Screening for Autism Spectrum Disorders in South Africa: Using the Modified Checklist for Autism in Toddlers (M-CHAT)

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Abstract

Autism Spectrum Disorder (ASD) occurs at a rate of 1 in 100 children worldwide, making it one of the most common neurodevelopmental disorders. Early detection, diagnosis and intervention results in significantly improved outcomes. However, there are currently no screening protocols available for use in South Africa. Therefore, this pilot study provides a preliminary investigation into the applicability of adapted and translated versions (English, Afrikaans and Xhosa) of the Modified Checklist for Autism in Toddlers (M-CHAT) screening tool in South Africa. The M-CHAT was given to parents (N=64) of children (18 months- 4 years 11 months) with (n=16) and without ASD (n=48). A subgroup (n=15) underwent formal diagnosis using the Autism Diagnostic Observation Schedule (ADOS). Logistic regression indicated that M-CHAT scores were significant predictors of ASD or non-ASD classifications, when using all 23 items (Nagelkerke R^2 =.70; χ^2 (1) = 41.80, p < .001) as well as when only using the six critical items (Nagelkerke R^2 =.62; χ^2 (1) = 34.69, p < .001). Preliminary cut-off scores for optimal sensitivity and specificity were determined by Receiver Operating Characteristic analyses. When using the 23-item scale, failure on three items had the best sensitivity (.94) for identifying ASD while maintaining high specificity (.98). When using the six critical items, failure on one item was the optimal cut-off to maintain high specificity (.92) and sensitivity (.81). The results are promising in terms of classifying ASD or non-ASD with a high sensitivity and specificity. The M-CHAT proved to be successful in predicting ASD, indicating its possible future use in the South African population.

Keywords: M-CHAT, ASD, screening, cut-off scores, South Africa, sensitivity, specificity

Screening for Autism Spectrum Disorders in South Africa: Using the Modified Checklist for Autism in Toddlers (M-CHAT)

Autism Spectrum Disorder (ASD) has been recognised as a highly prevalent disorder. Its symptoms are present from infancy or early childhood and their impact continues throughout a person's life, placing financial and functional strain on families and health care systems (Baird et al., 2006).

ASD is one of the most common neurodevelopmental disorders in childhood (Fombonne, 2009; Yama, Freeman, Graves, Yuan, & Campbell, 2012), with a prevalence of 60-116 cases per 10 000 children (Baird et al., 2006). There has been an increase in the prevalence of ASD in the last decade; this may be due to a real rise in incidence, but it may also result from the broader criteria for diagnosis. ASD is thought to occur in all classes and countries throughout the world, although epidemiological studies have mostly been conducted in North America and Western Europe (Sotgiu et al., 2011).

To date, there is no epidemiological data on ASD for many African countries, including South Africa (Grinaker et al., 2012). However, in a study of 355 Cape Town children (6-18 years) attending special schools for intellectual disability, 9.4% had a diagnosis of Autism (Molteno, G., Molteno, C., Finchilescu, & Dawes, 2008). Even though epidemiological data for ASDs in South Africa is not available, prevalence studies in various countries have provided similar rates to each other. Thus, we may assume that South Africa has similar rates to the rest of the world, (Baird et al., 2006; Robins, 2008) especially as ASD is a neurodevelopmental disorder.

In the review to follow, I will identify what ASDs are, as well as their age of onset. This information is relevant for identifying valid screening measures for detecting ASD at different ages of symptom onset, and distinguishing ASD from other developmental disorders. I will also consider the cross-cultural application of one such screening tool, the Modified Checklist for Autism in Toddlers (M-CHAT; Robins, Fein, Barton, & Green, 2001) and will then discuss its likely validity and benefits in South Africa. The identification and validation of screening tools for the diverse background of culture and language in this context is vital. In order for early intervention improvements to start appearing in South Africa, it is essential to introduce screening tools for easy and early detection of ASD.

ASD: Early Signs and Symptoms

ASDs are neurodevelopmental disorders, characterised by three areas of impairment:

communication, social interaction, and the repetition or stereotyping of behaviours or restriction of interests (Yama, et al., 2012). ASD is a grouping term for a number of related disorders that meet criteria from the Diagnostic and Statistical Manual of Mental Disorders - 4th Edition (DSM-IV-TR; American Psychiatric Association, 2000) classification. These include Autism Disorder, Asperger's Syndrome, and Pervasive Developmental Disorder -Not Otherwise Specified (PDD-NOS). However, research on the DSM-IV categories did not find clear-cut boundaries between the different subgroups (Matson, Beighley, & Turygin, 2012). The proposed revisions of the DSM-V suggest that there will only be two areas of impairment rather than three; the first is social and communication problems together and the second is restricted behaviour (Wing, Gould, & Gillberg, 2011). The DSM-V will also collapse Autism, Asperger's and PDD-NOS under one category, Autistic Disorder. Therefore, individual differences will rather be classified in terms of severity (Lord & Bishop, 2010).

The pathophysiological basis of ASD is not yet well understood; therefore, diagnosis at this point has to rely on behavioural criteria and the history of the child's development. Typical early indicators of ASD, found within the first year of life, are impairments in socialisation and communication behaviours. Impairments in socialisation behaviour include a preference for being alone, a lack of social interaction and gaze shifting, as well as avoidance of eye contact. Communication deficits in ASD include poor imitation of others, as well as a lack of suitable facial expressions and vocal communication. Four behaviours that are key to correctly differentiating 90% of older children with ASD from non-ASD children are (1) making little or no eye contact with others, (2) a deficit in orienting to name-calling, (3) a lack of pointing, and (4) a deficit in showing objects to others (Barbaro & Dissanayake, 2009).

Developmental problems most often become apparent between the ages of 12 and 24 months (Barbaro & Dissanayake, 2009), although autism symptoms can already appear as early as 8 months (Dumont-Mathieu & Fein, 2005). An ASD diagnosis made at 20 months is reliable, thus screening tools for this younger age group are valid predictors for ASD (Cox et al., 1999). Screening tools need to carefully take into account all the different ASD symptoms and ages of onset, in order to identify ASD and differentiate it from other developmental disorders.

Benefits and Limitations of Screening

Screening is a way of quickly attending to parental concerns, without being invasive

to the child. However, the outcome of screening is not a diagnosis, but rather an indication of an individual at high risk for ASD (Canal-Bedia et al., 2011). Screens are of vital importance in achieving early diagnosis, as paediatricians do not always recognise cases of ASD without a screening tool. For example, of the 21 cases diagnosed with ASD in the Robins (2008) study, paediatricians had recognised only four. Late diagnosis results in restricted improvements and limits access to needed services.

In autism, the average age at diagnosis is between 3.1 years and 5.7 years, and only 20-30% of US children showing signs of delay are identified before they enter school (Honigfeld, Chandhok, & Spiegelman, 2011). Decreasing the age of diagnosis to allow earlier intervention would likely result in developmental improvements in interactions with peers, decreased symptomology, and an increase in IQ scores and language ability (Baird et al., 2006). These improvements result from the plasticity of a younger, developing brain (Dawson, 2008). Improvements from early intervention would also decrease the costs associated with ASD.

In the United Kingdom and United States, there are societal costs of several billion dollars yearly due to autism (Elsabbagh et al., 2012). Family expenditure on children with autism in the US is also as high as 14% of their reported income (Montes & Halterman, 2008). The M-CHAT screen could help to alleviate the substantial costs involved with ASD in the long run (Robins, 2008) by improving future outcomes through early intervention. The M-CHAT is low cost in terms of money, time, and resources (Mawle & Griffiths, 2006).

Screening could shorten waiting lists for schools, diagnosis and services; therefore, reducing long-term burdens on families, education and healthcare systems (Gray & Tonge, 2005; Robins, 2008). Screening and early diagnosis are especially useful in a developing country like South Africa where healthcare resources are limited (Grinaker et al., 2012) and most people only have access to primary healthcare facilities. No formal training or prior ASD knowledge is required to administer the M-CHAT, so the screen coverage is to a greater population at low cost (Charman et al., 2001), thus, allowing more high risk cases to be identified.

There are also limitations to the use of screening devices. Screening poses the risk of false positives because it is not a diagnostic measure (Kozlowski, Matson, Worley, Sipes, & Horovitz, 2011), thus, a formal diagnosis is still required. However, early screens may also miss ASD when regression (between 18 and 24 months) and Asperger's disorder impairments occur after the screen (Dumont-Mathieu & Fein, 2005). Therefore, the age at screening is also an important aspect to consider.

A consistent finding is that ASD children aged 2 and below have more negative symptoms (a lack of communication and social behaviours), whereas those older than 2 years show more positive symptoms (high frequencies of repetitive behaviour and being more preoccupied with routines). These different ages of symptom appearance raise questions as to whether the same screening tool can be used for children below and above 2 years (Pandey et al., 2008; Ventola et al., 2006). Thus, ASD screens should possibly be administered at two high-risk ages, to identify children with different ages of symptom onset (Robins, 2008). The M-CHAT screening tool caters for the age range on either side of 2 years (18-30 months), therefore allowing the identification of risks early on and at later symptom onset.

M-CHAT Screening

The M-CHAT is a modification of the CHAT (Checklist for Autism in Toddlers; Baron-Cohen, Allen, & Gillberg, 1992) and it is one of the most respected screening instruments in its field (Snow & Lecavalier, 2008). It was initially developed as a population screening tool for ASDs in toddlers aged 18-30 months (Robins et al., 2001), although it is found to be relevant for children as young as 16 months (Ventola et al., 2006) up until 48 months (Yama et al., 2012). This tool is a quick, 23-item parental report checklist that requires yes/no answers to questions regarding the child's behaviour. Originally, a failure on the screen arose when two out of six critical items (questions 2, 7, 9, 13, 14, and 15) were failed, or any three items were failed. A failure indicates a high probability for an ASD (Robins et al., 2001).

If a child screens positive for ASD on the M-CHAT, the parents are given a telephone call for a follow-up interview. The researcher repeats the failed questions to the parents to check whether the behaviours are still present and details of the behaviours are investigated by getting specific examples of them. If the child still fails the screen, the researcher recommends that he/she goes for a formal diagnosis by a trained practitioner (Pandey et al., 2008). The M-CHAT has a high internal reliability of 0.85, when including the follow-up interview (Robins et al., 2001). Robins (2008) and Kleinman et al. (2008) both found that the positive predictive value (PPV; the number of cases positively screened and then diagnosed with ASD) was .36 on the original M-CHAT, but that with a follow-up interview, the figure rose to .74. Follow-up interviews are thus critical to increase specificity and to decrease the number of false positives (Pandey et al., 2008).

Effective screening maximises specificity (the ability to detect an absence of the disorder) and sensitivity (being able to detect the disorder). The sensitivity and specificity of

the M-CHAT differs depending on the cut-off scores used. In the original M-CHAT, the six critical items yield the best discrimination between those with and without autism, with values of .95 for sensitivity and .99 for specificity (Robins et al., 2001). Snow and Lecavalier (2008) noted lower overall levels of sensitivity and specificity (possibly due to the small sample size) but they noted that sensitivity was higher when using the 3 out of 23 items cut-off. ASD toddlers seem to have scores which are significantly higher than either of the cut-offs compared to non-ASD toddlers. Sensitivity is important for an early diagnosis, therefore initially these cut-offs were set at a low level to decrease false negatives; i.e. risk sending non-ASD toddlers for further assessment rather than risk missing an ASD child. However, if the scores between non-ASD and ASD are so different, current cut-off scores may be too low and may need adaptation for different populations (Kozlowski et al., 2012). Finding cut-off scores that maximise sensitivity and specificity is essential among different populations, as well as at different ages.

Cut-off scores may vary with age, as ASD follows a developmental course (Matson, J., Nebel-Schwalm, & Matson, M., 2007). In the study by Pandey et al. (2008), the M-CHAT PPV for ASD diagnosis was higher in older (0.79, aged 24-30 months) than younger (0.66, aged 16-23 months) toddlers. However, of those young children who failed the screen, only 8% were typically developing; the rest had a language or developmental delay. It is more difficult to screen as accurately in younger toddlers because of minimal peer interactions, making it difficult to observe social and language deficits (Matson, Wilkins, & González, 2008). Different symptoms appearing at different stages during the rapid early developmental phase of the child also result in difficulties with diagnosis (Ventola et al., 2006). Moreover, the shared symptomology in ASD and other intellectual disabilities, such as repetitive actions, makes it difficult to differentiate the disorders from one another. It is important to consider these difficulties when finding M-CHAT cut-off scores that are applicable across age groups and that differentiate ASD from other developmental disorders.

In summary, the sensitivity for population screening with the M-CHAT including its follow up interview looks promising (Pandey et al., 2008). However, one still needs to consider the cut-off scores and application across age groups, as well as the validity of its cross-cultural application.

Cross-Cultural Application of the M-CHAT

ASD prevalence rates can differ across cultures and ethnicities. However, it is likely that these differences are due to methodological issues with ASD assessment criteria.

Alternatively, hidden variables such as socioeconomic status (SES) and culturally determined behaviour may affect diagnosis (Norbury & Sparks, 2012).

It is important to be aware of the potential effects resulting from the application of a behaviourally defined screening tool across different cultures. It is also important to establish whether communities have the available resources to deal with the diagnosis once it has been made. The family's acceptance and perception of certain behaviours is determined by culture; therefore, it can be difficult to diagnose problematic and stereotypical behaviour in the same way for each population (Grinaker et al., 2012). Although there are challenges in applying the M-CHAT and its behavioural criteria across different cultures, the fact that it is a parental questionnaire helps reduce some of the cultural bias between a researcher and the child directly. For example, in some cultures, little eye contact may be a sign of respect; but the researcher may see it as an ASD symptom. However, parents would be able to clarify this discrepancy. There needs to be validation of tests across different cultures, even when they use the same language. Tests need to be 'culturally translated,' as different words may be used to represent the same things. However, it is critical not to culturally adapt the screening tool so much that it eventually tests something completely different (Norbury & Sparks, 2012). It is equally important to pilot newly translated versions in the population of interest in order to establish optimal cut-off scores.

The M-CHAT has been successfully adapted and translated into Spanish, Arabic, Japanese, Swedish and Chinese versions. These versions have yielded promising outcomes, similar to those of the Robins et al. (2001) study. However, their cut-off scores varied in order to allow optimal validity for cultural relevance (Canal-Bedia et al., 2011; Eldin et al., 2008; Inada, Koyama, Inokuchi, Kuroda, & Kamio., 2011; Kleinman et al., 2008; Nygren, Sandberg, Gillstedt, Ekeroth, Arvidsson, & Gillberg, 2012; Wong et al., 2004). The Arabic and Spanish versions used the two cut-off scores suggested by Robins et al. (2001) and found similar sensitivity and specificity values. The M-CHAT did not require modifications for Arab countries (Eldin et al., 2008). However, the Spanish version made minor modifications in terms of rewording three items, as well as including examples of toys relevant to Spanish cultures (Canal Bedia et al., 2011). Japanese cut-offs were found to have the best sensitivity (.75) and specificity (.89) values when using the 2/23 cut-off rather than the original 3/23 cut-off, however, they did administer the test to a younger age range of 4-20 months (Inada et al., 2011). The Swedish version only made minor adjustments to the M-CHAT in terms of translation. It used the original M-CHAT cut-offs and resulted in an acceptable sensitivity value (Nygren et al., 2012). These M-CHAT studies only had to make minor adjustments to

the screens where there were translations involved. Therefore, the validation of translated versions of the M-CHAT in different populations has been successful thus far, without requiring too many adaptations.

In summary, as acceptable behaviour differs between populations, tests should be adapted for the population that they are assessing. There is a need for validity testing of screening measures and their adaptations amongst the culturally and linguistically diverse populations in South Africa. However, from the promising outcomes of the M-CHAT adaptations across different languages and cultures throughout the world, it is likely that it will be a useful tool in South Africa too.

Summary and Rationale for Research

ASD is estimated to affect around 1% of the childhood population (Baird et al., 2006) and it has severe, lifelong effects on the child and their family. Thus, the introduction of early screening tools in South Africa is crucial to allow earlier diagnosis and intervention. However, at present, there is no evidence for ASD screening protocols in this context. Therefore, the validation of screening tools such as the M-CHAT in South Africa and for its diverse population is essential.

The M-CHAT does not give a diagnosis of ASD, but it has yielded promising results in successfully identifying high-risk individuals in primary care settings, even in other non-Western cultures. It is ideal for the South African context as it requires no training and is cost effective in terms of resources, money and time. This early screening would allow earlier interventions, resulting in decreased waiting lists for formal diagnosis, services and schools, as well as better overall outcomes for individuals, families, education, healthcare systems and society at large.

Specific Aims and Hypotheses

The main objective of this initial study was to translate, adapt and pilot South African versions of the M-CHAT screening tool. This pilot study aimed to give an indication of whether the M-CHAT was at all applicable to this context and to help with the planning of future large-scale investigations.

I carried out a preliminary investigation to check the correspondence of the M-CHAT screening scores with existing diagnosis (i.e. children reported to be without an ASD diagnosis, as well as with children reported to have an ASD diagnosis). I hypothesised that the M-CHAT screening scores would accurately predict diagnosis. Preliminary optimal cut-

off scores to maximise sensitivity and specificity were investigated.

I also did a preliminary investigation regarding the utility of the M-CHAT in a slightly older age range than suggested in the literature, as it is not clear which screening instruments are most appropriate for this range. I examined whether the M-CHAT scores were useful up until the age of 4 years 11 months.

Design and Methods

Design and Setting

This research project was a pilot study for a larger project that aims to adapt and validate screening tools for ASD in South Africa. The larger project will assess whether the adapted English, as well as the translated Afrikaans and Xhosa versions of the M-CHAT (Appendix A) are capable of distinguishing ASD from non-ASD in young South African children.

This pilot study used a quasi-experimental cross-sectional design, contrasting existing groups (children without ASD diagnosis and those diagnosed with ASD). I examined the extent to which children screening positive for ASD on the M-CHAT were also formally diagnosed with ASD. The Autism Diagnostic Observation Schedule (ADOS) was the gold standard diagnostic tool used to validate the ASD and non-ASD groups (Lord, Rutter, DiLavore, Risi, Gotham & Bishop, 2012). Any problems with particular questions on the M-CHAT were noted.

Participants

The screening data were collected from 64 parents/caregivers from around South Africa, specifically the Western Cape, Kwazulu-Natal and Gauteng. This was a pilot study, where time and resources were limited, thus, full population screening with a sample that was representative of South Africa was unfortunately not possible. Therefore, convenience and snowball sampling were used to access participants. The ASD sample (n=16) was recruited from children that had taken part in previous ASD research at the University of Cape Town (n=9)*;* autism organizations *(*n=4)*;* and Red Cross Hospital (n=3). The non-ASD group was made up of Typically Developing (TD) children (n=40) as well as children with diagnosed Developmental Disorders (DD) other than ASD (n=8). Most of the DD children were recruited from Red Cross Hospital while the majority of TD children were recruited through convenience and snowball sampling. Some of the questionnaires were filled in over the telephone (n=4) or face-to-face (n=10) but most of the forms were e-mailed to participants.

Once a few members of different populations had participated, they passed the questionnaires on to friends with children of the correct ages. Table 1 summarises the demographic characteristics of the ASD and non-ASD groups. Due to the convenience and snowball sampling, the groups were not well matched.

The children had to be between the ages of 18 months and 4 years 11 months. We extended the maximum suggested age found in the literature for the M-CHAT from 4 years to 4 years 11 months, to investigate its utility in a slightly older age range. This was to see whether the M-CHAT could successfully flag older individuals, as screening at this age with other instruments remains problematic (Allen, Silove, Williams, & Hutchins, 2007). Participants with sensory deficits present were excluded (n=2), as were cases where parents could not be reached for a follow-up interview (n=3).

Of the total sample, a subset of 15 children underwent a formal diagnosis using the ADOS (see Figure 1). Of this subset, 9 children had ASD and 6 did not have ASD (confirmed on assessment). The group that underwent an ADOS consisted of children above 3 years, whose parents were willing to bring them in for the assessment. Only older children could be assessed for the pilot because the ADOS Toddler Module was not yet available.

Table 1

Demographic Characteristics of the Sample

Demographic Characteristic	ASD (n=16)	Non-ASD (n=48)
Gender (Female:Male)	1:15	25:23
Home Language (English:Afrikaans:Xhosa:Other)	10:1:4:1	34:11:3:0
Ethnicity (White:Black:Coloured:Indian)	3:6:7:0	26:6:15:1
SES (Low:Medium:High)	8:5:3	13:15:20
Age in months (Mean with SD in brackets)	50.31 (7.00)	40.73 (10.98)

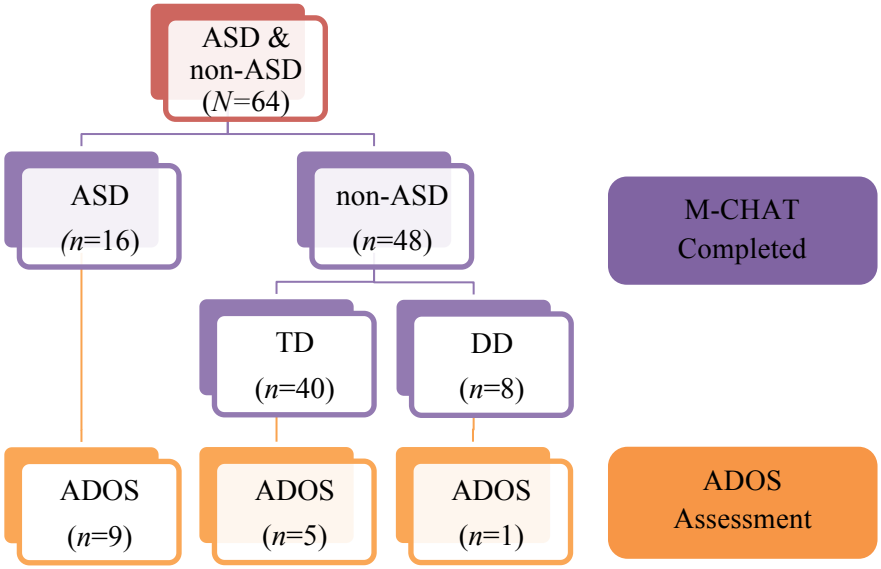

Figure 1. The Breakdown of Participant Groups that Completed the M-CHAT and Underwent an ADOS Assessment.

Measures

Socio-demographic questionnaire. This is a short questionnaire (Appendix B) requiring parents to fill in details such as household income and assets, race, education, child's age and home-language. A specific algorithm using household income, number of assets and parental education was then used to work out the SES of participants (Myer, Stein, Grimsrud, Seedat, & Williams, 2008).

In this socio-demographic section, there were also questions about parental concerns regarding the child's development, as well as whether the child had a formal diagnosis.

Modified Checklist for Autism in Toddlers (M-CHAT). The M-CHAT (Robins et al., 2001) is a 23-item yes/no parent report questionnaire, administered in a self-report format, which takes only 15 minutes to complete (Mawle & Griffiths, 2006). It enquires about critical aspects of the child's observed behaviour, indicating whether he/she is at high risk for ASD or not. The M-CHAT was culturally adapted and translated for the South African context (details below). It was available in English, Afrikaans and Xhosa, depending on the parent's first language. A child who screened positive for ASD (Western criteria: two out of six critical items failed or any three items failed), received a follow-up interview telephonically (see Figure 2). As mentioned previously, this follow-up increases specificity and decreases the number of false positives. A flow chart question format was used for the telephonic interviews to ensure consistency. In the follow up, failed questions were repeated to check whether the behaviour was still present and parents were asked to give examples of

the specific behaviour. The psychometric properties and cross-cultural applications of the M-CHAT were previously mentioned. These indicate that it is cross-culturally valid and reliable and should thus be applicable to South Africa.

We had written permission from the M-CHAT authors to translate the instrument. The original English version was forward and back translated into Afrikaans and Xhosa. The English and translated versions were adapted by using phrases and examples that were familiar to the South African population. For example, the Xhosa version offered examples of culturally specific games for item 8. Items 3 and 11 were specifically adapted in all versions by giving different examples of the behaviours, to increase the understanding of the questions. For example, in item 11 *(Does your child ever seem oversensitive to noise [e.g. blocks ears])*, the example of the behaviour given was changed from 'plugging ears' to 'blocking ears.' Equivalence across all languages was also ensured. For example, initially the Afrikaans version of item 16 was phrased as '*can* your child walk?' however, the English was phrased as '*does* your child walk?' The Afrikaans version asked whether the child is able to walk, whereas the initial English version did not ask if the child is able to walk, but rather whether they choose to walk. Therefore, the Afrikaans version was re-worded in order for it to be equivalent to the English version.

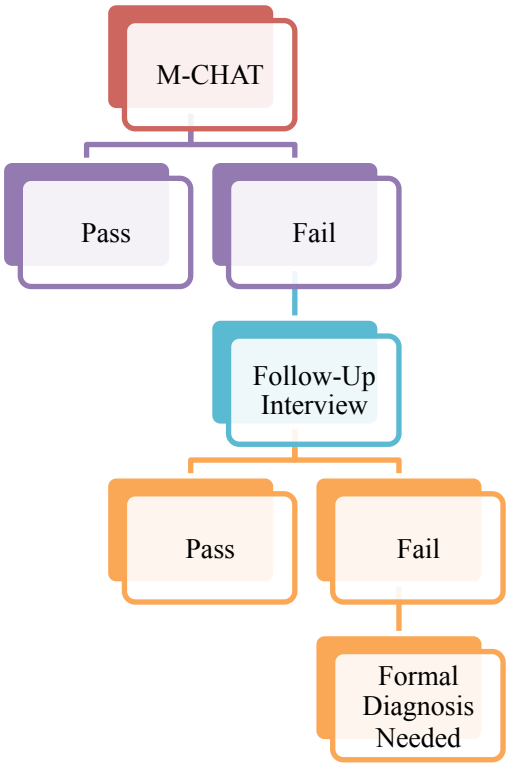

Figure 2. The Process of Administering the M-CHAT.

Autism Diagnostic Observation Schedule. The ADOS (Lord et al., 2000) is a gold standard, semi-structured, standardized assessment tool. It assessed the child's social interactions, communication, restricted and repetitive behaviours as well as play, by eliciting behaviours relating to ASD diagnosis through various planned activities. The child completes one of four different modules, depending on their language ability and developmental level. Each module involves activities in which interactive stimulus materials (e.g. snacks, bubbles, and remote control toys) are used. In this study, only modules 1 and 2 were used. Module 1 is for children aged 31 months and older, who do not use phrase speech consistently. Module 2 is for any age child who uses phrase speech but is not verbally fluent. Notes are taken during the activities and behaviours are then coded ('0' is for no abnormality, '3' is for severe abnormality). An algorithm (Gotham, Risi, Pickles, & Lord, 2006) is used to calculate the child's score, resulting in the classification of autism, ASD or non-spectrum. The ADOS module 1 has a high interrater reliability, with a mean exact agreement of 91.5% for all items. In the original study, the ADOS diagnostic classification interrater agreement for autism versus non-spectrum was 100% for module 1 and 91% for module 2 (Lord et al., 2000). In a study determining diagnostic validity among young children (20-55 months), the ADOS resulted in a sensitivity of .85 and a specificity of .89, when compared to a clinical diagnosis between autism and no autism (Gray, Tonge, & Sweeney, 2008). The ADOS is used globally as the gold-standard diagnostic measure for ASD (Filipek et al., 2000)

Procedure

Screening. Researchers spoke to the parents in person at private pre-schools and at Red Cross Hospital, or on the phone and otherwise via e-mail. We then read out, printed or emailed parents an information sheet about the study (Appendix C). At this point parents were encouraged to ask questions and were invited to participate. The parents gave written informed consent (Appendix D) or telephonic consent to take part in the screening. They were then given a socio-demographic questionnaire and the M-CHAT to fill in.

Researchers fluent in English, Afrikaans or Xhosa were available via email or over the telephone in case parents struggled with any of the questions or if follow-up telephonic interviews needed to be conducted. If the child screened positive for ASD, a follow-up interview was conducted over the telephone to check whether the problematic behaviours were indeed present. Failed questions indicating a risk for ASD were repeated and specific examples of the behaviour in question were obtained. This was to clarify any confusion that

parents may have had regarding the types of behaviours to look for. We took note of any problems that parents had with understanding any items in the M-CHAT.

Diagnosis confirmation. The formal diagnoses for the ASD group were conducted previously and ADOS results were available for nine of them. Parents of non-ASD children were invited to participate in the ADOS assessments. The assessment took place in a private room at the University of Cape Town (UCT) Child Guidance Clinic. Parents were given information about the assessment beforehand and were reminded that they could withdraw from the study without negative consequences. A qualified researcher, blind to the M-CHAT scores and trained in the ADOS, conducted the assessment. Parents were able to ask questions at the end of the assessment.

Ethical Considerations

This study followed the research with human subject's ethical guidelines of the UCT codes for research and the Declaration of Helsinki (2008). We obtained ethical approval from the UCT Department of Psychology Ethics Committee, the UCT faculty of Health Sciences Research Ethics Committee as well as from the School of Child and Adolescent Health at Red Cross Hospital.

Parents were informed that participation was voluntary, and that declining or discontinuing participation at any stage would not negatively affect them or their child. Parents gave written informed consent or telephonic consent to participate. Taking part in the study was not associated with any risks. Parents were informed that all information would be kept confidential and that they could receive feedback on their child, if requested. The parents of the one non-ASD child that failed the screen were referred to a professional for a formal assessment. The ASD group were previously diagnosed; therefore, there was no need to inform parents of the ASD diagnosis, as they were already aware of this.

Data Analysis

I used SPSS version 20 for all the statistical analyses. I duplicated the analyses conducted in the original M-CHAT and follow-up validation studies (Robins et al., 2001).

Two separate one-way ANOVAs investigated group differences on M-CHAT scores, once using the full list of 23 items, and once using the short list of only the six critical items. The scores from three groups were used: a) participants requiring no follow-up, b) participants who were ok on follow-up, as well as c) those that failed the follow up and had an ASD diagnosis (The ANOVAs excluded the "failed follow-up, non-ASD" group, as it

only had one participant). ANOVA also investigated the differences in M-CHAT scores between children older and younger than 4 years, who were with and without an ASD diagnosis. The data were non-normal and the variance was not homogenous. Therefore, alpha was made more stringent by adjusting it to .01 and the Welch statistic and Games-Howell Post Hoc tests were used.

The assumptions for logistic regression were upheld when using the full list of 23 items, as well as when using the six critical items of the M-CHAT.

Results

Reliability

Cronbach's alpha measured the internal consistency for both the full 23-item list and for the six critical items of the M-CHAT. When using all 23 items, the Cronbach's alpha was .85. When investigating the six critical items only, the Cronbach's alpha was .78. Item-total correlations did not indicate any problem items that should be removed. Thus, both the 23-item list and the six critical item short lists were reliable in this context.

Confirmation of Parent Report of Diagnosis

The diagnostic classification of each of the participants was based on the parent's report of whether the child was Typically Developing (TD), had a Developmental Disorder (DD) or had an ASD diagnosis. The, gold standard ADOS assessments were performed on a small sub-sample (n=15) to verify the accuracy of the parental reports. Of the non-ASD group, five TD children and one DD child underwent an ADOS and they were all diagnosed as non-ASD. ADOS assessment confirmed an ASD diagnosis in all nine children in the subset reported to have ASD. The results of the diagnostic assessments confirm that parent reports of their child's diagnostic status are reliable.

Analysis of Each M-CHAT Item

Table 2 shows a summary of the particular items failed within each group. Only one ASD participant did not fail the M-CHAT. This may be because he has already been involved in treatment and interventions, thus decreasing his ASD symptoms and their frequencies. Conversely, there was only one non-ASD participant that failed the M-CHAT even after the follow-up interview. However, this participant was not typically developing; he was HIV+ and had global developmental delay. As there was only one case in the "Failed on follow-up, non-ASD" category, this category was not included in the item analysis.

Items 1, 3, and 16 resulted in no failures from any of the groups. Thus, all these items were poor at distinguishing ASD from non-ASD. Item 11 was the most failed item in each group, although the failure rate was still much higher in the 'failed follow-up ASD' group. Items 2, 5, 7, 13, 15, 20 and 21 were the best at discriminating ASD from non-ASD (for each of these items, the 'failed follow-up ASD' group failure rate was at least 33% higher than the failure rate for the other groups).

Table 2

Percentage of Items Failed in Each Group for all 23 Items

	Item	No Follow-Up Needed (*n*=42)	Ok on Follow-Up (*n*=6)	Failed Follow-up: non-ASD (*n*=1)	Failed Follow-Up: ASD (*n=15)*
1.	Enjoys being bounced on knee	0	0	0	0
2.	Takes interest in other children	0	0	0	53.33
3.	Likes climbing on things	0	0	0	0
4.	Enjoy playing peek-a-boo/hide-and-seek	2.38	0	0	6.67
5.	Does pretend play	0	0	0	33.33
6.	Index finger to point to ask for something	4.76	0	100	33.33
7.	Index finger to point to indicate interest	4.76	0	100	40
8.	Child plays properly with small toys	4.76	0	0	20
9.	Child brings objects over to parents to show	0	0	100	26.67
10.	Child looks parent in the eye	0	0	0	26.67
11.	Oversensitive to noise	26.19	16.67	0	66.67
12.	Smiles in response to parents face/smile	0	0	0	6.67
13.	Imitates	2.38	0	0	40
14.	Responds to name	0	0	0	26.67
15.	Looks at toy when you point at it across the room	0	0	0	46.67
16.	Child walks	0	0	0	0
17.	Looks at things parent is looking at	2.38	16.67	0	26.67
18.	Makes unusual finger movements near face	2.38	16.67	0	40
19.	Attracts attention to own activity	2.38	0	100	20
20.	Wondered if child deaf	7.14	0	100	66.67
21.	Understands what people say	0	0	0	33.33
22.	Stares or wanders with no purpose	7.14	16.67	100	46.67
23.	Checks parents face when something unfamiliar	14.29	16.67	0	46.67

Note. Only one non-ASD participant failed the test, therefore, the failures on particular items register as 100%.

Analysis of the Differences Between Groups

I used one-way ANOVAs to investigate whether there were significant differences in M-CHAT final scores between the groups. Two separate ANOVAs were computed; the first using the scores on all 23 items and the second using only the scores from the six critical items. A summary of the group scores and ANOVA results are presented in Table 3.

All items. The ANOVA was statistically significant, F (2, 12.22) = 25.34, $p < .001$. One-way ANOVA indicated significant differences between the groups on M-CHAT scores. More specifically, the Games-Howell post hoc tests indicate that the "failed follow-up ASD" group, on average, had significantly higher scores on the M-CHAT than the "No follow-up" and "Ok on follow-up" groups (both $p < .001$).

Critical items. The ANOVA was statistically significant, F (2, 60) = 44.09, $p < .001$. One-way ANOVA indicated significant differences between the groups on M-CHAT scores. More specifically, the Games-Howell post hoc tests show that the "failed follow-up ASD" group, on average, had higher scores on the M-CHAT than the "No follow-up" and "Ok on follow-up" groups (both $p < .001$).

Table 3

Summary of ANOVA Results for the 23 Items and the Six Critical Items

Group	Means	SD	*F*	*p*	Effect Size (ω^2)
All Items					
No Follow-up	.81	.80	25.34	< .001	.71
Ok on Follow-Up	.83	.75			
Failed Follow-up ASD	7.07	3.28			
Critical Items					
No Follow-up	.07	.26	44.09	<.001	.58
Ok on Follow-Up	.00	.00			
Failed Follow-up ASD	2.33	1.63			

The M-CHAT's ability to predict ASD

I used binary logistic regression to investigate whether the number of failed M-CHAT items could successfully predict ASD or non-ASD. The logistic regression was performed

separately for the full list of 23 M-CHAT items, as well as with only the six critical items. In this analysis the whole sample was used, including non-ASD as well as ASD children.

All items. A logistic regression using all 23 items of the M-CHAT showed that M-CHAT scores were significantly and reliably able to discriminate between participants with and without ASD (Nagelkerke $R^2 = .70$; $\chi^2 (1) = 41.80$, $p < .001$). The relationship between the classifications and the M-CHAT scores was relatively strong. The Wald criterion gave a value of 15.80, $p < .001$; therefore, we may assume that the predictors significantly contributed to the outcome. The correct prediction percentage was 93.8% overall (97.9% for non-ASD and 82.4% for ASD). Finally, the Odds Ratio value indicated that a one-unit increase in the M-CHAT score would result in a 2.67 times greater likelihood of an ASD classification.

Critical items. A logistic regression using the six critical items of the M-CHAT showed that M-CHAT scores were significantly and reliably able to discriminate between participants with and without ASD (Nagelkerke $R^2 = .62$; $\chi^2 (1) = 34.69$, $p < .001$). There was a moderately strong relationship between classification and M-CHAT score. However, this relationship was not as strong as the relationship between classification and the full 23 item M-CHAT score. The correct prediction percentage was 87.5% overall (97.9% for non-ASD and 56.3% for ASD). The Wald criterion gave a value of 11.16, $p = .001$, indicating that the predictors significantly contributed to the outcome's prediction. Finally, the Odds Ratio value indicated that a one-unit increase in the M-CHAT score resulted in an 8.96 times greater likelihood of an ASD classification. This Odds Ratio was much higher than that for all 23 items, which was 2.67.

Preliminary Cut-Off Point Analysis

To determine cut-off scores resulting in the best sensitivity and specificity, Receiver Operating Characteristic (ROC) analyses were conducted. ROC curves allow a visual depiction of the sensitivity and specificity at different cut-off points.

All items. The ROC curve conducted with all 23 items is presented in Figure 3. In this figure, the area under the curve was significant, (.94, $p < .001$), therefore indicating that the logistic regression classified ASD/non-ASD a great deal better than by chance.

Critical items. The ROC curve conducted with the six critical items is presented in figure 4. In this figure the area under the curve is significant (.88, $p<.001$), therefore indicating that the logistic regression classified ASD/non-ASD better than by chance. However, the area presented under the curve is higher when using the 23 items (.94), thus

indicating that using all 23 M-CHAT items was probably a better predictor of ASD/non-ASD classifications.

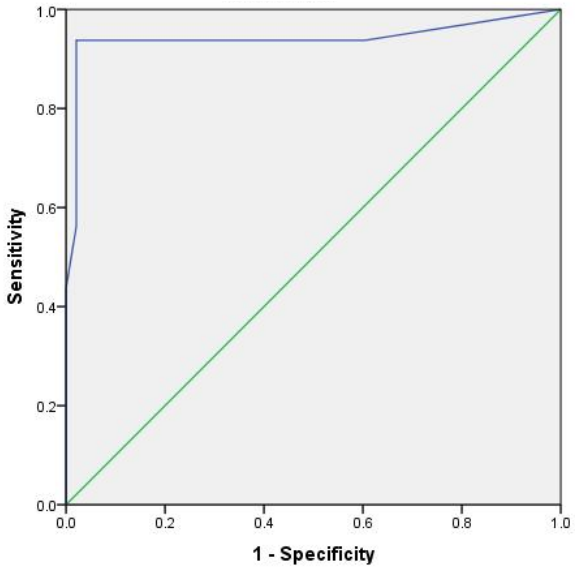

Figure 3. ROC Curve, Showing Sensitivity, Specificity and Area Under the Curve of the M-CHAT Results when Using all 23 Items

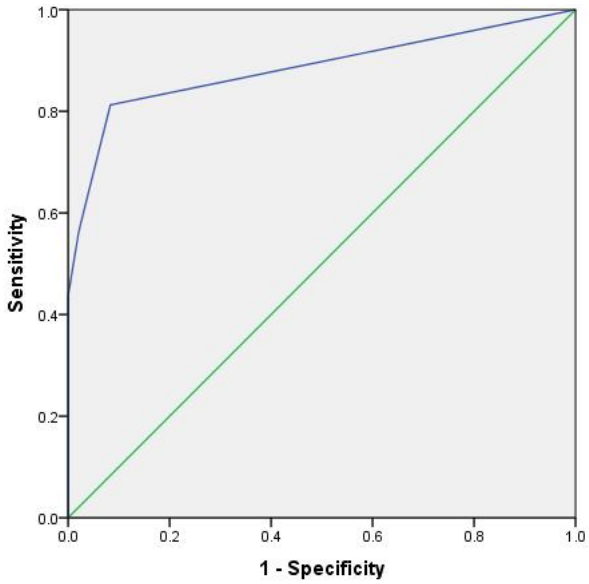

Figure 4. ROC Curve, Showing Sensitivity, Specificity and Area Under the Curve of the M-CHAT Results when Using the Six Critical Items

Tables 4 and 5 summarise the sensitivity and specificity associated with each possible cut-off score, when using the 23-item list and six critical items respectively.

All items. After analysing the ROC curve, as well as the sensitivities and specificities

at each cut-off point, it seems that the best cut-off for all 23 items is 2.5 (sensitivity=.94; specificity=.98). By rounding this value up, it is most likely that a three-item cut-off would result in the best balance between sensitivity and specificity.

Critical items. It seems that the best cut-off for the six critical items is .50 (sensitivity=.81; specificity=.92). By rounding this value up, it is most likely that using a critical item cut-off score of one would result in the best balance between sensitivity and specificity.

Table 4

Cut-Off Points for M-CHAT Scores and their Associated Sensitivity and Specificity Values, When Using All 23 Items

M-CHAT Cut-Off Score (All 23 Items)	Sensitivity	Specificity
.50	.94	.40
1.50	.94	.75
2.50	.94	.98
3.50	.88	.98
4.50	.81	.98
5.50	.56	.98
6.50	.44	1.00

Table 5

Cut-Off Points for M-CHAT Scores and their Associated Sensitivity and Specificity Values, When Using Six Critical Items

M-CHAT Cut-Off Score (Six Critical Items)	Sensitivity	Specificity
.50	.81	.92
1.50	.56	.98
2.50	.48	1.00
3.50	.313	1.00

Analysis of Differences in Scores Between Age Groups

This study extended the M-CHATs maximum suggested age of 4 years, to that of 4 years, 11 months. A one-way ANOVA investigated whether there were significant differences in scores between the age groups above and below age 4, with and without ASD. These results are summarised in Table 6.

The ANOVA results suggest that there were significant and substantial differences in the M-CHAT scores (when using all 23 items) between some of the groups, F (3, 10.51) = 13.71, p = .001. The significant differences in M-CHAT score, indicated by the post hoc tests, were between the groups (a) "older than 4 years - non-ASD" and "older than 4 years – ASD" as well as (b) "younger than 4 years – non-ASD" and "older than 4 years – ASD." This indicates that there were generally significant differences between the ASD and non-ASD groups. The only group with which none of the other groups were significantly different was that of "younger than 4 years- ASD," this is likely because this was a small group, with only 4 participants. However, when looking at the means, the ASD groups both had much higher M-CHAT scores than the non-ASD groups.

Table 6

Summary of ANOVA Results for Differences in Scores Between Age Groups on all 23 Items

Group	Means	SD	F	p	Effect Size (ω^2)
Younger than 4 years – ASD (n=4)	9.50	4.44	13.71	.001	.66
Younger than 4 years - non-ASD (n=33)	.85	.80			
Older than 4 years – ASD (n=12)	5.67	2.93			
Older than 4 years - non-ASD (n=15)	1.13	1.55			

Discussion

The main objective of this study was to translate, adapt and pilot South African versions of the M-CHAT screening tool. This study piloted not only the English M-CHAT in South Africa, but also translated the M-CHAT into Afrikaans and Xhosa. The study gives an indication that the M-CHAT and its adaptations will be applicable to the South African context; this information will contribute to the planning of future large-scale validation studies. This preliminary investigation confirmed the ability of the M-CHAT scores to differentiate between children reported to be with or without an ASD diagnosis. The ASD

group failed a significantly higher number of M-CHAT items than the non-ASD group. The M-CHAT successfully distinguished typical development from ASD. Furthermore, in all but one case, the screen was able to distinguish ASD from other Developmental Disorders.

In order to confirm the accuracy of parental reports about children being ASD or non-ASD, a smaller sub-group of the sample participated in a gold standard diagnostic assessment using the ADOS (Wallace et al., 2012). All the children reported to be non-ASD scored outside the ASD range on the ADOS and all children reported to have an ASD diagnosis, were within the ASD range on the ADOS. Based on the accuracy of parent report in this subset, I could assume more confidently that the classifications reported by the parents in the rest of the sample were most likely correct.

The M-CHAT scores were reliable and accurate predictors of the parent's reported ASD or non-ASD classifications. The logistic regression included all cases (English, Afrikaans and Xhosa M-CHATs) and confirmed that the M-CHAT scores were accurate predictors of a classification, when using all 23 items, as well as when only including the six critical items. The logistic regression using all 23 items produced a stronger relationship between M-CHAT scores and final classification as well as a higher percentage of correct classifications than the six critical item logistic regression. Thus, using the full 23-item list resulted in the M-CHAT scores being the best predictors of the most accurate classifications. However, the logistic regression for the six critical items was still significant and had a much higher Odds Ratio value, compared to the 23 items. This indicated that a one-unit change in the score when using the six items, resulted in more of a response in terms of increasing the likelihood of an ASD classification, compared to the full 23-item questionnaire. Thus, in order to flag ASD candidates as best one can, it may be worth following Robins et al. (2001), by including two cut-off scores, arising from all 23 items, as well as from the six critical items.

The ASD group that failed after follow-up had a significantly higher number of items failed than the non-ASD groups that did not need a follow-up or were ok on follow-up. This was true when using all 23 M-CHAT items and when using the six critical items. The ANOVA supported this by indicating that there were significant and substantial differences in M-CHAT scores between the different groups. The M-CHAT utility even looks promising in the older age range (4 years - 4 years, 11 months). The pattern of means for the sub-groups indicated that the older ASD children still score above the cut-offs and the ASD group scores look higher than the non-ASD group scores. Thus, further investigation is certainly warranted, given these encouraging indications

The adaptations made to the M-CHAT aimed to increase the parents understanding of the questions and they were assessed by a team of idiomatic speakers. Initially, all questions seemed well understood by parents, as they did not ask for clarification. However, the follow-up interviews gave a better idea of which questions may have been misunderstood. An in-depth analysis of the individual M-CHAT items found which items were better or worse at distinguishing ASD from non-ASD.

Some M-CHAT items were not useful in distinguishing ASD from typical development and other developmental delays. Items 1 (*Does your child enjoy being swung, bounced on your knee, etc.?*), 3 *(Does your child like climbing on things, such as on chairs or other things?)* and 16 *(Does your child walk?)* resulted in no failed responses from any of the groups, thus, not distinguishing ASD from non-ASD. The Canal-Bedia et al. (2011) and Nygren at al. (2012) studies also found these items to be unhelpful in distinguishing ASD from non-ASD. Item 11 (*Does your child ever seem oversensitive to noise [e.g. blocking ears]?)* was the most failed item in all groups. However, many non-ASD parents passed the item on follow-up, when asked if their child started 'screaming,' 'crying,' or 'getting upset' when hearing sounds. This indicated how important the follow-up interview was in qualifying the exact nature of the behaviour in the item of interest. It may also indicate that this item needs more detail and clarification on the initial M-CHAT, by giving a better example, such as 'the child gets upset and blocks ears.' In this way, non-ASD parents would not need an unnecessary follow-up for clarification. However, a larger study with a broader demographic sample needs to clarify whether these non-distinguishing items should be eliminated or reworded for the South African population.

Certain M-CHAT items were more important in distinguishing ASD from non-ASD. Specifically, items 2 *(Does your child take an interest in other children?*), 5 *(Does your child ever pretend, for example, to talk on the phone or take care of a doll or pretend other things?)*, 7 *(Does your child ever use his/her index finger to point, to indicate interest in something?)*, 13 *(Does your child imitate you? [e.g., you make a face-will your child imitate it?])*, 15 *(If you point at a toy across the room, does your child look at it?)*, 20 *(Have you ever wondered if your child is deaf?)* and 21 *(Does your child understand what people say?)* were best at discriminating ASD from the other groups. Four of these were the previously mentioned critical items in the Robins et al. (2001) study. The three critical items specific to the M-CHAT in this context were items 5, 20, and 21. Cultural differences in South Africa may have led to different items being identified as critical. The two critical items from the Robins et al. (2001) study that were not applicable in this case or in the Nygren et al. (2012)

study, were items 9 *(Does your child ever bring objects over to you (parent) to show you something?)* and 14 *(Does your child respond to his/her name when you call?)*. Further studies in the South African population need to consider whether the same six critical items identified by Robins et al. (2001) are to be used or if the seven items found in this study should replace these.

Another aim of the study was to investigate optimal cut-off scores for identifying potential ASD candidates. ROC curve analyses showed that the most appropriate cut-off for the 23-item list was 2.5, therefore rounded up to three failed items. The initial M-CHAT validation study (Robins et al., 2001) as well as later studies (Eldin et al., 2008; Nygren et al., 2012) also found that a failure on three items accurately predicted ASD, without too many false positives. This cut-off was associated with sensitivity and specificity values of about .94 and .98 respectively. Thus, indicating that 94% of the ASD children would be detected and only 2% of the children would have ASD falsely flagged. The ROC curve analysis of only the six critical items indicated a cut-off of around 0.5, which rounded up to one failed item. This cut-off point is lower than any of the other studies have suggested. Most studies found a cut-off of two out of six critical items required for an ASD classification (Eldin et al., 2008; Nygren et al., 2012; Robins et al., 2001). When using a one-item cut-off for the six critical items, the sensitivity and specificity values will be around .81 and .92. In future, the validation of critical items specific to South Africa may improve these sensitivity and specificity values. Although, the sensitivity and specificity of both the 23-item and the critical item cut-off scores were still high, indicating that the M-CHAT can be successfully utilised in South Africa. Nevertheless, keep in mind that this was a preliminary investigation into the M-CHATs applicability in South Africa. Thus, precise cut-off scores need to be confirmed within a larger study with a more stratified sample.

Considering the diversity of the South African population, it is important to validate the M-CHAT in different communities, as different populations may require different cut-off scores (Lee, David, Rusyniak, Landa & Newschaffer, 2007). The need for sensitivity compared to specificity needs to be weighed up, by considering the resources that populations have available to deal with these effects. It is important to note that the M-CHAT is a screening tool and thus a failure on the screen still requires a formal diagnosis. With a screening tool, a high sensitivity is usually preferable, so that ASD cases are not missed (Kozlowski et al., 2012). However, overly high sensitivity can also result in negative effects. False positives can cause unnecessary financial expense and emotional stress for parents with children that are not diagnosed with ASD in the end (Allen et al., 2007). It also needs to be

ensured that medical resources are able to cope with the diagnostic burden and the needless filling up of waiting lists from non-ASD cases, which are associated with a high sensitivity. On the other hand, early intervention results in significantly improved outcomes for ASD (Robins, 2008; Robins et al., 2001). Therefore, it seems worth having a few false positives in order to identify all cases at high risk for ASD, to ensure the best possible prognosis for them (Canal-Bedia et al., 2011). A high sensitivity to detect all ASD cases, together with a high specificity to increase cost effectiveness would likely be most beneficial to any population.

Limitations and Directions for Future Research

One must exercise caution when generalising the conclusions of this study to the rest of South Africa. There are a number of limitations that need to be addressed in future studies before the M-CHAT may be used in this context.

First, there were limitations regarding methodology. Due to the extended length of time before the Red Cross Hospital granted ethical approval, I had limited access to its patients (2 weeks of data collection only). Therefore, the majority of data was not collected from this setting, but rather via email. Although I informed parents that I was available at any time for questions, I did not receive any. This was probably due to the inconvenience of having to email questions, thus, it was difficult to note any problems that they may have had with certain items. Parents with a low level of education may have struggled to understand questions, thus answering incorrectly or not completing the forms at all. In future studies, researchers must be available to sit with parents, where they can offer to read the questions out, and answer any questions. Face-to-face interactions allow one to easily see when parents are confused, thus being able to help them out immediately. Therefore, with the majority of the M-CHATs being completed over e-mail, the validity of the study may have been affected.

A further limitation of this study was that ADOS verification of participant diagnoses was not obtained for the entire sample. This was either because participants lived in different provinces, were not willing to participate in the assessment, or the children were younger than the minimum age for the ADOS Module 1. The ADOS-Toddler Module was not yet available, thus, only children above the age of 31 months took part in the ADOS assessment. In future, more participants of all ages need to undergo an ADOS assessment. Future research could also request that parents participate in the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994) as further clarification of an ASD diagnosis. In future, all diagnoses also need to be made after the M-CHAT has been completed.

The ASD group was attained through groups working with ASD children; therefore,

the children already had an ASD diagnosis. These parents' awareness of ASD and potential hopefulness for further treatment may have influenced their answers. Furthermore, many of the ASD children were receiving intervention. Therefore, their ASD associated behaviours may have improved since their initial diagnosis. This may be why the ASD group's M-CHAT scores did not deviate as substantially from the cut-off as has been found in previous studies (Kozlowski et al., 2012). Further studies need to screen from a population where interventions or ASD diagnoses have not yet taken place, especially as the M-CHAT is to be used as a screening tool before diagnoses are made.

Future studies also need to investigate whether the M-CHAT or the Social Communication Questionnaire (SCQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999) screening tools work best in the age range of 3 years - 4 years, 11 months. The SCQ screens for ASD in children 3 years and up; however, it is not as sensitive and specific in the younger age range of 3 to 5 years (Allen et al., 2007). Research on the reliability of the SCQ in this age group in South Africa is currently underway at the University of Cape Town. Therefore, future investigations into the overlapping age ranges of the M-CHAT and SCQ are required to determine which screening device is most effective in identifying ASD in South Africa.

The sample in the present study was not diverse in terms of demographic characteristics; this was due to time constraints and late ethical approval from Red Cross Hospital. Therefore, convenience and snowball sampling meant that the results were skewed by the overrepresentation of certain populations within the ASD (older, low SES, Coloured and Black participants) and non-ASD groups (younger, white, English, high SES participants). Thus, cultural factors may have influenced the results, as some cultures have different concerns and beliefs regarding a child's normal development (Grinaker et al., 2012; Norbury & Sparks, 2012), therefore, possibly affecting the way that the M-CHAT was completed. This must be considered when generalising the M-CHAT applicability to all populations.

In terms of assessing the different language versions of the M-CHAT, unfortunately, too few Afrikaans and Xhosa M-CHATs were completed to conduct an in-depth comparison of the effects of each language version individually. Although, no predominant language version resulted in incorrect classifications, thus it is likely that they were all suitable in classifying ASD/non-ASD. However, the true applicability of the different language versions could not yet be determined.

In future studies, scores from participants with Developmental Disorders are important to consider when determining precise and reliable cut-offs for distinguishing ASD

from other DDs. It is likely that participants with DDs will be in the 'grey' area around the cut-off scores. In this study, the DD and TD groups were collapsed into the non-ASD group, as there was an insufficient number of DD participants for them to form their own group. Therefore, we were not able to get an exact idea of how well the scores specifically distinguished DD from ASD. Further investigations, with sufficient numbers of DD participants, are necessary for determining suitable cut-off scores for distinguishing ASD from other DDs. A better representation of the South African population would also allow an investigation into more accurate cut-off scores.

As mentioned previously, it is possible that cut-off scores will vary with different ages and populations (Lee et al., 2007). Thus, future studies should investigate the need for specificity over sensitivity on the M-CHAT in different socio-demographic areas within South Africa. This would depend on the extent of the burden on the diagnostic system at present, the importance of having a diagnosis as well as the impact of needless worry for parents. These options need to be weighed up in the different contexts, to determine the need for sensitivity versus specificity.

Each of the above limitations addressed when conducting larger validation studies. These future projects will include a larger sample that is more representative of South Africa. Therefore, allowing conclusions to be more accurately generalised to South Africa and its diverse population.

Conclusion

ASD has lifelong influences on children and their families and affects a significant portion of the population worldwide. Early intervention leads to the best prognosis and outcomes, thus, it is essential to detect and diagnose ASD as early on as possible. However, South Africa does not currently have ASD screening protocols available.

This preliminary investigation into the utilisation of the English, Afrikaans and Xhosa versions of the M-CHAT screening tool in South Africa has proven to be successful in this small sample. M-CHAT scores were accurate predictors of an ASD or non-ASD classifications, the scores were even successful in distinguishing ASD from other DDs in all but one case. This implies that the M-CHAT is of great potential use as an ASD screening tool in South Africa.

Ultimately, the M-CHAT could be used in clinics and schools to flag individuals at high risk for ASD, who are in need of a formal diagnosis. This would decrease the burden on paediatricians, as the screen filters out cases where an ASD diagnostic assessment is

unnecessary. The M-CHAT is of particular relevance as it is suitable for a young age group, as well as being quick, free of charge and easy to administer. This preliminary investigation suggests that it can be a valuable screening tool in South Africa. Thus, indicating that a full validation study of the M-CHAT in this context is certainly warranted.

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Appendix A

M-CHAT *English*

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

1. Does your child enjoy being swung, bounced on your knee, etc.?

YES	NO

2. Does your child take an interest in other children?

YES	NO

3. Does your child like climbing on things, such as on chairs or other things?

YES	NO

4. Does your child enjoy playing peek-a-boo/hide-and-seek?

YES	NO

5. Does your child ever pretend, for example, to talk on the phone or take care of a doll or pretend other things?

YES	NO

6. Does your child ever use his/her index finger to point, to ask for something?

YES	NO

7. Does your child ever use his/her index finger to point, to indicate interest in something?

YES	NO

8. Can your child play properly with small toys (e.g. cars or blocks) without just mouthing, fiddling, or dropping them?

YES	NO

9. Does your child ever bring objects over to you (parent) to show you something?

YES	NO

10. Does your child look you in the eye for more than a second or two?

YES	NO

11. Does your child ever seem oversensitive to noise (e.g., blocking ears)?

YES	NO

12. Does your child smile in response to your face or your smile?

YES	NO

13. Does your child imitate you? (e.g., you make a face-will your child imitate it?)

YES	NO

14. Does your child respond to his/her name when you call?

YES	NO

15. If you point at a toy across the room, does your child look at it?

YES	NO

16. Does your child walk?

YES	NO

17. Does your child look at things you are looking at?

YES	NO

18. Does your child make unusual finger movements near his/her face?

YES	NO

19. Does your child try to attract your attention to his/her own activity?

YES	NO

20. Have you ever wondered if your child is deaf?

YES	NO

21. Does your child understand what people say?

YES	NO

22. Does your child sometimes stare at nothing or wander with no purpose?

YES	NO

23. Does your child look at your face to check your reaction when faced with something unfamiliar?

YES	NO

M-CHAT *isiXhosa*

Nceda ugcwalise oku kulandelayo ngomntwana wakho nangendlela asoloko eyiyo/aziphata ngayo. Nceda uzama ukuyiphendula yonke lemibuzo. Ukuba yindlela engeqhelekanga(uyibone kanye, okanye kabini),nceda uphendule ngokungathi umntwana akayenzi

1. Ingaba umntwana wakho uyakuthanda ukujingiswa, ukuxhunyiswa edolweneni njalo njalo? Ewe Hayi
2. Ingaba umtwana wakho unomdla kwabanye abantwana? Ewe Hayi
3. Ingaba umntwana wakho uyakuthanda ukunyuka izitepusi / ukukhwela ezitulweni okanye ukunyuka ngezinto? Ewe Hayi
4. Ingaba umtwana wakho uyakuthanda ukudlala umdlalo wokuzifihla ubuso uphinde uziveze /ukuzimela uphinde uvele? Ewe Hayi
5. Ingaba umtwana wakho ukhe azenze ngathi uyazenzisa umzekelo ukuthetha efowinini okanye ukukhathalela unopopi/unodoli okanye ezinye izinto nje athanda uzenzise ngazo? Ewe Hayi
6. Ingaba umntana wakho wakhe/ukhe asebenzise lomnwe wokukhomba ukukhomba, okanye ukucela into? Ewe Hayi
7. Ingaba umntwana wakho wakhe/ukhe asenbenzise lomnwe wokukhomba ukukhomba ebonisa ukuba unomdla kwinto ethile? Ewe Hayi
8. Uyakwazi umntwana wakho ukudlala ngezinto/ithoyi zokudlala ezincinci umzekelo (imoto okanye ibloko,ipegs nokuba zeziphi izinto ezincinci umntwana wekho adlala ngazo) ngaphandle kokuzitya okanye azicofacofe okanye aziwise? Ewe Hayi
9. Ingaba umntwana wakho uzisa izinto kuwe (kubazali) ukukubonisa into? Ewe Hayi
10. Ingaba umntwana wakho ukujonga ngqo emehlweni okanye ebusweni imizuzwana emibini okanye omnye? Ewe Hayi
11. Ingaba umtwana wakho akayithandi kwaphela ingxolo? Umzekelo(Avale iindlebe xa kungxolwa)? Ewe Hayi
12. Ingaba umtwana wakho uyakuncumela xa ejonge ubuso bakho okanye xa umncumela? Ewe Hayi
13. Ingaba umtwana wakho uyakulinganisa umzekelo (xa udlala ngobuso-angakulinganisa)? Ewe Hayi
14. Ingaba umntwana wakho uyasabela xa umbiza? Ewe Hayi

15. Ukuba ubeke into yokudlala okanye ithoyi kwelinye icala endlwini, ingaba umtwana uyayijonga? Ewe Hayi

16. Uyahamba umntwana wakho? Ewe Hayi

17. Ingaba umtwana wakho uyazijonga izinto ozijongileyo? Ewe Hayi

18. Ingaba umntwana wakho ushukumisa umnwe ngendlela engaqhelekanga apha ngasebusweni? Ewe Hayi

19. Ingaba umtwana wakho uthanda ukuba usoloko uhoyene naye kwimidlalo yakhe/ xa edlala? Ewe Hayi

20. Ingaba seke wazibuza ukuba umntana wakho ingaba sisithulu na? Ewe Hayi

21. Ingaba umntwana wakho uyaqonda/uyava ukuba abantu bathini? Ewe Hayi

22. Ingaba umtwana wakho ukhe ajonge nje emoyeni ungazi ukuba ujonge ntoni kungekho nobangela wokuba maka jonge nto? Ewe Hayi

23. Ingaba umtwana wakho ujonga ubuso bakho ajonge ukuba uzakuthini na? xa athe wajongana nento/ imeko angayiqhelanga? Ewe Hayi

isiXhosa version by Sizwe Zondo, 01/03/12

M-CHAT *Afrikaans*

Voltooi asseblief die volgende vraelys oor hoe jou kind se gedrag gewoonlik is. Probeer om elke vraag te beantwoord. As die gedrag selde gebeur (u het dit nog net een of twee keer gesien), antwoord dat u kind dit *nie* doen *nie*.

1. Hou jou kind daarvan om geswaai te word, of om op jou knieë te ry, ensovoorts?	JA	NEE
2. **Is jou kind geïnteresseerd in ander kinders?**	**JA**	**NEE**
3. Hou jou kind daarvan om bo-op goed te klim, soos byvoorbeeld om op stoele of ander goed te klim?	JA	NEE
4. **Hou jou kind daarvan om wegkriupertjie of "waar's hy/daar's hy?" te speel?**	**JA**	**NEE**
5. Speel jou kind ooit verbeelding speletjies, soos byvoorbeeld om te maak asof hy/sy op die foon praat of om 'n pop te versorg, of ander verbeeldingspel?	JA	NEE
6. **Gebruik jou kind ooit sy/haar wysvinger om na iets te wys om daarvoor te vra?**	**JA**	**NEE**
7. Gebruik jou kind ooit sy/haar wysvinger om na iets te wys waarin hy/sy geïnteresseer is?	JA	NEE
8. **Kan jou kind op die regte manier met klein speeldinge (soos karre of blokkies) speel, sonder om net daarmee te vroetel, die speelgoed te laat val, of dit in die mond te sit?**	**JA**	**NEE**
9. Bring jou kind ooit vir jou (die ouer) dinge om dit vir jou te wys?	JA	NEE
10. Kyk jou kind jou ooit in die oë vir meer as net 'n sekonde of twee?	**JA**	**NEE**
11. Is jou kind ooit oormatig sensitief vir geraas? (byvoorbeeld druk ore toe)	JA	NEE
12. Reaggeer jou kind ooit met 'n glimlag as jy na hom/haar kyk of vir hom/ haar glimlag?	**JA**	**NEE**
13. Boots jou kind jou na? (byvoorbeeld as jy 'n gesig trek, sal jou kind dit	JA	NEE

namaak?)		
14. Reaggeer jou kind op sy/haar naam wanneer jy roep?	**JA**	**NEE**
15. As jy na 'n speelding aan die anderkant van die kamer wys, sal jou kind daarna kyk?	JA	NEE
16. **Stap jou kind?**	**JA**	**NEE**
17. Kyk jou kind na goed waarna jy kyk?	JA	NEE
18. Maak jou kind snaakse vingerbewegings/handgebare naby sy/haar gesig?	**JA**	**NEE**
19. Probeer jou kind jou aandag trek na sy/haar doenighede?	JA	NEE
20. Het jy al ooit gewonder of jou kind doof is?	**JA**	**NEE**
21. Verstaan jou kind wanneer mense praat?	JA	NEE
22. **Staar jou kind soms in die verte in of dwaal hy/sy soms doelloos rond?**	**JA**	**NEE**
23. Kyk jou kind na jou gesig om te sien hoe jy reaggeer wanneer hy/sy op iets onbekend afkom?	JA	NEE

Appendix B

Demographic Questionnaire

Participant no.: _____ Date: _____

A. Child's Information:

1. Name: _____
2. Age: _____
3. Date of Birth (dd/mm/yy): _____
4. Sex: Male Female
5. Ethnicity: White Black Indian Coloured Asian Other If other please specify: _____
6. Home Language: _____

7. How old was your child when you first noticed that they had developmental difficulties?
_____
8. How old was your child when you first sought help?
_____
9. To whom or where did you first go for help?
_____
10. Does your child have a formal diagnosis?
_____

B. Parent Information:

1. What is the total yearly income of the household in which you live? (Tick the appropriate block):
[NOTE: This should be total household income, not personal income.]

R 0-R3,500:_____R3,501-R7,500:_____R7,501-R12,500:_____
R12,501-R17,500:_____ 17,501-22,500:_____ 22,001-30,000:_____
30,001-40,000:_____ 40,001-50,000:_____50,001-60,000:_____
60,001-70,000:_____70,001-80,000:_____80,001-90,000:_____
more than 90,000:_____

2. Highest level of education reached for mother, father and/or guardian (please circle appropriate number).

	Biological mother	Biological father	Guardian
1) 0 years (No Grades / Standards) = Never went to school	1.	1.	1.
2) 1-6 years (Grades 1-6 / Sub A-Std 4) = Didn't complete primary school	2.	2.	2.
3) 7 years (Grade 7 / Std 5) = Completed primary school	3.	3.	3.
4) 8-11 years (Grades 8-11 / Stds 6-9) = Some secondary education (didn't complete high school)	4.	4.	4.
5. 12 years (Grade 12 / Std 10) = Completed high school	5.	5.	5.
6. 13+ years = Tertiary education Completed university / technikon / college	6.	6.	6.
7. Don't know	7.	7.	7.

3. Material and financial resources (please circle appropriate number).

Which of the following items, in working order, does your household have?

Items	Yes	No
1. A refrigerator or freezer	1.	1.
2. A vacuum cleaner or polisher	2.	2.
3. A television	3.	3.
4. A hi-fi or music centre (radio excluded)	4.	4.
5. A microwave oven	5.	5.
6. A washing machine	6.	6.
7. A video cassette recorder or dvd/blu-ray player	7.	7.

Which of the following do you have in your home?

Items	Yes	No
1. Running water	1.	1.
2. A domestic servant	2.	2.
3. At least one car	3.	3.
4. A flush toilet	4.	4.
5. A built-in kitchen sink	5.	5.
6. An electric stove or hotplate	6.	6.
7. A working telephone	7.	7.

Do you personally do any of the following?

Items	Yes	No
1. Shop at supermarkets	1.	1.
2. Use any financial services such as a bank account, ATM card or credit card	2.	2.
3. Have an account or credit card at a retail store (e.g Edgars)	3.	3.

Appendix C

Dear parent(s),

The Autism Research group at the University of Cape Town would like to invite you to take part in our research. We are conducting a study on the suitability of the Modified Checklist for Autism in Toddlers (M-CHAT) in the Western Cape. The M-CHAT is a short questionnaire that is used to screen for autism spectrum disorder (ASD) in countries such as the US. We would like to see whether the M-CHAT is a suitable screening tool for the South African context. If it is, this screening tool will hopefully be used in Primary Care Centre's throughout the country, in order to detect ASD at the earliest age possible.

What is the importance of the study?

Roughly 1 in 100 children have ASD. Many of these children are only diagnosed many years after their signs and symptoms are first noticed. It is therefore important that health care settings regularly use a screening tool that can detect ASD in young children. The M-CHAT can be administered by non-trained professionals and therefore will be of great use in a country like South Africa, where health care resources are limited.

Who can participate?

In our study, we will use the M-CHAT to screen a range of children between the ages of 18 months and 4 years 11 months. **We are asking parents of typically developing children and parents of children with ASD to fill it out** – we need to check that it can detect ASD **and also** that it can show that typically developing children and children with other developmental disorders do not have ASD.

What do I need to do?

The M-CHAT is quick to complete, it should take no longer than 15 minutes. Once the screen is complete, there may be a follow up telephone call clarifying some of the answers to the questions.

If you would like to participate, please fill in the consent form, demographic questionnaire and the M-CHAT.

If you have any further questions regarding the research, please do not hesitate to contact me, or my supervisor at any time.

Marina Stephens (stpmar014@myuct.ac.za or 084 921 3908)
University of Cape Town, Autism Research Group

Dr Susan Malcolm-Smith (Susan.Malcolm-Smith@uct.ac.za or 021 650 4605)

http://uctautism.com

Appendix D

Phase 1 - Screening
Consent form

We are conducting a study to see if short questionnaires can be used to screen for developmental disorders. We are asking different parents to be in our study because we want to see how the questionnaire works on typically developing children as well as on children with different kinds of problems.

If you agree to take part in our study, you will be asked to give us some information about yourself and your family; and to fill in a questionnaire that asks questions about your child's behaviour. This will take no longer than 30 minutes. Please answer all questions as accurately and honestly as possible.

You do not have to agree to take part in the study. If you agree and then change your mind, you can stop at any time. There will be no negative effects for you or your child. Neither you nor your child will be discriminated against, lose any privileges, or be treated negatively.

We understand that some of the questions asked may be sensitive, but all information will be kept strictly confidential. Only members of the research team will be able to see the information. When we publish the research, you will not be identified in any way.

Consent form to be contacted for future research

We might like to contact you to ask if you would take part in future research for this project, relating to child development.

Agreeing now that we can contact you DOES NOT mean you consent to take part in the research. If we do contact you in future, you can choose not to participate. You are not obliged to take part in the future if you fill in your details now- you can decide if you want to take part in the new research when you hear about it. No matter what you decide there will be no negative effects for you or your child.

If you have any questions or concerns please feel free to contact

Marina Stephens 084 921 3908 stpmar014@myuct.ac.za
Susan Malcolm-Smith on 021 650 4605
UCT Faculty of Health Sciences Research Ethics Committee on 021 406 6338.

Thank you for your help!
Autism Research Group
Department of Psychology, University of Cape Town
Developmental Clinic - Red Cross Children's Hospital
Division of Adolescent and Child Psychiatry, UCT

Consent to Participate in Phase 1 Screening

I consent to participate in this study.

Name: _____Signature: _____ Date: _____

Consent to be contacted for future research

I consent to be contacted about future research.

Name: _____ Signature: _____Date: _____

Your child's name: _____

Contact numbers (please give at least two): _____

_____

Consent was obtained by:

Name: _____ Signature: _____ Date: _____