Screening for Autism in Young Children: The Modified Checklist for Autism in Toddlers (M-CHAT) and Other Measures

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The literature on the importance of early identification and early intervention for children with developmental disabilities such as autism continues to grow. The increased prevalence of autistic spectrum disorders has fostered research efforts on the development and validation of autism-specific screening instruments for use with young children. There are currently several such autism-specific screening tools meant to be used with young children in various stages of development. Data from a few of these screening instruments have been published, and they include the Checklist for Autism in Toddlers (CHAT), Pervasive Developmental Disorders Screening Test (PDQST), Screening Tool for Autism in Two year olds (STAT), Checklist for Autism in Toddlers-23 (CHAT-23), and the Modified Checklist for Autism in Toddlers (M-CHAT). In this review, these five tools designed for use with children under three years old will be highlighted. In particular, the Modified Checklist for Autism in Toddlers (M-CHAT) will be discussed.

Key Words: autism; pediatric screening; early identification; early intervention

BACKGROUND

Autism is a neuro-developmental disorder first described by Leo Kanner in 1943. It is one of a group of disorders known as Pervasive Developmental Disorders (PDDs), now more commonly referred to as Autistic Spectrum Disorders (ASDs). This group of disorders includes Autistic Disorder, Pervasive Developmental Disorder—Not Otherwise Specified (PDD-NOS), Asperger’s syndrome, Rett syndrome, and Childhood Disintegrative Disorder (CDD) (American Psychiatric Association (APA), 1994). Autistic Spectrum Disorders are currently estimated to affect somewhere between 1 in 166 and 1 in 1000 children [Baird et al., 2000; Bertrand et al., 2001; Chakrabarti and Fombonne, 2001; Yeargin-Asprindt et al., 2003; Volkmar et al., 2004; Barbarese et al., 2005; Chakrabarti and Fombonne, 2005].

The diagnostic criteria for autistic disorder require impairment in three areas: reciprocal social interaction, communication, and specific patterns of behavior, interests, and activities [APA, 1994]. Research has documented areas of dysfunction related to these core categories of symptoms in autism: (1) social abilities (attachment, joint attention, social imitation, orienting to social stimuli, face and affect processing, expression of emotion, and symbolic play) [McEvoy et al., 1993; Dawson et al., 1998; Klin et al., 2002; Klinger et al., 2003]; (2) communicative abilities (use of language, both verbal and non-verbal, quality of communication and play) [Travis et al., 2001; Klinger et al., 2003; Dawson et al., 2004] and (3) restricted or stereotyped behaviors; interests, and activities (non-functional routines or ritualistic behaviors, resistance to changes in the environment, repetitive motor mannerisms, unusual interests and preoccupations; and visual fascinations) [Volkmar et al., 1986; Szatmari et al., 1989; Campbell et al., 1990; Turner, 1999; Charman and Swettenham, 2001; Klinger et al., 2003]. There are additional symptoms that are sometimes present with ASDs, these include self injurious behaviors, functional disturbances such as difficulties with sleeping and eating, abnormal fears, and abnormal responses to sensory stimuli [Klinger et al., 2003]. Cognitive functioning can range from severe mental retardation to above average intelligence quotient (IQ), with many children who have an ASD showing some degree of cognitive impairment. A recent study by Chakrabarti and Fombonne [2005] found that in a sample of four to six year olds diagnosed with an ASD, nearly a third had significant cognitive impairment.

Previous studies have found that regression in ASD occurs most often between 18 and 24 months of age, with the frequency of the regressive type of autism being somewhere between 10 and 50% [Tuchman and Rapin, 1997; Goldberg et al., 2003; Lord et al., 2004; Rogers, 2004]. Clinical experience of the present authors suggests that regression often occurs sooner, sometimes as early as 12–18 months. It is possible that parents may recall 18–24 months as the age of regression for children who were diagnosed later, or that parents are experiencing recall bias [Siperstein and Volkmar, 2004]. It is possible that as the age at diagnosis drops with earlier identification, so will the reported age at regression.

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There are many important theoretical and clinical issues related to the subject of regression in autistic spectrum disorders. Do parents and providers mean the same thing when they discuss regression? What constitutes regression as opposed to developmental stagnation? Is the regression seen with autism similar mechanistically to that seen in other regressive disorders such as Landau-Kleffner syndrome [Ballaban-Gil and Tuchman, 2000; Robinson et al., 2001; Stefanatos et al., 2002 Trevathan, 2004], or to disorders within the autistic spectrum, Childhood Disintegrative Disorder [Volkmar and Rutter, 1995; Malhotra and Gupta, 1999 Goldberg et al., 2003; Manning-Courtney et al., 2003], and Rett syndrome [Glaze, 2004]? Is the outcome different for those children who have had a normal developmental trajectory prior to the onset of regression, as compared with those whose regression is limited only to language or those who were developmentally delayed even before the regression? Does the timing of the regression impact outcome? Does autism with regression differ in etiology, impact, and prognosis than autism without regression?

Various mechanisms of regression have been suggested, including illness, sub-clinical seizures, and variations in postnatal brain development due either to the impact of genetic factors or postnatal events [Lainhart et al., 2002; Hrdlicka et al., 2004]. A discussion of these questions and issues is beyond the scope of this article and the readers are referred to a review of developmental regression published in this journal [Rogers, 2004]. However, there are two issues pertinent to this discussion of screening young children. Screening tools need to ask about regression in a way that is compatible with parent and provider perspectives. It is also important to not only ask about regression, but lack of developmental progression. Secondly, it is important to remember that autism screening will not capture regression if the screening precedes the regression.

Retroactive studies have shown that children who are later diagnosed with autism exhibit symptoms as early as 8–12 months of age [Osterling and Dawson, 1994; Baranek, 1999; Werner et al., 2000; Osterling et al., 2002]. In general these studies reviewed videotapes of the children prior to or at their first birthday and analyzed their behaviors, as compared with typically developing children or children with non-ASD diagnoses. Some children with ASDs seem to exhibit symptoms as early as 8 months, but more consistently around 12 months. The identified symptoms are fairly consistent and include delay or absence in pointing, showing objects, looking at others, and orienting to their name [Osterling and Dawson, 1994]. In addition to the difficulties with aspects of social responsiveness (poor visual orientation/attention, response to name) these children also seem to exhibit sensory-motor difficulties (mouthing objects excessively, aversions to social touch) [Baranek, 1999]. Other symptoms that seem to indicate possible ASD include stereotyped play with objects, unusual posturing of body parts, looking at a camera less frequently, staring/fixating on objects, and having less animated affective expressions [Baranek, 1999]. Lack of response to name seems to be the most consistent singular symptom at this young age [Osterling and Dawson, 1994; Baranek, 1999; Werner et al., 2000 Osterling et al., 2002].

The findings from these studies, although retrospective, document some of the behavioral signs of autism in very young children, and suggest that early screening might be feasible. Ongoing research is needed to uncover profiles of children with ASDs at young ages, since the signs may be different from those seen in older children. Prospective studies are needed with infants and toddlers to further investigate the best means of differentiating between variants of typical development and the earliest symptoms of autism. In the meantime, it would seem prudent to verify that children under 12 months old being seen for their well child care visit are looking at others and orienting to their name, since these two skills may be two of the earliest red flags for possible autism. Baranek [1999] states that the early markers for autism noted on videotape review preceded the voicing of concerns by parents. She also mentions that the parents in her study compensated for these markers, suggesting that these compensatory behaviors on the parents’ part may somehow be reflective of the child’s symptoms and a possible avenue for developing measures to help with the early identification of these children.

Despite this delay in parents’ concerns relative to the early markers identified retrospectively, studies suggest that parental concerns regarding their child’s development were typically expressed to pediatricians by the age of 1.5 years, and yet, a definitive diagnosis of autism is not made until approximately 4 years old. [De Giacomo and Fombonne, 1998; Siegel et al., 1988; Flannagan and Nuallain, 2001]. Simultaneously, the evidence suggesting that young children as young as 24 months old can be diagnosed with autism continues to grow [Dahlgren and Gillberg, 1989; Lord, 1995; Stone et al., 1999; Chakrabati and Fombonne, 2001; Zwaigenbaum, 2001; Charman and Baird, 2002; Dawson et al., 2002]. Furthermore the neurobiological abnormalities noted in the child with ASD in the first two years of life [Courchesne et al., 2004] support the idea that as early as 1 year of age, children with autism may show signs of developing quite differently from their typically developing peers.

Although discussions continue as to whether and why autism seems to be on the upswing, awareness has certainly increased [Fombonne, 2003]. Several studies have demonstrated that early detection and early intervention do have a positive impact on outcomes for children with autistic spectrum disorders [Hoyson et al., 1984; Lovaas, 1987; Rogers and Lewis, 1989; Harris et al., 1991; Birmbraver and Leach, 1993; McEachin et al., 1993; Lord, 1995; Dawson and Osterling, 1997; Smith et al., 1997; Jocelyn et al., 1998; Sheinkopf and Siegel, 1998; Smith and Lovaas, 1998; Harris and Handelmann, 2000; Sonnander, 2000]. In fact research suggests that intervention before three or three and a half years of age has the greatest impact. [Harris and Handelmann, 2000; Woods and Wetherby, 2003]. The findings that early identification and intervention lead to improved outcomes suggest that autism is an appropriate disorder for which screening should be undertaken. This realization has prompted a focus on the development of autism-specific screening tools appropriate for use with young children.

Several issues regarding the screening for autism in young children need further clarification. What type of screening is best: should the screening be broad-based developmental screening, or autism-specific? What is the best age at which to screen? What is the best method for screening; should parent report be used, or is direct observation a better approach?

**WHAT TYPE OF SCREENING IS BEST?**

Since research suggests that the first indication of a problem in children who are subsequently diagnosed with an ASD may occur as early as the first year of life [Osterling and Dawson, 1994; Baranek, 1999; Werner et al., 2000; Osterling et al., 2002] and that in the U.S., early intervention is not only an accepted but
manded means of addressing the needs identified for children from birth to the age of three, screening all children once or twice during that timeframe would facilitate the timely identification of children who need early intervention and/or monitoring.

There are generally two models used to screen for autism. The first model is consistent with practice parameters endorsed by the American Academy of Pediatrics (AAP), as well as the American Academy of Neurology (AAN) [Filipek et al., 1999; Filipek et al., 2000AAP, 2001a, 2001b, 2001c]. It consists of ongoing developmental surveillance of children within the primary care setting. In Dworkin [1993], developmental surveillance is defined as:

“a flexible, continuous process whereby knowledgeable professionals perform skilled observations of children during the provision of health care. The components of developmental surveillance include eliciting and attending to parental concerns, obtaining a relevant developmental history, making accurate and informative observations of children, and sharing opinions and concerns with other relevant professionals (p. 533).”

It is suggested that standardized general developmental screening tools be used as part of the developmental surveillance process. These tools can either be a parent–completed questionnaire or clinician-completed measure. If general screening raises concerns suggestive of possible autistic spectrum disorders, autism-specific screening could then be administered. The challenge of provider-implemented screening was highlighted by a recent study, which found that half of the surveyed physicians used a formal screening tool (Sices et al., 2003). However, a primary benefit of using this model to screen for autism is that it incorporates autism screening into an already accepted practice within the field of pediatrics. As such, autism-specific screening is less likely to represent an additional item to be included in the already overburdened well child care (WCC) visit. Another benefit is that it allows the screening to be undertaken within the context of the child’s “medical home.”

The term “medical home” was first used in 1967 [Sia et al., 2004]. The American Academy of Pediatrics (AAP) in a policy statement provided 7 dimensions (accessible, continuous, comprehensive, family-centered, compassionate, culturally effective, and coordinated with specialized services provided outside of the primary care setting) that should be found within a medical home [AAP, 2002; Bethell et al., 2004]. As a result of this type of care, the child is viewed as the multi-faceted being that he or she is. The fact that any identified concerns will be raised by a provider with whom the family and child already have a relationship may lend additional credibility to the screening process and findings. There are, however, potential limitations with this model. It depends on the primary care provider performing developmental surveillance/screening, recognizing the red flags for autism, and pursuing the appropriate next steps in a timely manner. This possibility is especially problematic as the frequency of well-child care visits begins to decrease in the toddler years. Also, a potential challenge with this approach is the limited amount of time available to most providers for accomplishing a growing number of tasks during the WCC visit. Perhaps due in part to this, in some instances, the dimensions of the medical home are not fully implemented [Strickland et al., 2004].

Although there are currently no validated autism-specific screening instruments designed for children less than 18 months old, several groups are working to better understand how autism presents in that age group in a prospective manner. Zwagenbaum et al. [2005] recently published data from their ongoing prospective study with siblings of children diagnosed with an ASD. They have designed an observational scale for assessing autism-specific behavior in children. This is a promising line of research whose findings may lead to validated measures for screening and diagnosing children less than 18 months of age, or even less than 12 months of age. At the present time, providers should use validated general developmental surveillance/screening with their patients under 18 months old.

The second model consists of the routine administration of autism-specific screens at multiple high-risk ages (e.g., 18 and 24 months of age) by primary care providers, regardless of the presence of symptoms or concerns suggestive of an ASD. This would be done in addition to developmental surveillance, including the use of general developmental screening. The primary benefit of screening at several ages is that the likelihood of not recognizing a child with possible ASD is diminished. There are three main limitations to this approach. First, it would require already busy primary care providers to remember to administer an autism-specific screening instrument to all children, even those who they feel are developing appropriately. Providers may hesitate to raise the possibility of a disorder such as autism with every parent they encounter at a preset interval due to concerns that the mere administration of these screens will be anxiety provoking for some parents. Secondly, the question arises as to which instrument primary care providers should use. Screening instruments for children younger than 16–18 months have not yet been validated, although multiple research groups are working to identify reliable signs in infancy. Multiple versions of a screener would be needed for children of different ages. Lastly, as the number of screening instruments for different conditions increases, primary care providers may be unable to fit them all into the limited time available for the well-child care visit.

Research suggests that the age at diagnosis seems to be influenced by socioeconomic status and/or race/ethnicity [Mandell et al., 2002]. Furthermore, missed and misdiagnosed ASDs seem to be more prevalent in certain populations [Mandell et al., 2002; Dyches et al., 2004; Pinto-Martin and Levy, 2004]. The cause for this is not yet known, but may be linked to several factors related to racial and ethnic disparities in the quality of health care [Smedley et al., 2003], including screening and referral practices. There is also the possibility that the symptoms of autism may differ across populations, not only in terms of which symptoms are present and the timing of presentation, but also which symptoms concern parents, and whether they share these concerns with pediatric providers. Providers need to ensure that all children in their care are being screened. Towards that end, whichever model is used to screen for autism should include pre-determined steps. Empirical data is needed to determine which model is most effective. It is possible that different models will work best in different patient and provider populations, and at different points in development.

**WHAT IS THE BEST AGE TO SCREEN?**

There are both advantages and disadvantages to early screening. On one hand, earlier screening may yield a diagnosis and subsequent intervention at an earlier age, allowing the maximum time for intervention. On the other hand, autism-specific screening at less than 16–18 months old has not yet been validated. Additionally, children who regress or those with Asperger’s syndrome and high functioning autism may be missed by early screening, as they often present...
later. Furthermore, health care providers may be reluctant to screen for autism at younger ages because of concerns that such screening will lead to parental anxiety. Perhaps contrary to this idea is the finding that significant numbers of parents have concerns about how their young child is developing, but if they are not asked, they may not share these concerns with their child’s primary care provider [Young et al., 1998; King and Glascoe, 2003; Bethell et al., 2004]. A core principle embedded in the concepts of developmental surveillance, the medical home, and early identification is eliciting and responding to parental concerns. Studies have demonstrated the importance of parental report in the early detection of developmental problems [Stone and Lemanek, 1990; Stone et al., 1994; Glascoe and Dworkin, 1995; Young et al., 2003]. It is important that providers respond to parental concerns and yet, a recent study found that expression of parental concerns did not lead to increased likelihood of the child being referred for the purpose of diagnosis or service provision [Sices et al., 2004].

Screening at later ages, such as screening after 18–24 months, may lead to missed opportunities for early intervention. However, this later screening will likely have better specificity and sensitivity. In addition, it may capture the children who develop autistic features at later ages, those who regress, or are higher functioning. Also, health care providers may feel more comfortable with the idea of screening older children. Another challenge to early diagnosis is the possibility that the provider may be concerned when the parents are not. Since participation in early intervention is voluntary, unless the parents agree to receive the services, the child will not have the opportunity to receive them. Some parents may even refuse to allow their child to undergo the evaluative process. In such instances, repeated screenings may increase the likelihood that the parents will be convinced that the concerns being identified are worth further investigation, and screening at an older age may be less likely to encounter parental denial of concern.

In deciding on what age is most appropriate for autism-specific screening, it is important to remember that different items may be needed for screening at different ages. For example, some studies suggest that toddlers diagnosed with autism and those with developmental delays both have impaired pretend play [Baron-Cohen et al., 1996; Charman et al., 1998; Cox et al., 1999]. Yet, when preschool aged children with autism are compared with those with developmental delays, children diagnosed with autism are found to exhibit less pretend play skills than those with developmental disabilities [Lord et al., 1994; Cox et al., 1999; Noterdaeme et al., 2000].

To further complicate the issue, many typically developing young toddlers may show behaviors consistent with those seen in ASD, such as repetitive behaviors (e.g., opening and closing drawers and doors, turning lights on and off), repetitive motor behaviors such as hand flapping when excited, and insistence on routines (and indeed a certain sense of consistency and routine is crucial to minimizing frustration in that age group).

**WHAT IS THE BEST METHOD FOR SCREENING?**

Several factors must be considered in contemplating the best approach to autism screening. These include the availability, cost, ease of administration of instruments with acceptable sensitivity/specificity, timing of well-child care visits for children, the amount of time available for these visits, the general approach to developmental screening and use of non-physician personnel (e.g., nurse practitioners, physical assistants, home visitors), cost-effectiveness, reimbursement, and the cultural expectations of the population served regarding screening and diagnosis both in terms of the process and the content.

Two methods often used in developmental screening are parent reports and observations by trained clinicians; each has advantages and drawbacks. Parental report is encouraged by many primarily because parents know their children best. They spend the most time with them in a variety of settings. This, therefore, provides them with many opportunities to observe the child across multiple settings, interacting with various individuals while they are in a variety of moods. This method, then, does not rely on a brief and what may be atypical sample of behaviors, and allows for observation of behaviors that may not be observable in most primary care offices, such as interest in peers.

Well-developed parent checklists are easy to administer, and in the short term may be the most cost effective option available to primary pediatric providers. Developmental surveillance, which includes clinical judgment, is aided by the systematic elicitation of parental concerns across developmental domains, using validated parent questionnaires.[Glascoe et al., 1989; Glascoe, 1994; Glascoe and Dworkin, 1995; Glascoe and Sandler, 1995; Glascoe, 1997]. Finally, parental concerns regarding the emotional, behavioral, cognitive, fine motor, and language development of their children are predictive of the existence of a true problem [Glascoe and Dworkin, 1995].

Efforts to increase public awareness of developmental disorders such as autism include the Centers for Disease Control and Prevention (CDC)’s Learn the Signs campaign (www.cdc.gov/actearly; 1–800–CDC–INFO), as well as a comprehensive parent-developed site (www.firstsigns.org). These campaigns are aimed at educating parents about child development and the warning signs of developmental disorders such as autism. As part of the campaign, both the CDC and First Signs have developed kits with information about screening and early development for pediatric providers. It is always possible that parents of typically developing children may unnecessarily become concerned as a result of public awareness campaigns such as Learn the Signs. In such instances, reassurance and parent education may be all that is required. More research is needed to ascertain whether the nature of the concerns raised by parents of typically developing children is different from those raised by the parents of typically developing children.

The advantages of professional observation include knowledge of the full range of what constitutes typical development. Clinicians are more objective than parents and may be less likely to over- or under-estimate a given child’s skills or problem behaviors. The significance of a given behavior may not be as clear to a parent as it might be to a trained observer. Finally, in many instances, the setting used for undertaking the observations can be standardized.

**GENERAL DEVELOPMENTAL SCREENING TOOLS**

There are many broad developmental screening tools that may have a role in the early identification process. Discussion of these many tools is beyond the scope of this article, and the reader is referred to a recent review article on the subject [Glascoe, 2000]. This review focuses briefly on two of the tools widely used by pediatric providers and one that focuses on communication and symbolic behavior. The three measures are the Parents’ Evaluation of Developmental Status (PEDS), the Ages and Stages Questionnaire (ASQ), and the Communication and Symbolic Behavior Scales.
Developmental Profile (CSBS DP). As screens of general development some of these tools may not target the core signs and symptoms of autism, for example, the PEDS does not include questions about play and imitation.

The Peds is a ten item instrument designed to be self-administered by parents of children from birth to 8 years of age, and elicits parent concern in developmental domains such as fine and gross motor skills, receptive and expressive language, and self-help skills. The type of parental concerns leads to categorization of risk for developmental difficulties: high, moderate, and low with corresponding responses such as refer, reassure, and offer developmental promotion and parent education. The Peds has been standardized and validated and meets the recommended psychometric properties for a screening instrument (sensitivity and specificity greater than 0.70) [Glascoe, 2001; Glascoe, 2003; www.pedstest.com].

The Ages and Stages Questionnaire (ASQ) is developed for use with children 4–60 months old, parents are asked to respond to descriptions of a list of skills with the response options: not yet, sometimes, or yes [Bricker and Squires, 1999]. Each form is intended for use with a certain age group (e.g., 4 years old) and consists of thirty developmental items divided into five areas: communication, gross motor, fine motor, problem solving, and personal-social. There is also a section for general parental concerns. Many of the items are accompanied by illustrations, and the reading level is sixth grade or below. The items were selected based on the likelihood of being observed or elicited by parents in the home setting. The ASQ reportedly has a range of classification agreement from 76 to 91% [Bricker and Squires, 1999], with developmental assessment tools such as the Bayley Scales of Infant Development [Bayley, 1993].

The Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP, Wetherby and Prizant, 2002) includes three measures: the Infant-Toddler checklist, an expanded Caregiver Questionnaire, and a Behavior Sample. The CSBS DP is based on a tool previously designed by the same authors the CSBS [Wetherby and Prizant, 1993]. The CSBS DP is a screening and evaluation instrument designed to measure the communicative and symbolic abilities of children aged 12–24 months. The measured skills form three composites: social (emotion, eye gaze, and communication), speech (sounds and words), and symbolic (understanding and object use) [Wetherby et al., 2004]. The 24 item Infant-Toddler checklist asks about developmental milestones (e.g., when you look at and point to a toy across the room; does your child look at it; does your child point to objects?). Nineteen of the twenty four items have the answer choices: not yet, sometimes, and often, the remaining five are ‘how many’ questions. At the bottom of the form parents are also asked a yes/no question: do you have any concerns about your child’s development? They are asked to describe any existing concerns they may have. It is designed to be completed by the parent or caregiver. The Behavior Sample is a videotaped evaluation of the child during an interaction with his/her parent and the clinician. Wetherby et al., [2004] propose the use of the Infant-Toddler Checklist as a first level screen, with the Behavior Sample serving as a second level evaluation tool. The tool was not designed to be an autism-specific screening tool, but rather a tool to screen for delays in communication, including prelinguistic skills; as such, it may be sensitive to a range of social communicative delays, including autistic spectrum disorder.

The PEDS, ASQ, and CSBS DP are not designed to selectively screen for autism, but they may be effective in detecting children whose developmental problems are consistent with autism. Screening a large sample of children from an unselected population will be needed to demonstrate their usefulness as primary screens for children with autism.

SCREENING TOOLS FOR AUTISTIC SPECTRUM DISORDERS (ASD)

There are several autism-specific tools currently under development, or revision, and as such it would be premature to recommend one. Many of these promising tools still need to undertake continued follow up of the original samples used in their development, as well as cross-validation with new samples.

In addition to the Modified Checklist for Autism in Toddlers (M-CHAT), which will be discussed in more detail later, four other autism-specific screening tools are the Checklist for Autism in Toddlers (CHAT), Pervasive Developmental Disorders Screening Test-II (PDDST-II), Screening Tool for Autism in Two year olds (STAT), and Checklist for Autism in Toddlers-23 (CHAT-23).

CHAT

The CHAT is a screening tool intended for use in the general population at 18 months of age. It consists of nine parent report items (A1–9) and five observation items (Bi–v) [Baron-Cohen et al., 2000; 1996; 1992]. When looked at together five of the fourteen items have been found to be key indicators of possible autism based on the Diagnostic and Statistical Manual (DSM) criteria for autistic disorder: gaze monitoring (Bi); proto-declarative pointing (pointing to indicate interest rather than to request) (A7 + Biv), and pretend play (A5 + Bii). Baron-Cohen et al., [1996] found that if at 18 months the items gaze monitoring, proto-declarative pointing, and pretend play were failed, there was an 83.3% risk of being subsequently diagnosed with autism via a diagnostic evaluation. A follow up study [Baird et al., 2000] with 16,235 eighteen month old children using the CHAT found, however, that although the specificity of the CHAT was excellent, the sensitivity (20–38% depending on criteria used) was unacceptably low. This suggests that the CHAT may not be an appropriate tool to use as an exclusive screening tool for identifying children who may have an ASD, and is currently under revision by the authors.

PDDST-II

PDD ST-II [Siegel, 2004] consists of 3 stages designed to be used in three different clinical settings. The PDDST Stage 1 consists of 22 items with the response choices ‘yes, usually true’ or ‘no, usually not true.’ Its intended use is in the primary care setting with 12–48 month olds. A positive screen signals the need for further evaluation and is defined as 5 or more items being answered ‘yes, usually true.’ The author reports a sensitivity of 0.92 and 0.91 based on a sample of 681 children ‘at risk for ASD’ and 256 children with ‘mild-to-moderate other developmental disorders’.

The other two stages of the PDDST are intended to be used in settings other than the primary care provider’s office. Stage 2 is a 14-item screening tool for use in developmental clinics. The cut-off is still 5 items with a reported sensitivity and specificity of 0.73 and 0.49 based on 490 children with confirmed ASD (Autism, PDD-NOS, or Asperger’s syndrome) and 194 children who were evaluated for an ASD, but who did not receive a diagnosis on the autistic spectrum [Siegel, 2004]. Stage 3 is a 12 item screening tool designed to be administered in autism clinics with a cut-off score of 8. The reported sensitivity and specificity is 0.58 and 0.60, respectively [Siegel, 2004]. The sensitivity and speci-
ifictivity reported for stage 1 are good. Those for stage 2 and 3 are not as good, particularly, the specificity for stage 2. The major statistical shortcoming of this instrument is that no sensitivity/specificity data are reported for large-scale screening of an unselected sample.

**STAT**

The STAT [Stone et al., 2000; Stone et al., 2004] is designed as a second level screening tool for autism. It is intended to be used by professionals in communities to identify children with possible autism, as opposed to other developmental disabilities. The items are administered within a twenty-minute long play-based interactive session. The ten scored items include play (2), imitation (4), directing attention (4), and do not require language comprehension. Two additional requesting items are included as a means of promoting interaction between the evaluator and child. Two samples were used to assess the validity of the STAT as a second level screening instrument. The sample used in the development phase consisted of 40 children (5 with autism, 33 without), the sample used for validation had 33 children (12 with autism, 21 without autism). The children in the two samples ranged in age from 24 to 35 months old. The children with autism had lower developmental ages than the children without autism. Data from a subsample of children with (12) and without (12) autism matched for developmental age was also analyzed. The two examiners administering the STAT were blind to the referral questions and the results of the diagnostic assessments. The parents of the participating children were blind to the results of the diagnostic evaluation until after the STAT screening was completed. The diagnoses were made based on DSM-IV criteria (APA, 1994) and the Childhood Autism Rating Scale (CARS, Schopler et al., 1988). The sensitivity and specificity of the subsample matched for DA were each 0.83. The sensitivity and specificity for the validation sample were 0.83 and 0.86, respectively.

The authors of the STAT highlight three areas needing additional research. Firstly, replication studies with larger samples from many different settings are needed before the findings can be generalized. Secondly, future studies need to use standardized measures such as the Autism Diagnostic Observation Schedule—Generic (ADOS-G) [Lord et al., 1999], in addition to clinical judgment. Finally, follow up studies with larger sample sizes need to match those children diagnosed with autism and those without for mental ages and assess the sensitivity and specificity of the STAT in that instance. Nevertheless, the STAT is a promising Level 2 screening tool for autism in children between two and three years old.

**The M-CHAT**

The M-CHAT [Robins et al., 2001] is a 23-item (yes/no) parent report checklist developed to screen children aged 16–30 months. As suggested by the name; the M-CHAT is a modification of CHAT [Baron-Cohen et al., 1992], described above. The M-CHAT expands upon the parent report portion of the CHAT, and seeks to identify children with a possible autistic spectrum disorder, including PDD-NOS, and not just strictly defined Autistic Disorder.

The initial population screened by the M-CHAT consisted of 1,293 children aged 16–30 months [Robins et al., 2001]. Of the 1,293 children screened 58 were evaluated and 39 were diagnosed with an autistic spectrum disorder. None of the children evaluated at that time were found to be typically developing. Although absolute sensitivity and specificity are pending completion of follow up of the initial sample, based on the discriminant function analysis (DFA) classification at the time of first screening and evaluation, the M-CHAT has a sensitivity of 0.87, specificity of 0.99, positive predictive power of 0.80, and negative predictive power of 0.99 [Robins et al., 2001].

Excluded from the ongoing validation study are children who already have an ASD diagnosis prior to completion of the M-CHAT, and children younger than 16 months or older than 30 months at the time of M-CHAT completion. The sample is drawn from primary care practices, as well as early intervention sites. Children who fail the M-CHAT receive a confirmatory follow up telephone call at which time the completed M-CHAT is reviewed to clarify the selected answers and ascertain whether the child has in fact screened positive on the checklist. The completed forms are scored and the child is considered to have failed the initial screening if he/she fails any three of the twenty three items or two of the six critical items. The critical items on the M-CHAT are as follows: item 2 (interest in other children), item 7 (proto-declarative pointing), item 9 (bringing objects to show the parent), item 13 (imitating), item 14 (responding to name), and item 15 (following a point).

Those who fail in both the initial screening and the telephone follow up are evaluated by a team of evaluators, using the Autism Diagnostic Interview-Revised (ADI-R) [Lord et al., 1994]; ADOS-G [Lord et al., 2000; 1999]; CARS [Schopler et al., 1988]; Mullen Scales of Early Learning [Mullen, 1995]; Vineland Adaptive Behavior Scales [Sparrow et al., 1984], and the DSM-IV criteria [APA, 1994]. The ADOS is a semistructured instrument, which allows assessment of a child’s communication and social interactions. The ADI is a parent report measure with questions on the child’s communication, social relatedness, including play and interests and behaviors. The ADI and ADOS are currently considered the gold standard for diagnosing autism.

The number screened at Time 1 (completed form between 16 and 30 months old) has been increased to 4,200 children. 236 children who failed the initial screening have been evaluated at a mean age of 27.63 months: 165 were found to have an ASD, 67 have been diagnosed with a non-ASD developmental disorder, and 4 have been assessed as typically developing. To date 1,937 children evaluated at Time 1 have reached eligibility for rescreening at age 4. Data has been collected from 940 (mean age = 55.35 months). At rescreening, parents are asked to complete the M-CHAT, and are also asked whether in the interim the child has been referred for or diagnosed with an ASD. Six children have been identified as possible misses (failed the rescreening or referred for possible ASD): 2 of the 6 have been confirmed as misses, two are not misses, and two are classified as possible misses because they have not been able to be evaluated. Sixty three children evaluated at Time 1 have been reevaluated at Time 2. At Time 2, 38 of the 63 children have been diagnosed with an ASD, 17 have been diagnosed with a non-ASD developmental disorder, and 8 have been assessed as typically developing. Based on the M-CHAT score at Time 1 and the evaluation outcome at Time 2, the sensitivity and specificity are 0.85 and 0.93, respectively. (The sensitivity is as high as 0.95 if the possible misses are not included as misses). It is possible that the psychometric properties of the M-CHAT will be different when larger numbers from an unselected population are obtained.

Although this is still a work in progress, based on the data collected to date, certain items appear to be helpful in distinguishing between children with ASD as compared to those with a non-
The diagnoses made at 2 years old also appear to be relatively stable based on the available follow-up data. Although in a few cases, children moved from a non-ASD diagnosis to the typical development category, most of the changes in diagnosis were from an ASD to a non-ASD developmental disorder. Whether this change in diagnosis is due to misdiagnosis at Time 1 or is the result of early intervention and/or increasing maturity remains unclear at this time.

Part of the Early Detection study is the screening of the siblings of children with ASDs. Recent analyses of data collected from younger siblings of children diagnosed with an ASD found that the CHAT-23 was a positive screen (before phone interview) of 43%. As the M-CHAT is a parent-report measure, it is possible that these findings are partially inflated because of increased parental concern as a result of the previous ASD diagnosis of the older sibling. After the phone interview, 30% remained a positive screen. Twenty-three percent of the younger siblings were evaluated and diagnosed with an ASD. This is a higher rate than what has been reported in the literature for siblings, which may be due to an ascertainment bias, the parents of the siblings in this study may have sought participation in the study as a result of concerning signs that they observed.

The study also involves screening of children within low risk settings (primary care provider sites, Peds) and high risk settings (early intervention sites, EI). Based on 20 children screened through pediatric offices, the items that discriminate the children with Peds-referred ASD from the EI-referred ASD appear to be highly similar.

**CHAT-23**

Wong et al. [2004] used the M-CHAT and CHAT to develop a screening tool for use with a sample of Chinese children, the CHAT-23. The changes made to the original M-CHAT were the translation of the questions into "traditional chinese" and the addition of a graded scoring system (never (0%), seldom (<25%), usually (25–50%), or often (>50%) for 22 of the 23 M-CHAT questions instead of the yes/no responses of the original M-CHAT. The graded system was subsequently collapsed into yes (usually/often) and no (never/seldom) grouped to define fail/pass. In addition to the 23 item-questionnaire, the CHAT-23 has an observational section consisting of 5 direct observational items from the CHAT. When used with 212 children (87 with ASD and 125 non-ASD) with the mental age range of 18–24 months, Wong et al. found that failing any 2 of 7 key questions (imitate, pretend, point for interest, check reaction of parent, bring objects to show, follow a point, and take interest in other children) or any 6 of the overall 23 questions in the parent administered questionnaire yielded a sensitivity of 0.931 and 0.839, respectively. The specificity was of 0.768 or 0.848, respectively. The authors suggest a two-level screening system beginning with the M-CHAT and proceeding to the use of the observational portion of the CHAT for those who failed the M-CHAT. If the observation is failed, the child would then be referred for an autism evaluation. The fact that the psychometric properties being found when the CHAT-23 is used with a sample of Chinese children so closely resemble what is being found with the M-CHAT supports the validity of these instruments. In Wong et al.’s study, the chronologic ages of the enrolled children whose mental ages were 18–24 months old were 16–86 months old. It is important to note that when used with children whose mental ages are not known to be 18–24 months, the efficacy of the tool may be different. In addition, this range of chronologic ages is quite wide, future research should examine whether the screener is equally valid across this age range.

**CONCLUSION**

At this time, early intervention is the best response to Autistic Spectrum Disorders. Given this fact, the development of reliable tools for screening children under three years old is imperative. Early screening will lead to early diagnosis, early intervention, and the ultimate goal—improved outcomes. There remains the need for further research to elucidate many issues. When is the best age to screen? Are the diagnoses made in the toddler years stable? If the children subsequently improve, is it due to the effects of early intervention or was the early diagnosis incorrect? What is the best way to screen for autism? Is preliminary general developmental surveillance/screening best or is autism-specific screening needed for all children? Are there populations, such as the siblings of children with ASDs, for whom autism-specific tools are best?

Since many of the autism—specific tools for screening in young children are still under development, close attention needs to be paid to their psychometric properties in different SES and ethnic-cultural groups. The M-CHAT is one of a few tools, which show promise as a screening tool in different populations of unselected children. It has been translated into Turkish, Chinese, Japanese, and Spanish. It will be important to evaluate the findings of studies using the M-CHAT in these different languages and cultures for similarities and differences in their findings. Beyond the languages being used, different cultural and socio-economic groups may interpret the questions differently, yielding different results. Not only may the specific signs/symptoms of autism vary across cultural groups, the meaning attributed to them by parents may as well. For example, the fact that a child does not point or make eye contact may be considered appropriate and acceptable if to point and make eye contact with adults is considered a sign of disrespect. Therefore, more work focused on understanding what concerns compatible with ASDs may be more universal than others is needed.

Despite these unresolved issues, a few facts remain clear. First, primary care providers are the appropriate people to screen children between birth and the age of 5 years old, since they are the qualified professionals with whom parents have ongoing contact. Second, the well-child care visit provides only a limited amount of time for the screening of children, with each of the many disorders potentially requiring that their own screening tool and process be used. The tools that will be used by providers are likely to be those that accurately flag children for many developmental disorders. Third, in light of the data supporting the usefulness of eliciting parental concerns, any tool used will probably need to incorporate the parent’s perspectives. Fourth, data suggests that children of parents from minority racial/ethnic backgrounds regardless of SES and those with lower socio-economic status may not be receiving quality health care. This disparate care includes a lack of screening, evaluation/diagnosis, and service provision. This must be addressed promptly, since the literature supports the notion that the earlier the identification of and intervention for developmental disorders, the better the outcomes.

**ACKNOWLEDGMENTS**

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REFERENCES


CDC’s Learn the Signs. Available at www.cdc.gov/ earlyact; 1–800-CDC-INFO


APPENDIX: M-CHAT*

Please fill out the following about how your child usually is. Please try to answer every question. If the behavior is rare (e.g., you have seen it once or twice), please answer as if the child does not do it.

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Does your child enjoy being swung, bounced on your knee, etc.?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Does your child take an interest in other children?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Does your child like climbing on things, such as up stairs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Does your child enjoy playing peek-a-boo/hide-and-seek?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Does your child ever pretend, for example, to talk on the phone or take care of dolls, or pretend other things?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Does your child ever use his/her index finger to point, to ask for something?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Does your child ever use his/her index finger to point, to indicate interest in something?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Can your child play properly with small toys (e.g., cars or bricks) without just mouthing, fiddling, or dropping them?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Does your child ever bring objects over to you (parent) to show you something?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Does your child look you in the eye for more than a second or two?</td>
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<td></td>
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<tr>
<td>11</td>
<td>Does your child ever seem oversensitive to noise? (e.g., plugging ears)</td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td>Does your child smile in response to your face or your smile?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Does your child imitate you? (e.g., you make a face—will your child imitate it?)</td>
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<tr>
<td>14</td>
<td>Does your child respond to his/her name when you call?</td>
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<td></td>
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<tr>
<td>15</td>
<td>If you point at a toy across the room, does your child look at it?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Does your child walk?</td>
<td></td>
<td></td>
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<tr>
<td>17</td>
<td>Does your child look at things you are looking at?</td>
<td></td>
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<tr>
<td>18</td>
<td>Does your child make unusual finger movements near his/her face?</td>
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<tr>
<td>19</td>
<td>Does your child try to attract your attention to his/her own activity?</td>
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<tr>
<td>20</td>
<td>Have you ever wondered if your child is deaf?</td>
<td></td>
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<tr>
<td>21</td>
<td>Does your child understand what people say?</td>
<td></td>
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<tr>
<td>22</td>
<td>Does your child sometimes stare at nothing or wander with no purpose?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Does your child look at your face to check your reaction when faced with something unfamiliar?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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