

Screening for neurodevelopmental conditions: good or bad idea?

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The bottom line

- “All screening programmes do harm; some do good as well, and, of these, some do more good than harm at reasonable cost. The first task of any public health service is to identify beneficial programmes by appraising the evidence.”

(JA Muir Gray et al [BMJ](#). 2008 336: 480–483.)

WHO criteria for screening programmes:

- The condition should be an important health problem
 - The natural history of the condition should be understood
 - There should be a recognisable latent or early symptomatic stage
 - There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific
 - There should be an accepted treatment recognised for the disease
 - Treatment should be more effective if started early
 - There should be a policy on who should be treated
 - Diagnosis and treatment should be cost-effective
 - Case-finding should be a continuous process
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The condition should be an important health problem

- Neurodevelopmental problems certainly are! For example:
 - ADHD predicts injuries, problem substance use and smoking¹
 - Language delay predicts mental health problems at age 7² and at age 34³
 - Autism predicts bad outcomes in anorexia nervosa⁴
 - 1958 UK birth cohort: children rated by their teachers as being in the highest scoring quartile for emotional and behavioural problems had about double the mortality by age 46 years of children scoring in the lowest quartile⁵
 - In the Dunedin cohort, “A segment comprising 22% of the cohort accounted for 36% of the cohort’s injury insurance claims; 40% of excess obese kilograms; 54% of cigarettes smoked; 57% of hospital nights; 66% of welfare benefits; 77% of fatherless child-rearing; 78% of prescription fills; and 81% of criminal convictions. Childhood risks, including poor brain health at three years of age, predicted this segment with large effect sizes”⁶

¹Wilens et al JAACAP 2011,50: 543-553.

²Miniscalco et al. Dev Med Child Neurol 2006, 48: 361-366. ³Law et al. J Speech Lang Hearing Res 2009, 52: 1401-1416. ⁴Nielsen et al. J Eat Disord 10, 4 (2022). <https://doi.org/10.1186/s40337-021-00518-1>

⁵Jokela et al. JAACAP 2009, 48:19-24. ⁶Caspi et al Nature Human Behav. 2016 1: 0005

The natural history of the condition should be understood

- Many cohorts have answered questions about the trajectories of developmental problems, including:
 - ADHD
 - Autism
 - Conduct problems
 - Language development problems
 - Etc
 - But note that there are often problems with selective drop-out among the families with children with disruptive behaviour disorders
 - In general, the problems don't go away though the symptoms and specific diagnoses may change substantially – see Gillberg's work on "ESSENCE"
 - Autism, conduct disorder and ADHD symptoms often worsen during adolescence
 - Some conditions may improve after recognition and adapting the environment accordingly
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There should be a recognisable latent or early symptomatic stage

- Yes, there is for several conditions:
 - Abnormal gaze, response to sound/name, lack of protodeclarative pointing, pretend play etc for autism¹
 - Lack of canonical babbling for some language disorders²
 - Emotional dysregulation for conduct disorders³
 - Poor impulse control for ADHD and conduct disorder⁴
 - Lack of active parental engagement for ADHD and conduct disorders (but no obvious ADHD symptoms or signs seen in infancy)⁵
 - etc

¹Baron-Cohen et al. *B J Psychiatry* 1996;168:158-63. ²Lieberman et al, *Acta Paediatrica*, in press. ³Morrell & Murray. *JCPP* 2003; 44:489-508.

⁴Schoemaker et al. *J Abnormal Child Psychol.* 2013;41:457-71.

⁵Allely et al. *RIDD.* 2013;34:985-93, Johnson et al. *Int J Methods Psychiatr Res.* 2014;23:9-18., Marwick et al. *RIDD* 2013;34:562-72, Puckering et al. *BMC Pediatrics.* 2014;14:223

There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific

- This is where it gets interesting – and difficult! A few considerations:
 - Sensitivity
 - Specificity
 - Single problems or multiple problems?
 - Variation in test performance with age
 - Variation in test performance in different populations
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There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific

- Sensitivity – the proportion of “True Positive” cases detected
 - Ideally we want 100% sensitivity so we don’t miss any cases
 - If the condition/disease is very severe we usually try to ensure very high sensitivity
 - We can usually increase the sensitivity by lowering the cut-off point of the screening test (the threshold) but that will increase the number of “False Positives”
 - Some standard screening tests have low sensitivity – for example the Ages and Stages Questionnaire in detecting language disorder¹
 - Sometimes screening tests can have low sensitivity but still be useful, if they pick up a high proportion of severe or complicated cases deserving intensive treatment – for example lack of canonical babbling at 8 months²

¹Wilson et al. *BMJ Paediatrics Open*. 2022;6(1):e001324

²Lieberman et al, *Acta Paediatrica*, 2022, 111, 1914-20

There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific

- Specificity – the proportion of “True Negative” cases identified correctly
 - Ideally we want 100% specificity so we don’t overwhelm specialist services and worry parents unnecessarily
 - We can usually increase specificity by raising the cut-off point of the screening test (threshold) but that usually means we miss real cases (ie we increase the number of “False Negatives”)
 - In very severe conditions we can accept lower specificity. For example, most cancer screening tests have quite low specificity, but at a cost of anxiety for many patients without the disease
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There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific

- Trading off sensitivity and specificity – the Receiver-Operating Characteristic (ROC) curve

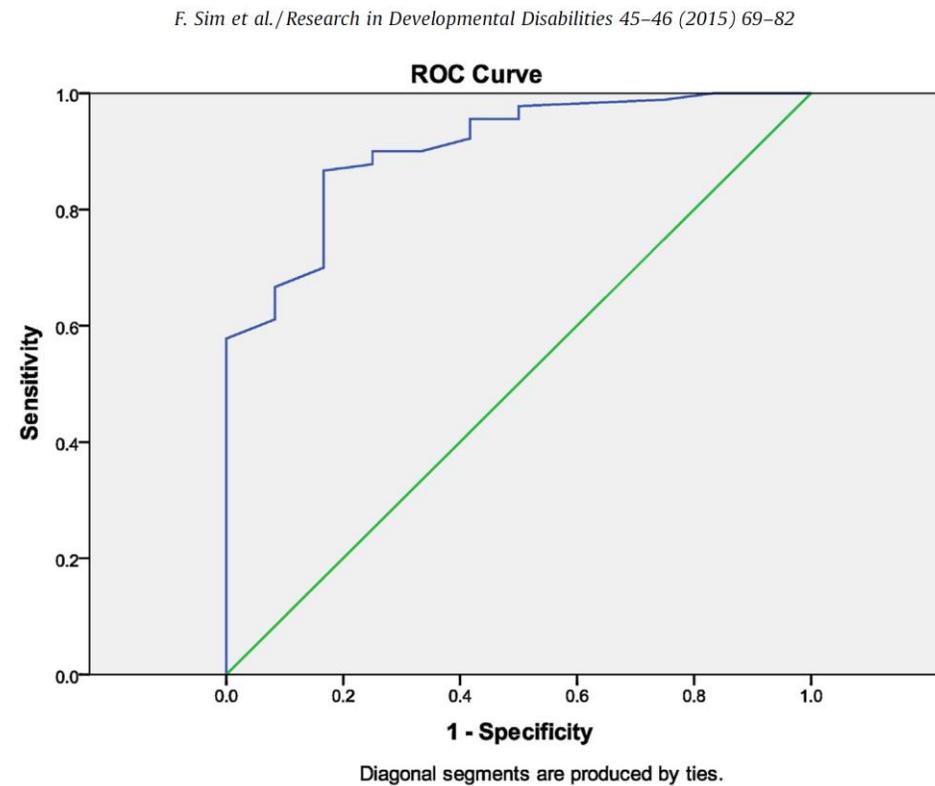


Fig. 2. Receiver-Operating Characteristics curve comparing *Sure Start Language Measure* as a screening tool against *New Reynell Language Development Scale* production OR comprehension scores $>2SD$ below mean for age 1–2 years later.

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- Single problems or multiple problems?
 - Neurodevelopmental conditions overlap and symptoms change with time
 - Having one neurodevelopmental problem increases the probability of having another
 - Screening for many conditions is more burdensome for parents, services and the economy
- So could we just screen young children for one thing – language ability?
 - Recent study in 333 children aged 24-30 months suggests that very few children with significant social/emotional/behavioural/attention problems (as assessed by the Strengths and Difficulties Questionnaire) have normal language function. Language screen had 87% sensitivity and 47% specificity for these problems.
 - Very similar results in Sim et al. study of 103 children aged 30 months¹ (“enriched sample”) given detailed neurodevelopmental assessments 1-2 years later: only 1/18 with any diagnosis had normal language development
 - Language screening may be more acceptable than screening for some other neurodevelopmental/neuropsychiatric conditions

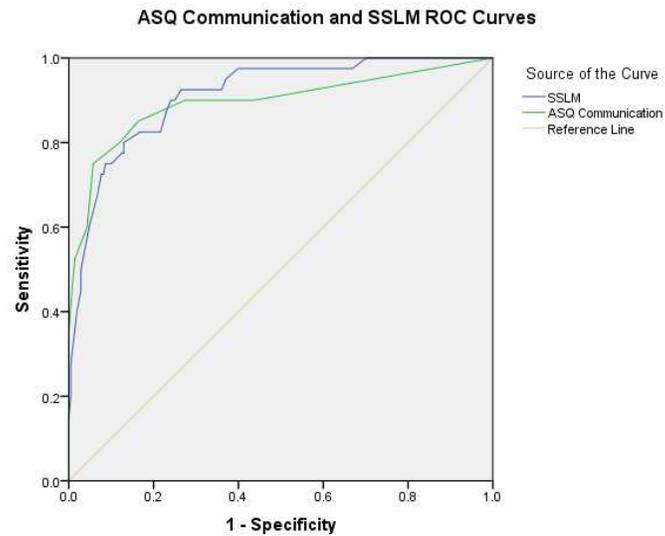
¹Sim et al. *Development of a triage tool for neurodevelopmental risk in children aged 30 months*. RIDD. 2015;45–46:69-82.

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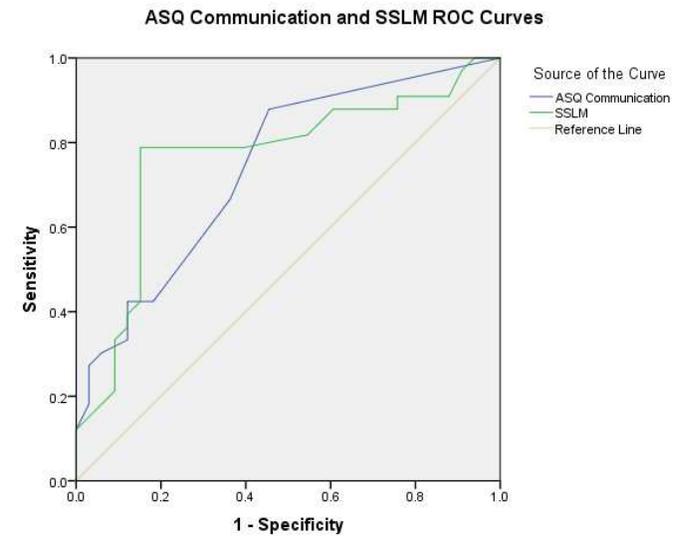
- Variation in test performance with age
 - We need to think carefully about the best age to screen for specific conditions
 - For example in assessment of language we need to take into account the fact that early trajectories of language development vary a lot before 2 years of age, so language screening tests perform less well in younger children
 - Earlier positive screening tests may indicate more severe pathology – eg lack of babbling
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There should be a test that is easy to perform and interpret, acceptable, accurate, reliable, sensitive and specific

- Variation in test performance in different populations



Exclusively English-speaking families



Families with other languages

There should be an accepted treatment recognised for the disease

- Some neurodevelopmental conditions are definitely treatable – ADHD, early conduct problems, epilepsy
 - Some neurodevelopmental conditions are probably treatable – language delay
 - Some neurodevelopmental conditions may be treatable – autism, tic disorders
 - Some neurodevelopmental conditions are not very treatable – eg global cognitive impairment
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Treatment should be more effective if started early

- Very difficult to prove this using clinical trials
- But there is lots of circumstantial evidence that early treatment works better than just waiting for bad things to happen:
 - Conduct disorder is certainly largely preventable with early intervention before age 5¹ and very difficult to treat later in life
 - Language development has critical/sensitive periods but there is annoyingly little randomised trial evidence for early intervention
 - Some evidence that autism symptoms (and diagnoses) can be reduced in the long term if high-risk infants are treated with a pre-emptive video-interactive programme²

There should be a policy on who should be treated

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COMMENTARY ARTICLE

International variation in programmes for assessment of children's neurodevelopment in the community: Understanding disparate approaches to evaluation of motor, social, emotional, behavioural and cognitive function

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Diagnosis and treatment should be cost-effective

- So far there is almost no useful evidence on this topic, and it's unlikely that screening policies will improve until there is.
- In Scotland the lack of evidence for effectiveness of developmental screening led to it being completely abandoned between 2006 and 2015. The reasons given for abandoning developmental assessments after age 6 weeks were:
 - Inequitable use of resources – the most deprived families had very low attendance, and the most affluent had very high attendance rates. So screening, if it worked, would increase health inequalities!
 - A belief that parents would attend their GP or health visitor if they had concerns about a child's development. We proved this to be untrue in the case of language disorder.¹ Similar recent evidence has emerged about severe visual impairment.²
 - A belief that most developmental problems could be predicted very early in life. Again we disproved that in the case of language delay and other neurodevelopmental problems^{1,3} and there were many reports that children were arriving at school with very major language problems that should have been treated

So beware! We need to gather evidence for effectiveness of screening

Case-finding should be a continuous process

- This is particularly relevant in child development screening. There needs to be a system for catching the children who “fall through the net”, particularly since a lot of high-risk children are not brought to appointments.
 - Continuity of care is likely to be important here – families need to feel comfortable about using primary care services, and personal therapeutic relationships with a known doctor/nurse or other clinician are likely to be valuable.
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Thank you!

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