrics (AAP) developed guidelines for screening for ASDs in primary care settings so more young children can be identified and referred for early intervention (Johnson et al., 2007). Specifically, the AAP recommended that pediatricians screen all children for ASDs at the 18- and 24-month well-child visits in addition to general developmental screening at the 9-, 18-, and 24- or 30-month well-child visits (Council on Children with Disabilities, Section on Developmental Behavioral Pediatrics, Bright Futures Steering Committee, & Medical Home Initiatives for Children with Special Needs Project Advisory Committee, 2006; Johnson et al., 2007).

Yet screening for ASDs in pediatric offices has proved difficult. Despite AAP recommendations, screening rates for ASDs in pediatric practices remain low (DosReis et al., 2006; Radecki et al., 2011; Sand et al., 2005). In one survey, most (82%) pediatricians routinely screened for general developmental delays, but few (8%) pediatricians screened specifically for ASDs (DosReis et al., 2006). Survey respondents noted lack of familiarity with tools (62%), inadequate ASD referral sources (47%), or not enough time (32%) as reasons for neglecting ASD-specific screens. Although use of screening instruments has increased in recent years, less than half of pediatricians report consistent use of appropriate tools when caring for patients younger than 36 months (Radecki et al., 2011).

The low screening rates for ASDs in pediatric practices is troubling since many children with ASD may have unique symptom profiles not detected by general developmental screens. Indeed, when comparing the Modified Checklist for Autism in Toddlers (M-CHAT; Robins et al., 1999b, 2001), an ASD-specific screen, to the Parents Evaluation of Developmental Status (PEDS; Glascoe, 1998), a broad-based screen, one study found that the M-CHAT and PEDS identify different groups of children, with fewer than one-third of children who screened positive on the M-CHAT also indicated predictive concerns on the PEDS (Pinto-Martin et al., 2008). Another study indicated that use of the PEDS alone (without a subsequent ASD screen) resulted in an over-referral of ASD assessments (Glascoe et al., 2007).

One limitation of the aforementioned research is that these studies did not verify ASD diagnoses or compare screening results to those of a gold standard clinical evaluation. Verifying ASD diagnoses would allow a direct comparison of agreement between ASD diagnosis and results of screening instruments in the same population of young children. Another limitation of past research is that developmental concerns noted on the M-CHAT or PEDS were not examined for children who screened negative but were later diagnosed with an ASD to inform early identification efforts. Thus, the goals of

this study were to (a) compare agreement between ASD diagnosis and outcomes of the M-CHAT and the PEDS in a sample of toddlers and (2) examine specific concerns noted for children who screened negative on the M-CHAT or PEDS but were later diagnosed with ASD. We were particularly interested in comparing agreement between the M-CHAT, PEDS, and ASD classification (versus non-ASD classification) to determine the magnitude of "missed" cases and ASD screen results.

Methods

Participants were identified from an ongoing screening study at Georgia State University (GSU) approved by the GSU Institutional Review Board. Families of participants provided written informed consent during 18- and 24-month well-child visits to participating physicians in the metropolitan Atlanta region. A total of 3980 children were screened: 432 children screened positive on the M-CHAT and 1000 children had one or more predictive concerns noted on the PEDS. Diagrams outlining flow of participants can be found in Figures 1 and 2. The study sample was restricted to 52 children who completed both the M-CHAT and PEDS and received a clinical evaluation. Of these 52 participants, 44 screened positive on the M-CHAT and M-CHAT Follow-Up Interview (M-CHAT FUI; Robins et al., 1999a) and 8 received an evaluation either because the pediatrician noted developmental concerns on the M-CHAT or there was a family history of autism. The mean ages at time of screening and evaluation were 21.1 (range 15.2–27.0) and 26.0 (range 19.3–41.4) months, respectively. The racial makeup of the sample was 60% White, 19% Black, 8% Biracial (not Hispanic/
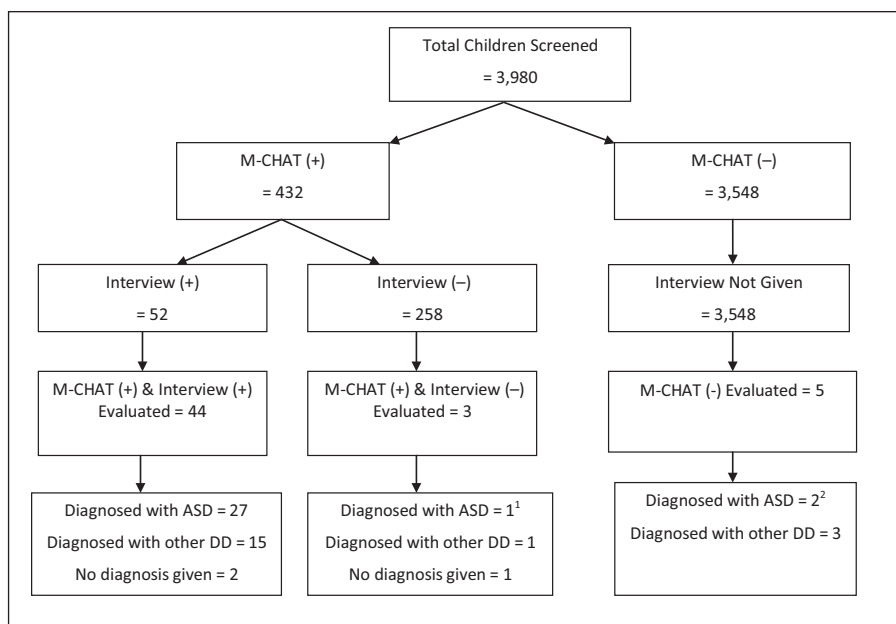

Figure 1. Screening and diagnostic test results for toddlers who received the M-CHAT during a routine well-child visit.
M-CHAT: Modified Checklist for Autism in Toddlers; ASD: autism spectrum disorder; DD: developmental disorder.
[1]The one child who screened positive on the M-CHAT but negative on the interview and was diagnosed with ASD had concerns noted in (1) pretend play, (2) proto-declarative pointing, and (3) staring spells or wandering noted on the M-CHAT (see Table 2).
[2]Of the two children who screened negative on the M-CHAT but were diagnosed with ASD: one child did not have any concerns noted on the M-CHAT and the other child had only sensitivity to noise noted on the M-CHAT (see Table 2).
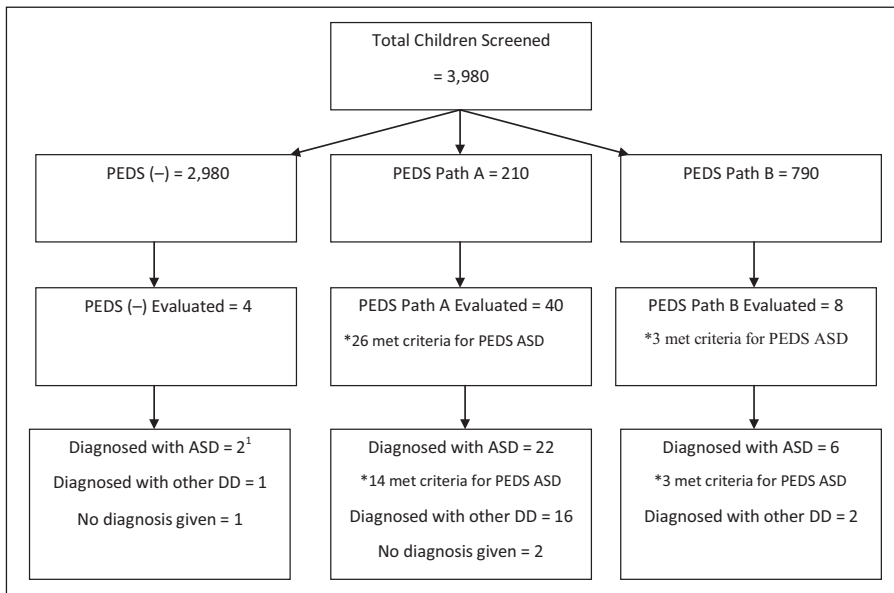
Figure 2. Screening and diagnostic test results for toddlers who received the PEDS during a routine well-child visit.
M-CHAT: Modified Checklist for Autism in Toddlers; PEDS: Parents Evaluation of Developmental Status; ASD: autism spectrum disorder; DD: developmental disorder.
[1]Of the two children who screened negative on the PEDS but were diagnosed with ASD: one child had only sensitivity to noise noted on the M-CHAT and the other child had concerns in (1) eye contact, (2) proto-declarative pointing, (3) sensitivity to noise, and (4) showing noted on the M-CHAT (see Table 2).

Latino), 5% Asian, 5% White-Hispanic/Latino, 2% Black-Hispanic/Latino, and 2% not stated (which is comparable to the entire sample screened). The sample was 71.2% male and 28.8% female.

Measures

The M-CHAT (Robins et al., 1999b, 2001) is a short parent-reported checklist designed to detect risk of ASDs in very young children. A child screened positive when any 3 of 23 items were failed or any 2 of 6 critical items were failed (Robins et al., 2001). The most current estimate of M-CHAT sensitivity suggests an upper bound of 0.91, which corroborates the original validation study (Kleinman et al., 2008). For this study, physicians were also asked to note concerns on the M-CHAT regardless of screen results in an attempt to identify false negative cases. The *M-CHAT FUI* (Robins et al., 1999a) is a structured interview designed to clarify parents' responses and elicit examples of behaviors relevant to each at-risk response. The M-CHAT FUI improves the specificity and positive predictive value of the M-CHAT by reducing the false positive rate (Kleinman et al., 2008; Robins, 2008).

The PEDS (Glascoe, 1998) is a parent questionnaire designed to detect broad developmental and behavioral problems in children from birth to 8 years of age. Two items are open-ended and eight are forced choice; parents have the opportunity to describe their concerns on forced-choice items. Physicians are guided toward appropriate action if "predictive" concerns are noted in global/cognitive, expressive language, receptive language, social–emotional, and other developmental domains. The reported sensitivity of the PEDS for global developmental concerns is between 0.74 and 0.79, and the reported specificity for global developmental concerns is between 0.70 and 0.80. The sensitivity of the PEDS for detecting ASDs has not been reported.

The PEDS manual recommends different screening and referral outcomes based on the number of predictive concerns noted and the type of concerns endorsed. Predictive items vary based on the child's age. Predictive items for children in the sample who were less than 18 months old were in the global/cognitive, expressive language, social–emotional, and other domains, and predictive items for children 18 months and older were in the global/cognitive, expressive language, receptive language, and other domains. "Path A" is defined as two or more predictive concerns noted by the parent; the PEDS manuals recommend that children who meet Path A criteria receive prompt referral for early intervention and developmental testing. "Path B" is defined as exactly one predictive concern noted by the parent; it is recommended that children who meet Path B criteria receive additional developmental screening in order to determine the need for referral for early intervention or developmental testing. The PEDS manual also notes that young children who have three or more concerns noted in the behavior, fine and gross motor, receptive language, or social–emotional domains be referred to an ASD specialist (Glascoe, 1998). For the purposes of this article, this latter path will be defined as "PEDS ASD."

The *Autism Diagnostic Interview–Revised* (ADI-R; Lord et al., 1994) is a semi-structured, parent interview used to classify children with a mental age of ≥24 months as autism or no autism; the ADI-R does not classify children with other ASDs. The ADI-R gathers comprehensive information about the child from a parent in three domains of development: social, communication, and behavioral. Autism classification is determined by scores on all the three domains and the presence of developmental delays or deviances before 3 years of age.

The *Autism Diagnostic Observation Schedule* (ADOS; Lord et al., 1999) is a standardized observation of a child, which tries to elicit social interaction and communication using structured play activities. The examiner implements the module that best corresponds to the child's expressive language level in order to prevent language aptitude from impeding accurate classification. Most children in this study were administered Module 1, designed for children who are not regularly using phrase speech. The final diagnostic algorithm is further divided into four domains: social, communication, behavioral, and play. ASD classification (determined by scores on the social and communication domains) places the child in one of three groups: autism, autism spectrum, and non-ASD.

The *Childhood Autism Rating Scale* (CARS; Schopler et al., 1988) is a standardized observation of the child that facilitates ASD diagnoses in children. Parent report can also be considered during CARS scoring. The CARS rates children suspected of having an ASD on 15 items that include social and communication skills and stereotyped interests and behaviors. The final diagnostic algorithm represents a sum of item scores and classifies the child as having severe autism, mild–moderate autism, or no autism indicated.

The *Mullen Scales of Early Learning* (MSEL; Mullen, 1995) is a standardized measure of cognition appropriate for children from birth to 68 months of age. The examiner presents a series of tasks created to measure gross motor, fine motor, expressive language, receptive language, and visual reception skills. Raw scores can be converted to *t* scores, percentile ranks, and age equivalents. An early learning composite, created from all the domains except gross motor, is also provided.

The *Vineland Adaptive Behavior Scales* (2nd ed.; Vineland-II; Sparrow et al., 2005) is a semi-structured parent interview that assesses personal and social sufficiency in individuals from birth to 18 years of age in four domains: (a) communication, (b) daily living skills, (c) socialization, and (d) motor abilities. Raw scores can be converted to standard scores, percentile ranks, and age equivalents. An adaptive behavior composite, created from all the domains, is also provided.

Procedures

During a routine 18- or 24-month well-child visit, parents of all children 16–30 months of age were asked to participate in the study regardless of whether developmental concerns were noted by

the family or physician. Caregivers who provided informed consent were given the PEDS and then the M-CHAT by physician office staff in one packet of materials. The PEDS was offered first in order to prevent the targeted M-CHAT questions from influencing the open-ended responses elicited by the PEDS. Completed forms were then mailed to study staff at GSU who scored both screeners and conducted the M-CHAT FUI for children who screened positive on the M-CHAT. The M-CHAT FUI was conducted either on the telephone or in person. Children who continued to screen positive on the M-CHAT FUI were invited for a free diagnostic evaluation.

Most evaluations were completed at the GSU clinic (*n* = 50), although two evaluations were completed in the child's home. Evaluations included the ADI-R, ADOS, CARS, MSEL, Vineland-II, and a developmental and medical history questionnaire. All clinicians had prior experience with the diagnostic measures before study administration, and clinicians who administered the ADI-R and ADOS had established research reliability. Clinicians were blind to M-CHAT and PEDS score. Final diagnosis was made using clinical judgment, integrating all the data obtained during the evaluation. After the evaluation was complete, clinicians immediately scored the instruments, discussed evaluation results, and provided feedback to the family. A comprehensive evaluation report was mailed within 6 weeks of the clinical evaluation.

Data analyses

All the data analyses were performed using SPSS version 19.0. We calculated agreement statistics of the M-CHAT alone, M-CHAT + FUI, PEDS when two or more predictive concerns were noted (Path A), PEDS when only one predictive concern was noted (Path B), PEDS Paths A and B combined, and PEDS when three or more concerns were noted about behavior, motor, receptive language, or social–emotional development (PEDS ASD). Agreement statistics were reported instead of psychometric properties (i.e. sensitivity, specificity, positive predictive value, and negative predictive value) because PEDS screen results did not influence whether the child received a developmental evaluation (which would be untenable given the number of screen positive PEDS forms). Yet the agreement statistics we report allowed examination of the magnitude of "missed" cases by assessing agreement with ASD classification that takes into account the number of true positives, the number of children who screen positive, and the number of children diagnosed with an ASD (Cicchetti, 1988). Moreover, agreement statistics also allowed examination of the clinical significance of proportionate observed agreement that takes into account both agreement with ASD classification and agreement with non-ASD classification (Cicchetti, 1988, 2001). Descriptive statistics were used to describe concerns noted for children who screened negative on the M-CHAT or PEDS but were later diagnosed with an ASD.

Results

A total of 30 children (58% of those evaluated) received an ASD diagnosis. Of these 30 children, 20 were diagnosed with Pervasive Developmental Disorder–Not Otherwise Specified (PDD-NOS, 67%) and 10 were diagnosed with Autistic Disorder (33%). A total of 22 children (42% of those evaluated) received a non-ASD diagnosis. Of these children, three were typically developing or given no diagnosis (14%), eight were labeled as having other developmental concerns (36%; e.g. no diagnosis but elevated scores on the ADOS and/or ADI-R, although scores were subthreshold), seven were diagnosed with global developmental delay (32%), and four were diagnosed with a language disorder (18%; e.g. developmental language disorder, expressive language disorder, mixed expressive–receptive disorder, or language delay).

Agreement between ASD classification and results of the M-CHAT and PEDS is outlined in Table 1. Agreement between ASD classification and the M-CHAT alone was 0.73 and agreement between ASD classification and the M-CHAT and M-CHAT FUI was also 0.73. One child screened positive on the M-CHAT but reverted to screen negative on the FUI and was diagnosed with an ASD: this child had concerns noted in (a) pretend play, (b) proto-declarative pointing, and (3) staring spells or wandering noted on the M-CHAT (Table 2).

There were two children who screened negative on the M-CHAT and were diagnosed with an ASD (Figure 1). Of these two children, one child did not have any concerns noted on the M-CHAT and the other child had only sensitivity to noise noted on the M-CHAT (Table 2). The child that did not have any concerns noted on the M-CHAT met PEDS criteria for ASD since he had concerns noted in behavior, gross motor, and receptive language. This child was later diagnosed with an ASD and had ADOS scores within the range of an ASD but ADI-R and CARS scores below the autism diagnostic threshold (i.e. CARS score was 21 points). Therefore, this child displayed mild ASD symptoms detected by a trained clinician on the ADOS but not reported by the parent, although general developmental delays were reported on the PEDS.

Agreement between ASD classification and the PEDS was 0.63 when two or more concerns were noted (Path A), 0.32 when exactly one concern was noted (Path B), 0.72 for Paths A and B combined (one or more concerns noted), and 0.57 for PEDS ASD. There were two children who screened negative on the PEDS but were diagnosed with ASD (Figure 2). Of these children, one child screened positive on the M-CHAT and the other child screened negative on the M-CHAT. The one child who screened negative on the PEDS and positive on the M-CHAT had concerns in (a) eye contact, (b) proto-declarative pointing, (c) sensitivity to noise, and (d) showing noted on the M-CHAT. The one child who screened negative on the PEDS and negative on the M-CHAT had only sensitivity to noise noted on the M-CHAT.

Agreement between non-ASD classification and screen results was poor for all screen results except PEDS Path B (0.61) and PEDS ASD (0.41), both of which showed poor to fair agreement with ASD classification (0.32 and 0.57, respectively). The poor agreement between non-ASD classification and screen results is reflected in the proportionate observed agreement statistics reported in Table 1. Even still, the M-CHAT and M-CHAT FUI showed higher proportionate observed agreement with clinical diagnosis than any PEDS screen result reported (0.60 and 0.62 for M-CHAT and M-CHAT FUI, respectively; versus 0.50–0.58 for PEDS).

Discussion

The goals of our study were to compare agreement between ASD diagnosis and outcomes of the M-CHAT and PEDS in a sample of toddlers who were given a comprehensive clinical evaluation and examine specific concerns noted for children who screened negative on the M-CHAT or PEDS but were later diagnosed with ASD. Results showed that the M-CHAT had higher agreement with ASD classification than any single PEDS path except when PEDS Paths A and B were combined (denoting at least one predictive concern noted). However, 1000 children had at least one predictive concern noted on the PEDS (25% of the sample screened) versus 432 children who screened positive on the M-CHAT (11% of the sample screened). Thus, a positive score on the PEDS without concurrent ASD-specific screen results may tax the ASD diagnostic system and delay ASD diagnosis and intervention (Glascoe et al., 2007). We therefore support past research that encourage use of an ASD-specific screen in addition to a broad-based developmental screen to streamline and prioritize referrals to ASD specialists (Glascoe et al., 2007).

Table 1. ASD screen results and agreement with ASD classification and non-ASD classification given after a comprehensive developmental evaluation.

	ASD Classification	Non-ASD Classification	Agreement with ASD Classification	Agreement with non-ASD Classification	Proportionate Observed Agreement	Clinical Significance[2]
M-CHAT alone						
M-CHAT Positive[1]	28	19	.73			
M-CHAT Negative	2	3		.23	.60	Good
Total	30	22				
M-CHAT+FUI						
M-CHAT+FUI Positive[1]	27	17	.73			
M-CHAT+FUI Negative	3	5		.33	.62	Good
Total	30	22				
PEDS Path A						
PEDS Path A Positive[1]	22	18	.63			
PEDS Path A Negative	8	4		.24	.50	Fair
Total	30	22				
PEDS Path B						
PEDS Path B Positive[1]	6	2	.32			
PEDS Path B Negative	24	20		.61	.50	Fair
Total	30	22				
PEDS Paths A+B combined						
PEDS Paths A+B Positive[1]	28	20	.72			
PEDS Paths A+B Negative	2	2		.15	.58	Fair
Total	30	22				
PEDS ASD						
PEDS ASD Positive	17	13	.57			
PEDS ASD Negative	13	9		.41	.50	Fair
Total	30	22				

[1]A positive screen is above the published cutoff; [2]Cicchetti (2001).

Table 2. Concerns noted on the M-CHAT for children diagnosed with an ASD who screened negative on the M-CHAT or PEDS

	Concerns noted on M-CHAT					
	Eye contact	Pretend play	Proto-declarative pointing	Sensitivity to noise	Showing	Staring or wandering
PEDS negative and M-CHAT negative (*n* = 1)				X		
PEDS negative and M-CHAT positive (*n* = 1)	X		X	X	X	
PEDS positive and M-CHAT positive but M-CHAT FUI negative (*n* = 1)		X	X			X

ASD: autism spectrum disorder; M-CHAT: Modified Checklist for Autism in Toddlers; FUI: Follow-Up Interview; PEDS: Parents Evaluation of Developmental Status.
There was one child who screened positive on the PEDS and negative on the M-CHAT and was diagnosed with ASD. This child did not have any concerns noted on the M-CHAT but had PEDS concerns noted in the behavior, gross motor, and receptive language domains and thus screened positive for PEDS ASD.

It is not surprising that more children screened positive on the PEDS compared to the M-CHAT given the PEDS was designed to detect general developmental delays rather than ASD-specific delays. In fact, 94% (46 of 49) of children in our sample who screened positive on the M-CHAT or had concerns noted by the pediatrician also screened positive on the PEDS and met criteria for an ASD or other DD. Conversely, 6% (3 of 49) of children who had ASD or DD screened negative on the PEDS. Two of the three children with ASD or DD who screened negative on the PEDS screened positive on the M-CHAT. Consequently, the PEDS proved useful as a general developmental screen in our sample of toddlers, especially when combined with the M-CHAT. One child who screened negative on the M-CHAT screened positive on PEDS ASD. However, this result could be due to the unique developmental profile of this child since PEDS ASD showed low agreement with ASD classification overall (0.57), and a total of 13 children with ASD screened negative on PEDS ASD. Future research is needed to investigate the relationship between M-CHAT and PEDS ASD screen results in larger samples of toddlers.

Our descriptive results encourage consideration of specific concerns noted when a child screens negative on both the M-CHAT and PEDS or when screen results do not agree with one another. Specifically, one child with ASD in our sample screened negative on both the M-CHAT and PEDS but was noted to be overly sensitive to noise. Sensory concerns are noted to be common in young children with ASD and are even argued to distinguish young children with ASD from young children with other DD (Wiggins et al., 2009). Thus, sensitivity to noise could be an important "red flag" for further ASD screening or evaluation.

Likewise, deficits in proto-declarative pointing were noted for one child with ASD who screened negative on the PEDS but positive on the M-CHAT and one child who screened positive on the PEDS and M-CHAT but negative on the M-CHAT FUI. Thus, impairments in proto-declarative pointing in the toddler years, along with a positive ASD screen, may also be an important "red flag" that prompts diagnostic referral despite M-CHAT FUI responses. In fact, impairments in

proto-declarative pointing most discriminated children with ASD from children without ASD in the original M-CHAT validation study (Robins et al., 2001), which offers further support for additional screening and/or diagnostic referral when deficits are noted in this particular developmental skill. Again, future research is needed to investigate the relationship between specific concerns noted and M-CHAT and PEDS screen results in larger samples of toddlers.

Agreement between non-ASD classification and screen results was poor for almost every M-CHAT and PEDS path (Table 1), which influenced weighted average agreement and may question the clinical utility of the screens (DosReis et al., 2006). In terms of M-CHAT results, 19 of 22 children not diagnosed with an ASD screened positive on the M-CHAT and 17 of 22 children not diagnosed with an ASD screened positive on the M-CHAT + FUI. However, ASDs are extremely heterogeneous disorders that overlap with other developmental conditions, and the majority of children in our sample not diagnosed with ASDs had other developmental delays or concerns. Thus, the utility of the M-CHAT as a first-stage ASD screen is to prioritize and streamline referral for ASD assessment, identify as many children with ASD as soon as possible, and identify children with overlapping symptoms but another developmental delay or concern as soon as possible. Yet our results also highlight the importance of following ASD screen positive results with a comprehensive clinical evaluation in order to confirm or reject an ASD diagnosis. As such, pediatricians should know diagnostic professionals and evaluation centers proficient in the assessment and diagnosis of children with ASDs within their community. Early intervention programs (i.e. intervention programs for children from birth to age of 3 years) and preschool education programs may be valuable diagnostic resources for pediatric referrals.

The primary limitations of our study were the small sample of children who received the M-CHAT, PEDS, and clinical evaluation and the fact our evaluation sample was limited to children who screened positive on the M-CHAT and M-CHAT FUI, had concerns noted by the pediatrician, or had a family history of ASD (which limited the ability to calculate psychometric properties of the M-CHAT and PEDS rather than agreement with ASD classification). Despite these limitations, we describe specific behaviors that can be considered "red flags" for further ASD screening or evaluation in toddlers despite screening results (i.e. oversensitivity to noise and deficits in proto-declarative pointing). Moreover, we found that results of an ASD-specific screen, the M-CHAT, showed higher agreement with ASD diagnosis than results of any single path of a broad-based screen, the PEDS. The PEDS was useful in detecting children with a variety of developmental diagnoses, especially when combined with the M-CHAT. These findings support AAP recommendations to administer ASD-specific screens to all children at 18 and 24 months regardless of broad-based screening results. Future research should consider the many broad-based and ASD-specific screens available and ways to encourage early identification of very young children with ASDs.

Disclosures

Diana L Robins is a co-owner of M-CHAT, LLC, which licenses use of the M-CHAT in electronic format. However, the paper-and-pencil M-CHAT is still available for free use in research, clinical, and educational settings. The paper-and-pencil M-CHAT is the version used in this study.

References

American Psychiatric Association (1994) *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association, Centers for Disease Control and Prevention, Autism and Developmental Disabilities.

Autism and Developmental Disabilities Monitoring Network. Prevalence of autism spectrum disorders – Autism and Developmental Disabilities Monitoring Network, 14 sites, United States, 2008. *MMWR Surveillance Summaries* 61: 1–19.

Cicchetti DV (1988) When diagnostic agreement is high but reliability is low: some paradoxes occurring in joint independent neuropsychology assessments. *Journal of Clinical and Experimental Neuropsychology* 10: 605–622.

Cicchetti DV (2001) The precision of reliability and validity estimates re-visited: distinguishing between clinical and statistical significance of sample size requirements. *Journal of Clinical and Experimental Neuropsychology* 23: 695–700.

Council on Children with Disabilities, Section on Developmental Behavioral Pediatrics, Bright Futures Steering Committee, & Medical Home Initiatives for Children with Special Needs Project Advisory Committee (2006) Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening. *Pediatrics* 118: 405–420.

DosReis S, Weiner CL, Johnson L, et al. (2006) Autism spectrum disorder screening and management practices among general pediatric providers. *Journal of Developmental and Behavioral Pediatrics* 27: S88–S94.

Fombonne E (1996) Is the prevalence of autism increasing? *Journal of Autism and Developmental Disorders* 26: 673–676.

Gillberg C, Steffenburg S and Schaumann H (1991) Is autism more common now than ten years ago? *British Journal of Psychology* 158: 403–409.

Glascoe F (1998) *Collaborating with Parents: Using Parents' Evaluation of Developmental Status in Screening, Surveillance, and Promotion*. Nashville, TN: Ellsworth & Vandermeer Press.

Glascoe F, Macias M, Wegner L, et al. (2007) Can a broadband developmental-behavioral screening test identify children likely to have autism spectrum disorders? *Clinical Pediatrics* 46: 801–805.

Howlin P and Asgharian A (1999) The diagnosis of autism and Asperger syndrome: findings from a survey of 770 families. *Developmental Medicine and Child Neurology* 41: 834–839.

Johnson CP and Myers SM; Council on Children with Disabilities (2007) Identification and evaluation of children with autism spectrum disorders. *Pediatrics* 120: 1183–1215.

Kleinman JM, Robins DL, Ventola PE, et al. (2008) The modified checklist for autism in toddlers: a follow-up study investigating the early detection of autism spectrum disorders. *Journal of Autism and Developmental Disorders* 38: 827–839.

Landa R (2007) Early communication development and intervention for children with autism. *Mental Retardation and Developmental Disabilities Research Reviews* 13: 16–25.

Lord C, Rutter M and Le Couteur A (1994) Autism diagnostic interview-revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders* 24: 659–685.

Lord C, Rutter M, DiLavore P, et al. (1999) *Autism Diagnostic Observation Schedule* (WPS ed.). Los Angeles, CA: Western Psychological Services.

Mullen E (1995) *Mullen Scales of Early Learning*. Circle Pines, MN: American Guidance Service.

Pinto-Martin J, Young L, Mandell D, et al. (2008) Screening strategies for autism spectrum disorders in pediatric primary care. *Journal of Developmental and Behavioral Pediatrics* 29: 345–350.

Radecki L, Sand-Loud N, O'Connor KG, et al. (2011) Trends in the use of standardized tools for developmental screening in early childhood: 2002-2009. *Pediatrics* 128: 14–19.

Robins DL (2008) Screening for autism spectrum disorders in primary care settings. *Autism* 12: 537–556.

Robins DL, Fein D and Barton M (1999a) *Follow-up Interview for the Modified Checklist for Autism in Toddlers (M-CHAT FUI)*. Self-published.

Robins DL, Fein D and Barton M (1999b) *The Modified Checklist for Autism in Toddlers (M-CHAT)*. Self-published.

Robins DL, Fein D, Barton M, et al. (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.

Rogers S and Vismara L (2008) Evidence-based comprehensive treatments for early autism. *Journal of Clinical Child and Adolescent Psychiatry* 37: 8–38.

Rutter M (2005) Incidence of autism spectrum disorders: changes over time and their meaning. *Acta Paediatrica* 94: 2–15.

Sand N, Silverstein M, Glascoe F, et al. (2005) Pediatricians' reported practices regarding developmental screening: do guidelines work? Do they help? *Pediatrics* 116: 174–179.

Schopler E, Reichler RJ and Renner BR (1988) *The Childhood Autism Rating Scale*. Los Angeles, CA: Western Psychological Services.

Sparrow S, Balla D and Cicchetti DV (2005) *Vineland Adaptive Behavior Scales*. 2nd ed. Circle Pines, MN: American Guidance Services.

Wiggins LD, Baio J and Rice C (2006) Examination of the time between first evaluation and first autism spectrum diagnosis in a population-based sample. *Journal of Developmental and Behavioral Pediatrics* 27: S79–S87.

Wiggins LD, Robins DL, Bakeman R, et al. (2009) Brief report: sensory abnormalities as distinguishing symptoms of autism spectrum disorders in young children. *Journal of Autism and Developmental Disorders* 39: 1087–1091.