Parental Concerns Based General Developmental Screening Tool and Autism Risk: The Taiwan National Birth Cohort Study

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ABSTRACT: Early detection of developmental delay and childhood disorders are important for early intervention. This study aimed to describe the distribution of responses in a large population-based survey, identify cutoff points for the parent concern checklist (PCC) suitable for the Chinese language and culture, and explore how many children were identified as having evidence of problems at age 18 mo different from those at age 6 mo. Using a national randomly selected sample, the overall development of 21,248 children was investigated using the Taiwan Birth Cohort study instrument, and the PCC, a problem-oriented screening instrument. The Newton-Raphson iteration showed that the PCC should be separated into three groups, those scoring 1–2 in the first group, 3–6 in the second group, and 7–8 in the third group. Structural equation models showed that 6-mo development was predictive of 18-mo development; additionally, 18-mo development and the PCC showed good concurrent validity. This study identified three groups with distinct developmental trajectories and two cutoff points of 2/3 and 6/7. Thus, the PCC can be used as a first-stage screening instrument in a two-stage window screening procedure. Further studies are needed to investigate the factors, which contribute to the differences among these groups; follow-up on the typical and atypical development of these children is necessary. (*Pediatr Res* 67: 226–231, 2010)

Autism spectrum disorders (ASD) have an estimated prevalence of 6.7 per 1000 (1). Although previously, children with ASD were not normally diagnosed until age 4 y or older, recent advances have facilitated the identification and diagnosis of these children at toddlerhood (2). Early diagnosis has enabled these children to attend early intervention sooner, which has been shown to be effective in decreasing autistic symptomology (3) and also decrease family stress (4). Glascoe and Dworkin (5) proposed that parental reports increased the accuracy of clinical judgments in detecting children with behavioral and developmental problems; this seems to be the most efficient developmental detection method for physicians to administer and interpret (6). For ASD, autism-specific screening tools, such as the modified checklist of autism in

toddlers (M-CHAT) have been widely used in research and clinical settings (2); however, parents need to be aware of these children and bring these concerns to their pediatrician before the children can receive such screening. In addition, pediatricians sometimes fail to ask parents about their concerns, thus a broadband screening checklist can be helpful for pediatricians in understanding parental concerns.

Although some research suggests that ASD can be detected at 6 mo (7), another study showed that most parents reveal their concerns regarding their children's slow or uneven development in language and socialization at 18 mo (8). Similarly, other studies have shown that delayed language was the most frequently reported behavior at 18 mo, and some even noted a regression of language at 18 mo (9–11). Eighteen months can be a critical point for detection, because before or up to 6 mo, executive and activity dysregulation are normal due to the immaturity of the frontal lobe function (12), and these action schemata are better coordinated at about 1 y of development age (13,14). Thus, from 12 to 18 mo, children's cognitive functions are more mature, so it is easier for parents and physicians to detect their slow or uneven development.

To increase sensitivity, it has been suggested that surveillance and screening be included in every well-child preventive care visit (15). However, broadband screening has been criticized for its high rate of over referrals, which may lengthen the waiting list for treatment (16); therefore, after the first broadband screening, a more specific testing is needed (15). Chien *et al.* (17) proposed a more efficient two-stage window screening method, which can be used to reduce the aforementioned broadband screening limitation. In this screening method, two cutoff points are needed, yielding three groups: those in the first (highest scoring) group are normal (assuming higher scores are better); and those in the third (lowest) group have the highest risk for the disorder and can be directly assessed using diagnostic tools such as the autism diagnostic inventory—revised (ADI-R) (18); those in the middle group,

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Abbreviations: ADI-R, autism diagnostic inventory—revised; ADOS, autism diagnostic observation schedule; AGFI, adjusted goodness-of-fit index; ASD, autism spectrum disorders; DD, developmental delays; M-CHAT, modified checklist of autism in toddlers; PCC, parent concern checklist; SEM, structural equation modeling; TBCHS, Taiwan Birth Cohort study

between the two cutoff points, have the highest probability of being misclassified and need to be further screened using a more specific screening instrument, such as the M-CHAT. A lower number of people need to be screened in the second stage using this method, which also decreases the cost of testing (17).

As mentioned earlier, broadband screening can be used to assist pediatricians in asking parents about their concerns. Previous studies that compared ASD-specific (*e.g.* M-CHAT) and broadband screening instruments [*e.g.* parents' evaluation of developmental status (PEDS)] have criticized broadband screening for its over referral (16) and failure to detect a portion of those with ASD (19). This problem can be solved by using the two-stage window screening method; however, to use this method, a large sample is needed to look at the distribution of these children to determine the two best cutoff points, so as to increase the positive predictive value. Also, to reduce over referral, Glascoe *et al.* (16) recommended that unique patterns of parental concerns should be noted. To detect these patterns, we would need to detect the differences in developmental distributions in a large-scale population-based sample. Therefore, there were two purposes to this study: 1) to describe the distribution of responses in a large population-based survey and identify cutoff points for the parent concern checklist (PCC) suitable for the Chinese language and culture and 2) to investigate how many children identified as different at 18 mo had evidence of problems at 6 mo, using a large sample.

METHODS

This study used the dataset from the Taiwan Birth Cohort study (TBCS). The TBCS is a large-scale national study on child development. Out of all infants born in 2005, 24,200 were selected using two-stage stratified random sampling. At the first stage of sampling, 85 cities and towns were systematically randomly selected out of the 369 cities and towns in Taiwan. At the second stage, proportional probability to the rate of birth (separated into 12 levels) was used to select newborns from the birth registers of these 85 cities. At 6 mo, 21,248 newborns and families (87.8%) were visited by trained researchers, and the collection of both demographic and developmental information was completed. At 18 mo, these researchers revisited these families again, and 20,172 (94.94%) agreed to participate in the follow-up. The study protocol was approved by the institutional review board of a teaching hospital in Taiwan, and informed consent was obtained from all participants at both stages of the study.

At 6 mo, parents were asked to fill out the TBCS instrument for 6-mo development, and at 18 mo, parents had to fill out the TBCS for 18 mo and an additional PCC instrument. Both the PCC and TBCS are broadband screening instruments; however, the PCC is a problem-oriented instrument inquiring into parental concerns about their children's development, and the TBCS measures the overall development of children. Both instruments were used in this study to investigate the developmental distribution of children.

The PCC includes eight items with yes-no responses. Items from PEDS (20) were used as a reference for this checklist in combination with the structure of the TBCS developmental instrument (21). Different from the PEDS, there is no algorithm in the PCC; the scoring of the PCC only requires the addition of all the items. In line with the structure of the TBCS developmental instrument, the eight items can be separated into four dimensions of gross motor (1 item), fine motor (1 item), and language (2 items), and four items measuring social communication development. Higher total scores meant parents expressed more concerns, thus worse development.

There are 26 items in the TBCS 6-mo scale, and 17 in the 18-mo scale measuring the children's daily performance based on parental observations. The items were answered using a three-point Likert scale. Higher scores meant better development. The TBCS has shown good reliability and validity in Taiwan (21).

Statistical analysis. The demographic distribution of the infants and parents was analyzed using descriptive analysis. The internal consistency of the PCC was tested using the Spearman correlation. SPSS 15.0 for Windows (Chicago, IL) was used for the earlier analysis. The developmental distribution of the PCC was analyzed using the Newton-Raphson iteration on the computer program MIX (22), which decomposes the distribution of the dataset under the estimated and defined parameters of components. In addition, Newton-Raphson was also used to find the two best cutoff points for the PCC. ANOVA was used to investigate the differences between the groups using the cutoff points found using the Newton-Raphson iteration. Finally, the concurrent validity of the TBCS and PCC at 18 mo was analyzed using structural equation modeling (SEM) analysis in the AMOS 7.0 statistical software package (SPSS). SEM was also used to test whether 6-mo TBCS results can predict 18-mo PCC results. Alternative hypothesized null models were analyzed and modified to reach the final model with the best fit. SEM results are presented in terms of χ^2 , *p* value, goodness-of-fit index, and adjusted goodness-of-fit index (AGFI). The significance of χ^2 is judged by the *p* value: a greater *p* value implies that the model has a better fit. AGFI indicates the variance of the model: when AGFI is >0.9, the model exhibits a good fit; therefore, a model with a *p* value >0.5 and AGFI >0.9 implies that the null model approximates the real structure.

RESULTS

The demographics of the infants and their parents are shown in Table 1. Of the 21,248 children, about half were male (52.5%). The mean age of the fathers was 32.5 ± 5.5 y and the mothers, 28.9 ± 4.9 y.

Correlation coefficients of gross motor, fine motor, language, and behavior were between 0.26 and 0.61, all statistically significant. A previous study has shown that the ideal correlation between different dimensions is between 0.30 and 0.75 (21). A correlation >0.30 demonstrates that the dimensions are in synch with each other; however, a correlation >0.70 shows that the dimensions have bad discriminative validity. Thus, the PCC shows good synchronization and still maintains its discriminative ability.

The distribution of the PCC as shown on the Newton-Raphson iteration for these 21,248 children at 18 mo is shown in Table 2. The Newton-Raphson iteration shows that the PCC should be separated into three groups, those scoring 1–2 in the first group, 3–6 in the second group, and 7–8 in the third group, thus, yielding the two cutoff points of 3/4 and 6/7.

The differences in the TBCS developmental results of these three groups were compared using ANOVA. There were 17,492 infants in the first group, 2,420 in the second, and 256

Table 1. The demographics of the children and their parents (N = 21,248)

	n (%)	
Boys	11145 (52.5)	
Maternal education		
Elementary school	846 (4.0)	
Junior high	2301 (10.8)	
High school	8498 (40.0)	
University/college	8861 (41.7)	
Graduate school	741 (3.5)	
Paternal education		
Elementary school	307 (1.4)	
Junior high	2631 (12.4)	
High school	8460 (39.8)	
University/college	8236 (38.8)	
Graduate school	1614 (7.6)	
	Mean (SD)	Range
Paternal age	32.8 (5.5)	17–79
Maternal age	28.9 (4.9)	14–48

Table 2. The Newton-Raphson iteration on the distribution of the PCC

PCC score	<i>p</i>		
	Group 1	Group 2	Group 3
1	85.08	14.92	0.00
2	73.29	26.71	0.00
3	48.58	51.42	0.00
4	18.84	81.15	0.01
5	3.88	95.61	0.51
6	0.43	84.99	14.58
7	0.01	26.89	73.10
8	0.00	0.03	96.97

in the third group. There were statistically significant differences between all groups in the TBCS developmental dimensions, with effect sizes ranging from 0.13 to 1.18, as shown in Table 3. At 6 mo, the effect sizes were inconsistent among the four dimensions, and there was a large effect size (1.18) in the dimension of fine motor. At 18 mo, the effect size of the four dimensions was synchronistic (around 0.6).

Using the PCC cutoff points for analysis, with the means of mixture analysis, the prevalence of developmental delays (DD) at 18 mo was 13.4% (12.2% mild DD and 1.2% moderate DD), as shown in Figure 1. There were significant differences in the PCC measure using the TBCS developmental instruments at 6 and 18 mo (Table 3). Especially, the PCC seemed also to have good discriminative ability in the four dimensions of gross motor, fine motor, language, and social development at 6 mo and to suggest a probable screening method before 18 mo.

Figure 1. Overview of the participation rate. TBCS, Taiwan Birth Cohort study instrument; PCC, parent concern checklist. At 6 mo, there was 87.8% response rate. At 18 mo, there was 94.9% response rate. Of 2461 participants have mild delayed (12.2%). Of 242 participants have moderate delayed (1.2%).

SEM analysis was used to test the concurrent validity of the TBCS and PCC results at 18 mo. In addition, the sample was separated based on the three groups suggested by the Newton-Raphson analysis: the first group with the lowest scores on the PCC was composed of those presumed to be normal (with the least number of concerns). Results showed that 6-mo TBCS was predictive of 18-mo results; in addition, 18-mo TBCS and PCC showed good concurrent validity with each other in both the second group and the third group, as shown in Figure 2.

Table 3. The developmental differences in the three parent concern groups measured using Taiwan Birth Cohort study developmental instruments at 6 and 18 mo

TBCS dimensions	Group 1 <i>n</i> = 17,492 mean (SD)	Group 2 <i>n</i> = 2420 mean (SD)	Group 3 <i>n</i> = 256 mean (SD)	ANOVA	Tukey's posthoc test	Cohen's <i>d</i>
6 mo						
Gross motor	22.93 (3.36)	22.47 (3.46)	21.77 (4.35)	$F = 32.78$ $p < 0.001$	G1 > G2, MD = 0.46, $p < 0.001$ G1 > G3, MD = 1.16, $p < 0.001$ G2 > G3, MD = 0.71, $p < 0.001$	0.13 0.30 0.18
Fine motor	16.65 (1.90)	16.39 (2.11)	13.96 (2.62)	$F = 32.36$ $p < 0.001$	G1 > G2, MD = 0.25, $p < 0.001$ G1 > G3, MD = 0.68, $p < 0.001$ G2 > G3, MD = 0.43, $p < 0.001$	0.13 1.18 1.02
Language	21.18 (2.45)	20.83 (2.58)	20.57 (2.88)	$F = 27.11$ $p < 0.001$	G1 > G2, MD = 0.34, $p < 0.001$ G1 > G3, MD = 0.60, $p < 0.001$ G2 > G3, MD = 0.25, $p < 0.001$	0.14 0.23 0.10
Social	6.09 (1.62)	5.97 (1.65)	5.71 (1.68)	$F = 12.99$ $p < 0.001$	G1 > G2, MD = 0.13, $p < 0.001$ G1 > G3, MD = 0.38, $p < 0.001$ G2 > G3, MD = 0.25, $p < 0.001$	0.07 0.23 0.16
18 mo						
Gross motor	14.06 (1.39)	13.54 (1.81)	12.70 (2.93)	$F = 228.58$ $p < 0.001$	G1 > G2, MD = 0.52, $p < 0.001$ G1 > G3, MD = 1.36, $p < 0.001$ G2 > G3, MD = 0.84, $p < 0.001$	0.32 0.59 0.34
Fine motor	8.11 (1.26)	7.70 (1.50)	7.20 (2.02)	$F = 155.02$ $p < 0.001$	G1 > G2, MD = 0.40, $p < 0.001$ G1 > G3, MD = 0.91, $p < 0.001$ G2 > G3, MD = 0.51, $p < 0.001$	0.29 0.53 0.28
Language	10.17 (2.12)	9.26 (2.38)	8.70 (2.70)	$F = 237.79$ $p < 0.001$	G1 > G2, MD = 0.91, $p < 0.001$ G1 > G3, MD = 1.46, $p < 0.001$ G2 > G3, MD = 0.55, $p < 0.001$	0.40 0.61 0.22
Social	13.29 (1.70)	12.59 (1.98)	12.00 (2.91)	$F = 227.50$ $p < 0.001$	G1 > G2, MD = 0.70, $p < 0.001$ G1 > G3, MD = 1.29, $p < 0.001$ G2 > G3, MD = 0.59, $p < 0.001$	0.38 0.54 0.24

G1, group 1; G2, group 2; G3, group 3.

Figure 2. Structural equation model of concurrent validity between TBCS and PCC 18-mo results. $\chi^2 = 5.519$; $df = 9$; $p = 0.787$; AGFI = 1.000. Group 2 PCC results (PCC 3–6): gross motor: $\beta = -0.05$, $p < 0.001$; fine motor: $\beta = -0.03$, $p < 0.001$; language: $\beta = -0.08$, $p < 0.001$; social: $\beta = -0.05$, $p < 0.001$. Group 3 PCC results (PCC 7,8): gross motor: $\beta = -0.07$, $p < 0.001$; fine motor: $\beta = -0.03$, $p < 0.001$; language: $\beta = -0.03$, $p < 0.001$; social: $\beta = -0.02$, $p < 0.001$. r value: PCC 7,8 $\times$ PCC 3–6 = -0.06 ; 6-mo gross motor $\times$ 6-mo fine motor = 0.43; 6-mo gross motor $\times$ 6-mo language = 0.41; 6-mo gross motor $\times$ 6-mo social = 0.34; 6-mo fine motor $\times$ 6-mo language = 0.47; 6-mo fine motor $\times$ 6-mo social = 0.41; 6-mo language $\times$ 6-mo social = 0.56; 18-mo gross motor $\times$ 18-mo fine motor = 0.38; 18-mo gross motor $\times$ 18-mo language = 0.22; 18-mo gross motor $\times$ 18-mo social = 0.36; 18-mo fine motor $\times$ 18-mo language = 0.25; 18-mo fine motor $\times$ 18-mo social = 0.36; 18-mo language $\times$ 18-mo social = 0.41.

The concurrent validity between the TBCS at 18 mo and the PCC in groups 2 and 3 resulted in a p value of 0.787 and AGFI of 1.000, as shown in Figure 2. All four dimensions of the TBCS (gross motor, fine motor, language, and social) were concurrent with the group 2 PCC results (gross motor: $\beta = -0.05$, $p < 0.001$; fine motor: $\beta = -0.03$, $p < 0.001$; language: $\beta = -0.08$, $p < 0.001$; social: $\beta = -0.05$, $p < 0.001$). Along the same line, the concurrent validity between the TBCS at 18 mo and the PCC in group 3 also showed that all four dimensions of the TBCS were concurrent with the PCC results (gross motor: $\beta = -0.07$, $p < 0.001$; fine motor: $\beta = -0.03$, $p < 0.001$; language: $\beta = -0.03$, $p < 0.001$; social: $\beta = -0.02$, $p < 0.001$).

The predictive validity of the TBCS 6-mo results for the PCC 18-mo results showed a good fit, with a p value of 0.637 and AGFI of 1.000 for groups 2 and 3, as shown in Figure 3. TBCS results at 6 mo were predictive of parental concern for gross motor, fine motor, and language development at 18 mo in the second group (gross motor: $\beta = -0.02$, $p = 0.005$; fine motor: $\beta = -0.01$, $p = 0.027$; language: $\beta = -0.03$, $p = 0.001$) and gross and fine motor development in the third group (gross motor: $\beta = -0.02$, $p = 0.001$; fine motor: $\beta = -0.03$, $p < 0.001$).

DISCUSSION

Our results showed that the PCC had good internal consistency and discriminative ability in the four dimensions of gross motor, fine motor, language, and social development. In addition, it had good concurrent validity with the TBCS

Figure 3. Structural equation model of predictive validity between 6-mo TBCS and 18-mo PCC results in (A) those scoring 3–6 in the PCC and (B) those scoring 7 and 8 in the PCC. $\chi^2 = 1.701$; $df = 3$; $p = 0.637$; AGFI = 1.000. r value: PCC 7,8 $\times$ PCC 3–6 = -0.04 ; 6-mo gross motor $\times$ 6-mo fine motor = 0.43; 6-mo gross motor $\times$ 6-mo language = 0.41; 6-mo gross motor $\times$ 6-mo social = 0.34; 6-mo fine motor $\times$ 6-mo language = 0.47; 6-mo fine motor $\times$ 6-mo social = 0.41; 6-mo language $\times$ 6-mo social = 0.56. TBCS results at 6 mo were predictive of parental concern for gross motor, fine motor, and language development at 18 mo in the second group (PCC 3–6): gross motor: $\beta = -0.02$, $p = 0.005$; fine motor: $\beta = -0.02$, $p = 0.027$; language: $\beta = -0.03$, $p = 0.001$. Gross and fine motor development in the third group (PCC 7,8): gross motor: $\beta = -0.02$, $p = 0.001$; fine motor: $\beta = -0.03$, $p < 0.001$.

developmental instrument at 18 mo. For using two-stage window screening, the two cutoff points of 2/3 and 6/7 were found. The results from the *posthoc* comparisons indicated that the three groups showed statistically significantly different developmental distributions.

The TBCS 6-mo results were predictive of PCC 18-mo results in gross motor and fine motor development in the second group and gross motor, fine motor, and language development in the third group. Social development was not predicted in either the second or the third group. However, it has been shown that social development is a vital factor in distinguishing ASD from other DD (23). Specifically, a previous study found that children with ASD can be distinguished from other children with DD in their ability to respond to names, followed by pointing, face “reading” and functional play (24). But at 6 mo, children have greater development in the motor dimensions. Another study found that 6-mo motor development was predictive of the overall development of children at 18 mo (21). This may explain why at 6 mo, TBCS results could not predict 18-mo PCC results. The instability of the development of children before 1 y of age can also explain why the stability of ASD diagnosis is better at 2 y of age (25). On the other hand, the effect size (<0.3) showed a similar finding of a lack of discriminating validity in the gross motor, language, and social dimensions. In addition, the effect size of fine motor (>1.0) may be considered for further study.

Of interest, the TBCS language dimension at 6 mo was predictive of 18-mo PCC results in the second group, but not in the third. Language, especially communication, is another diagnostic criterion for ASD. A previous study found that

Figure 4. The two-stage window screening for autistic spectrum disorder using PCC as the first-stage screening instrument.

ASD children had greater impairment in receptive language and functional communication than those with language impairment (26). In addition, another study found that ASD children performed globally younger than other DDs (23); therefore, it may be possible that the differences distinguishing those in the second and third groups are the ASD and other DDs.

Although we are unsure of the cause of the differences among these three groups, we are sure that these groups do perform statistically significantly different in all dimensions of their development at 6 and 18 mo. Thus, the PCC can be used as the first-stage screening instrument in a two-stage window screening procedure. The American Academy of Pediatrics has proposed that developmental surveillance using developmental screening tools be incorporated into every well-child's visit (15). Herein, we propose an algorithm, which incorporates the use of two-stage window screening (17). Because the PCC has only eight items, it can easily be administered to parents in clinics or during home visits and be administered by professional or nonprofessional health workers. Parents can be given the PCC in the waiting rooms or asked by the pediatricians or nurses at every visit. The scoring of the PCC only requires the counting of the number of items that the parents are concerned, thus the person administering the screening can immediately judge, which developmental group the child falls into. As shown in Figure 4, once the person administering the screening calculates the score and decides, which group the child falls into, he/she will know if the child needs further testing. Those in the borderline group (group 2) should be administered another more specific screening instrument (such as the M-CHAT) to decide if they need a more invasive test; those in the third group are already at high risk, and so should directly receive a more invasive and detailed diagnostic assessment, such as the ADI-R (18) or the autism diagnostic observation schedule (ADOS) (3). The ADI-R and ADOS are both semistructured diagnostic assessments, which require intensive training on the part of the administrator; administration time generally requires 40 min for the ADOS and 2–3 h for the ADI-R (3,18). In the traditional method of two-stage screening, all those scoring higher than the cutoff point need to be tested at the second stage, using a more invasive and

expensive assessment (in this case, the ADOS or ADI-R) (6). However, using two-stage window screening, fewer people need to be assessed in the second stage, which decreases the cost of testing (17) and the number of false positives.

Frankenburg (27) proposed that a developmental screening tool include the four criteria of a precise developmental norm, predictive validity, identification of children at risk, and validity. The PCC fulfills all four of these criteria. Our developmental norm has been developed in a large national randomized sample, with the two cutoff points of 3/4 and 6/7 identifying those at borderline and high risk, and finally, it has predictive validity with 6-mo TBCS results and concurrent validity with 18-mo TBCS results.

A limitation of this study is that we did not know the differences between these three groups of children, what factors contributed to their differences, or whether they were children with different diagnoses. However, the results of our study are from the follow-up of a large randomized national sample. Therefore, there are no recalled biases in the reporting of earlier development. Furthermore, to find out whether the PCC can be used as a valid screening tool for ASD, a case-cohort study design or nested case-control study for this purpose will need to be implemented (28). This National Birth Cohort Study, that as designing is requirement for the understanding the prevalence of psychiatric disorder and comorbidity, and further identifying the developmental psychopathology in the future.

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REFERENCES

1. Autism and Developmental Disabilities Monitoring Network Surveillance Year 2000 Principal Investigators; Centers for Disease Control and Prevention 2007 Prevalence of autism spectrum disorders-autism and developmental disabilities monitoring network, six sites, United States, 2000. *MMWR Surveill Summ* 56:1–11
2. Robins DL, Fein D, Barton ML, Green JA 2001 The modified checklist for autism in toddlers: an initial study investigating the early detection of autism and pervasive developmental disorders. *J Autism Dev Disord* 31:131–144
3. Lord C 2000 Commentary: achievements and future directions for intervention research in communication and autism spectrum disorders. *J Autism Dev Disord* 30:393–398
4. Scahill L 2005 Diagnosis and evaluation of pervasive developmental disorders. *J Clin Psychiatry* 66:19–25
5. Glascoe FP, Dworkin PH 1995 The role of parents in the detection of developmental and behavioral problems. *Pediatrics* 95:829–836
6. Glascoe FP, Foster EM, Wolraich ML 1997 An economic analysis of developmental detection methods. *Pediatrics* 99:830–837
7. Gillberg C, Nordin V, Ehlers S 1996 Early detection of autism. *Diagnostic instruments for clinicians. Eur Child Adolesc Psychiatry* 5:67–74
8. Siegel B, Pliner C, Eschler J, Elliott GR 1988 How children with autism are diagnosed: difficulties in identification of children with multiple developmental delays. *J Dev Behav Pediatr* 9:199–204
9. Bernabei P, Camaioni L 2001 Developmental profile and regression in a child with autism: a single case study. *Autism* 5:287–297
10. Davidovitch M, Glick L, Holtzman G, Tirosh E, Safir MP 2000 Developmental regression in autism: maternal perception. *J Autism Dev Disord* 30:113–119
11. DeMyer MK, Hingtgen JN, Jackson RK 1981 Infantile autism reviewed: a decade of research. *Schizophr Bull* 7:388–451
12. Zilbovicius M, Garreau B, Samson Y, Remy P, Barthélémy C, Syrota A, Lelord G 1995 Delayed maturation of the frontal cortex in childhood autism. *Am J Psychiatry* 152:248–252
13. Piaget J 1977 *The Grasp of Consciousness*. Routledge and Kegan Paul, London
14. Adrien JL, Rossignol-Deletang N, Martineau J, Couturier G, Barthelemy C 2001 Regulation of cognitive activity and early communication development in young autistic, mentally retarded, and young normal children. *Dev Psychobiol* 39:124–136
15. Council on Children with Disabilities, Section on Developmental Behavioral Pediatrics; Bright Futures Steering Committee and 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
16. Glascoe FP, Macias MM, Wegner LM, Robertshaw NS 2007 Can a broadband developmental-behavioral screening test identify children likely to have autism spectrum disorder? *Clin Pediatr (Phila)* 46:801–805
 17. Chien CC, Huang SF, Lung FW 2009 Maximally efficient two-stage screening: determining intellectual disability in Taiwanese military conscripts. *J Multidiscip Healthc* 2:39–44
 18. Le Couteur A, Lord C, Rutter M 2003 The Autistic Diagnostic Interview-Revised (ADI-R). Western Psychological Services, Los Angeles
 19. Pinto-Martin JA, Young LM, Mandell DS, Poghosyan L, Giarelli E, Levy SE 2008 Screening strategies for autism spectrum disorders in pediatric primary care. *J Dev Behav Pediatr* 29:345–350
 20. Glascoe FP 2006 Parents' Evaluations of Developmental Status: A Method for Detecting and Addressing Developmental and Behavioral Problems in Children. Ellsworth & Vandermeer Press, Nashville, TN
 21. Lung FW, Shu BC, Chiang TL, Lin SJ 2008 Efficient developmental screening instrument for 6- and 18-month-old children in the Taiwan Birth Cohort Pilot Study. *Acta Paediatr* 97:1093–1098
 22. Macdonald PD, Pitcher TJ 1979 Age-groups form size-frequency data: a versatile and efficient method of analyzing distribution mixtures. *J Fish Res Board Can* 36:987–1001
 23. Ventola P, Kleinman J, Pandey J, Wilson L, Esser E, Boorstein H, Dumont-Mathieu T, Marshia G, Barton M, Hodgson S, Green J, Volkmar F, Chawarska K, Babitz T, Robins D, Fein D 2007 Differentiating between autism spectrum disorders and other developmental disabilities in children who failed a screening instrument for ASD. *J Autism Dev Disord* 37:425–436
 24. Trillingsgaard A, Ulsted Sørensen E, Nemec G, Jørgensen M 2005 What distinguishes autism spectrum disorders from other developmental disorders before the age of four years? *Eur Child Adolesc Psychiatry* 14:65–72
 25. Stone WL, Lee EB, Ashford L, Brissie J, Hepburn SL, Coonrod EE, Weiss BH 1999 Can autism be diagnosed accurately in children under 3 years? *J Child Psychol Psychiatry* 40:219–226
 26. Loucas T, Charman T, Pickles A, Simonoff E, Chandler S, Meldrum D, Baird G 2008 Autistic symptomatology and language ability in autism spectrum disorder and specific language impairment. *J Child Psychol Psychiatry* 49:1184–1192
 27. Frankenburg WK 1994 Preventing developmental delays: is developmental screening sufficient? *Pediatrics* 93:586–593
 28. Gordis L 2009 Epidemiology. 4th ed. Elsevier Inc., Philadelphia, PA