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Interventions for preschool children with autism typically require professionals and parents to identify which social and language skills the individual child shows deficits in. Many assessment tools aimed at identifying such deficits exist, but they often require extensive training to use. The present study investigated the potential usefulness for said assessment purposes of the Norwegian assessment tool, TRAS—“Tidig Registrering Av Språktveckling” (i.e. Nordic acronym for assessment of early language development), which can be used by preschool teachers without any specific training. Participants were 54 children with ASD, aged 2–5 years, enrolled in a behavioral intervention program. Participants were scored using TRAS at three time points during treatment to investigate TRAS’ sensitivity for detecting change. Only participants who had TRAS scores registered at all three time points were used for this analysis (n = 27). At intake, children were also scored using the Vineland Adaptive Behavior Scales, the results of which was then compared to TRAS scores. Results showed that TRAS scores increased significantly across time points, indicating that the tool is sensitive to treatment effects. TRAS scores also correlated significantly with Vineland communication subscale (n = 50), indicating that the measure can be used to measure language abilities in children with ASD. We conclude that TRAS is a potential alternative to more comprehensive language assessment tools for children with ASD.

Key words: Language development, autism spectrum disorder, assessment tool, TRAS, Vineland.

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INTRODUCTION

Over the past decades, many psychiatric diagnoses have seen a marked rise in prevalence (Stolzer, 2016; Twenge, Cooper, Joiner, Duffy & Binau, 2019). Autism Spectrum Disorder (ASD) is one of the diagnoses with sharply rising prevalence (Wicks-Nelson & Israel, 2015), with approximately 1–2% of the population fulfilling the diagnostic criteria in the United States (CDC, 2012) and the United Kingdom (Baird, Simonoff, Pickles et al., 2006; Brugha, McManus, Bankart et al., 2011). However, it is important to note that this rise does not necessarily imply a rise in prevalence of the autism symptom phenotype, as indicated in a large population-based Swedish study (Lundström, Reichenberg, Anckarsäter, Lichtenstein & Gillberg, 2015). While language difficulties have been removed from the diagnostic criteria in the latest edition of the DSM (APA, 2000, 2013), ASD is often associated with deficits in both verbal and non-verbal communication (Brignell, Chenausky, Song, Zhu, Suo & Morgan, 2018; Wicks-Nelson & Israel, 2015). Problems with language in children with ASD have been implicated as contributing to behavioral difficulties, poor adaptive functioning and poor social skills (Brignell et al., 2018). This is likely due to individuals with ASD having fewer opportunities for social interaction and learning, compounding developmental problems in other areas as well. Similar issues have been conducive to the development and promotion of interventions targeting young children, in the hope of minimizing long-term negative impact of ASD.

One of the most studied of these interventions is Early Intensive Behavioral Intervention (EIBI), an intervention based on applied behavior analysis. Studies have shown EIBI to be effective for improving adaptive functioning (Eldevik, Hastings, Hughes, Jahr, Eikeseth & Cross, 2009; Reichow, 2012; Reichow, Hume, Barton, Boyd, 2018) and language development (Howard, Stanislaw, Green, Sparkman & Cohen, 2014) in children with ASD. A comprehensive review based on 389 studies of the effectiveness of treatments for children and youth aged 0–22 years diagnosed with ASD, the National Standards Project Phase II, led to EIBI receiving the status of an “established” treatment due to good evidentiary support (National Autism Center, 2015).

The effects of interventions such as EIBI are likely greater if the intervention is initiated at an age as low as possible, which indicates the necessity of early discovery of related difficulties, and if it targets specific behavioral deficits and excesses that have been shown to benefit from said intervention(s). To aid with the identification of behaviors suited for intervention efforts, professionals have a plethora of rating scales and tests at their disposal, such as the Vineland Adaptive Behavior Scales (Sparrow, Cicchetti, & Balla, 2005), the Assessment of Basic Language and Learning Skills (ABLLS, Partington & Sundberg, 2006), or the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008). However, these tools often require training and a professional license and are thus not available for those in daily contact with the children, such as preschool teachers and daycare personnel, who are most likely to initially raise suspicions about learning and/or behavioral problems. As this contributes to children suspected of having ASD often having to wait for extended periods for a proper
investigation and possible diagnosis, a means of identifying language related deficits by personnel working in direct contact with those children affords those individuals the possibility of initiating interventions, such as added support and attention during language training, without unnecessary delay. We therefore identify a need to develop and validate tools ready for use by teachers and other preschool personnel, as this has the potential to expedite the discovery of problems related to ASD, to provide a basis for support measures, and to inform the selection of treatment goals.

One such assessment tool showing promise for use with children with ASD, and without extensive formal training, is TRAS – “Tidig Registrering Av Språkutveckling” (i.e. Nordic acronym for assessment of early language development), a tool for systematic observation of language development in preschool environments.

TRAS

TRAS was developed by researchers from different Norwegian special education institutions and reading research institutes, in cooperation with the Norwegian State’s Special Education Support System (statlige spesialpedagogiske tjenesten for kommuner og fylkeskommuner – Statped), for the assessment of language development in preschool children based on observations in a natural context. The idea behind TRAS came from the realization that reading and writing difficulties were often not identified until children started school, and because of a perceived lack of knowledge among preschool staff regarding how to work with language development in a more goal-oriented fashion (Frost, Færevaag, Horn & Espenakk, 2013). Its development was based on two survey studies, in 2000 and 2005, where the main focus was exploration of how preschool teachers worked with children to support their language development (Espenakk et al., 2013). Among other things, the first of these studies investigated the use of systematic observation of language development with the children and/or the use of any kind of observation aids. Among the 270 preschool teachers who answered the questionnaires approximately 10% were using some form of observation aid, but only 2% were using systematic observations of language development. In the second study, the purpose was to evaluate how TRAS, which by this time had been developed and made available for use in preschools, was being used. Out of the 550 preschool teachers participating 91% reported using TRAS on a daily basis, 86% reported that it had contributed to improved cooperation among staff, and 93% reported that TRAS had contributed to improving their understanding about the language development of children (Espenakk et al., 2013). Together, these studies indicate the potential for TRAS to benefit work with language development, and the apparent ease with which it has been implemented in these environments.

TRAS tracks eight domains of social- and language-development (translated from Nordic): Interaction, Communication, Attention, Language Comprehension, Linguistic Awareness, Pronunciation, Word Production, and Sentence Construction. The ratings are compiled and visualized as a circle divided into slices dedicated to different aspects of these eight domains and structured by the age ranges of 2–3, 3–4, and 4–5 (see Results section). To exemplify, what follows are translated examples of some age specific questions from the domain of Interaction: (1) 2–3 years: “Does the child show an interest in playing with others?”; (2) 3–4 years: “Is the child directing the positive attention of other children towards something he or she is interested in?”; and (3) 4–5 years: “Is the child joining others in play for a longer period of time”. Detailed explanations regarding how to answer each question and what constitutes normal language development in each domain between ages 0–5 are found in the manual (Espenak et al., 2013). It is also possible to disregard the standard age categorization of the questions and instead fill in the slices of the circle relevant for the specific child and his/her stage of development. This can be especially useful when working with children with ASD, as they often show irregular progress across domains of language development.

As TRAS has already been implemented in many preschools, but mainly studied with typically developing children, we believe it is prudent to investigate its potential use for work with children diagnosed with ASD, and for evaluating the effects of interventions such as EIBI.

The current study

There is a need to develop and validate tools to allow for the charting of language and social skills in young children with ASD by non-licensed professionals, and to increase the chances of earlier detection of related deficits. The aim of the current study was to investigate the utility of TRAS as tool for these purposes by analyzing: (1) its concurrent validity in relation to an established and validated rating instrument, the Vineland Adaptive Behavior Scales second edition (Vineland-II); and (2) its sensitivity to change over time, namely, during treatment. For these purposes, we conducted a retrospective registry study based on data collected in connection with an EIBI program implemented at a habilitation center in Sweden.

METHOD

Data were collected by staff at Banyan Center, Stockholm, Sweden, a private habilitation agency funded by Stockholm County to provide habilitation services to preschool-aged children with ASD. The funding agency required that Banyan collected data on their service provision, including collecting child outcome data. Vineland and TRAS data collected between October 2014 and April 2016 were anonymized by staff at Banyan Center and made available to one of the authors (LK) at Stockholm University for analysis. Prior to the intervention, all participating children’s parents and/or caretakers had provided written consent for future use of the registry data for evaluation and research purposes. As all data and consent for the current study had already been collected, no further involvement from participants and/or caregivers was required. All procedures were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Participants

Participants were 54 children (46 boys and 8 girls) with a diagnosis of ASD. The diagnosis was based on the DSM-IV criteria (APA, 2000) and set by a licensed medical doctor or by a licensed clinical psychologist. The
mean chronological age at intake was 3.8 years (SD = 0.84; Range 2.2–5.3). Mean intake Vineland Adaptive standard score was 56 (SD 9.32; Range = 20–89), and mean intake Vineland communication standard score was 57 (SD 15.74; Range = 32–75).

**Measures**

Data were collected at three time points; pre-intervention, after 6 months of intervention, and after 12 months of intervention. TRAS data were collected at all time points, whereas Vineland-II data were only collected pre-intervention. There was a maximum of two weeks separating the two pre-intervention measurements. For the follow-up measurements, deviation from the exact 6- and 12-month dates was never more than two weeks. Assessments were conducted by EIBI treatment supervisors from the habilitation center, with parents or preschool personnel present and as needed. Supervisors were psychologists, behavior analysts, speech therapists, or physical therapists, had received supervision and training in relevant theory and practice at the center, and most also had long experience working with and training others to implement EIBI.

**Vineland-II**

Vineland-II is a rating instrument widely used in both research and clinical practice that provides measures of adaptive behavior within the domains of communication, daily living, socialization, motor skills, as well as problem behaviors, for individuals aged from 2 to 90 (Sparrow, Cicchetti & Balla, 2005). There is a sizeable body of evidence supporting the validity and reliability of Vineland-II as a whole (Floyd et al., 2015), and a study investigating the convergent validity of the first edition of Vineland communication and socialization subscales with similar subscales from the Social Functioning Scale for the Mentally Retarded in a population of mentally disabled children and adolescents, revealed correlations of $r_c = 0.67–0.89$ depending on the subscales and severity of disability (de Bildt, Kraijer, Sytema & Mindera, 2005).

For purposes of validating TRAS, both Vineland-II total scores and communication scores have been used and compared with TRAS scores. Using the Parent/Caregiver Rating Form, parental ratings were given after care instruction by supervisors on how to use the instrument; however, the supervisors were not present while guardians filled out the forms.

The Vineland test was deemed too time-consuming for repeated measurements.

**Tidig Registrering Av Språk - TRAS**

TRAS is a rating instrument for systematic observation of language development in young children, developed in Norway for use by preschool personnel (Espenakk et al. 2013). The instrument can be completed in approximately 30 minutes and consists of a circle divided into eight domains of competence, which is further divided into three age groups, with three questions per age group. The instrument was validated in 2006 in a study comparing TRAS with two already established tests; TROG-R (Test for Reception of Grammar revised 2001), a test of grammatical comprehension developed for ages 4–16, and BPVS II (The British Picture Vocabulary Scale 1997), a vocabulary test developed for ages 2 and up (Horn, Espenakk, Ottem & Solheim, 2013). Significant correlations were found with both TROG-R ($r = 0.38, p < 0.001$) and BPVS II ($r = 0.24, p < 0.001$), indicating that TRAS measures some of the same linguistic competences as these tests.

TRAS scores are recorded as 0, indicating a lack of mastery of the skill, 0.5, indicating partial mastery, or 1, indicating that the child on a number of occasions has shown mastery of the skill. Scores within a domain are compiled into a domain score, giving an indication of the extent of mastery of that domain. For the current study, the scores from TRAS’ domains were compiled into a total TRAS score to allow for comparisons with Vineland-II Communication domain and Total scores.

**Treatment**

Following initial TRAS and Vineland-II assessments, all participants received an EIBI program. Intervention was based on existing EIBI treatment manuals (e.g., Leaf & McEachin, 1999; Lovaas, 1981), although no specific manual was used for all programs. Intervention goals for each child was tailored to fit individual needs and was guided by typical developmental sequences. Communication, daily living skills, motor skills and social skills were all possible areas of teaching, depending on the needs of the child. Teaching included, but was not limited to, discrete-trials-teaching, and also included teaching in group settings and natural environment teaching. The habilitation center provided supervision, preschool personnel and parents provided training for 20 hours per week (15 hours at the preschool and 5 hours at home), the scheduling of which was agreed upon by the participant’s parents/caretakers and preschool. A specific staff member at the participant’s respective preschool was assigned responsibility for implementation. After initial instruction, given by a supervisor from the habilitation center to preschool staff and parents on how to implement EIBI, supervision meetings were held every or every other week.

**Data collection and analyses**

Data analyses had two primary goals: to investigate the concurrent validity of TRAS and whether TRAS is sensitive to change. To measure the concurrent validity, we performed Spearman correlation analyses comparing the available pre-treatment measures of TRAS total scores with Vineland-II Communication domain scores and Total scores. To investigate whether TRAS is sensitive to change, we performed a repeated measures ANOVA to see if there was a significant difference between the TRAS test scores at the three time points. Additionally, TRAS data were aggregated for each time point using the TRAS circle, to visualize the percentage of children mastering each area of competence and development within these domains over time.

**Attrition and missing data**

Out of a total of 54 registered participants, at the intake measurement 53 participants had TRAS total scores registered, 51 participants had Vineland-II Communication scores registered, and 49 had Vineland-II Total scores registered. As some participants with TRAS scores registered had missing data from at least one of the other tests, this meant that for the analysis of concurrent validity the Vineland-II Communication scores of 50 children, and Vineland-II Total scores of 48 children, were available for comparisons with TRAS. By the time of the 6-month follow-up, four children had ended their participation in the EIBI program, while assessments had not been performed for 11 other children due to practical reasons, leaving a total of 38 children still left in the study out of the 53 children for whom initial TRAS measurements had been conducted. By the time of the 12-month follow-up, another 11 children had either dropped out of the program or had not had their assessments performed within the two-week time period prescribed. Thus, 27 children in total remained for an analysis of language development over three time points using TRAS.

**RESULTS**

**Concurrent validity of TRAS**

There was a significant positive correlation between intake measures of TRAS and Vineland-II Communication scores ($r_c = 0.60, p < 0.001; n = 50$), as well as a significant positive correlation between intake measures of TRAS and Vineland Total scores ($r_c = 0.63, p < 0.001; n = 48$). See also Figs. 1 and 2.

A density plot of intake TRAS and Vineland-II scores is appended in Fig. 3. Both Vineland-II measures passed normality...
testing, whereas only the intake TRAS measures passed normality testing.

Sensitivity to change
A one-way repeated measures ANOVA was conducted to compare the effect of time on TRAS scores. There was a significant effect of time on TRAS scores, $F(2, 52) = 56.97, p < 0.0001; n = 27$. Post hoc comparisons using Tukey’s multiple comparison test indicated that the mean score at intake ($M = 17; SD = 15.10$) was significantly different than the mean score at both 6- ($M = 26.7, SD = 19.06$) and 12-month ($M = 33.7, SD = 21.97$) follow-ups. The mean score at the 6-month follow-up was also significantly different than the mean score at the 12-month follow-up. See also Fig. 4.

Aggregated TRAS data
The percentage of children mastering each area of development as charted by TRAS is appended in Figs. 5–7. A completely white area means 0% of the children mastered that skill at that time point, a completely black area means 100% of the children mastered that ability, and shades of gray means intermediary percentage rates of mastery. As the age ranges imply, abilities commonly more easily mastered are found towards the center of the circle, while domains of development often presenting more of a challenge are found progressively towards the outer rim of the circle.

Attrition
With regards to attrition, to investigate possible differences between the participant and drop-outs, we conducted t-test for

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Vineland total, Vineland communication and TRAS total scores. No significant differences were found between the two groups on any of the comparisons (Vineland total $p = 0.09$; Vineland communication $p = 0.08$; TRAS total $p = 0.27$).

DISCUSSION

Having identified a need to validate tools for charting language and social skills available for use by non-licensed professionals working with children with ASD in preschools, we conducted a retrospective registry study investigating the utility of TRAS for these purposes.

Spearman correlation analyses revealed significant positive correlations between TRAS and Vineland-II total scores ($r_s = 0.63, p < 0.001$) and between TRAS and Vineland-II communication scores ($r_s = 0.60, p < 0.001$). In light of the original validation study for TRAS showing correlations of 0.24 and 0.38 with established tests of vocabulary and grammar, respectively, the correlation with both Vineland-II measures used in the current study is relatively strong, indicating that TRAS measures many of the same abilities as Vineland-II. A significant difference between all of the assessment time points was found, with a clear increase in scores over time. As the mean age at intake was close to 4 years old, at the end of the study its length would have covered approximately 20% of the participant’s life span during a period of rapid and wide-ranging development.
Based on this, and that the study participants took part in a treatment with substantial evidentiary support, we would expect to find increases in scores over time such as those seen in the current study. We believe this indicates that TRAS is indeed sensitive enough to discover change over time.

The similarity in the strength of the correlations between TRAS and both Vineland-II measures is somewhat surprising as the Vineland Total score is affected by measures of domains not directly related to communication. We had expected the correlation between TRAS and the Total score to be lower than the correlation with the Communication subscale, as the broader range of abilities measured in the Total score is likely to introduce additional, uncorrelated variation into the comparison, thereby lowering the correlation. One possible explanation is that the domains of Interaction and Attention in TRAS measure some of the same underlying aspects as Vineland-II when excluding the communication domain. For instance, the rating of “Stays on task for 5 min. without teacher attention”, from the Daily Living domain in Vineland-II, is likely to measure something similar to the question “Does the child maintain attention directed at something for an extended period of time?” from the Attention domain in TRAS.

While both Vineland-II measures passed normality testing, only the pre-intervention TRAS measure passed normality testing, with density plots of the pre-intervention TRAS scores showing a positive skew. One way of interpreting the accumulation of low scores is that TRAS is less sensitive to differences in ability at the lower range of the developmental spectrum than Vineland-II. This might be due to Vineland-II providing a more comprehensive audit of the child’s development at a given age due to the greater number of questions (32 questions compared to TRAS’ 24 for a given age group, i.e., a 33% increase) and/or the content allowing for the instrument to cover a lower range of ability. Another interpretation would be that Vineland-II is more sensitive due to the handling of test administration and interpretation by experienced professionals trained in relevant skills. However, as Vineland-II ratings were made by parents without direct oversight of a test administrator, while TRAS ratings were made by supervisors together with parents, this does not seem to be the case here.

A result of note is that the Linguistic Awareness (Språklig Medvetenhet) in TRAS is an area that saw relatively little development across measurements compared to areas of Interaction (Samspel) and Communication (Kommunikation, see Figs 57). As linguistic awareness is not explicitly trained in EIBI, whereas interaction and communication are, this could be seen as an indicator of EIBI effectively contributing to the development of the skills targeted by it.

The mean adaptive intake score for the participants in the current study seems comparable to what has been reported previously. In a study designed to develop supplementary norms for the Vineland Adaptive Behavior Scales for individual with ASD, Carter, Volkmar, and Sparrow (1998) reported a mean adaptive standard score of 55 (SD = 15.9; N = 141) in verbal children less than 10 years-of-age, and 49 (SD = 14.0; N = 252) for non-verbal children under that age of 10. In the current study, mean intake Vineland Adaptive standard score was 56 (SD = 9.32), which is similar to what was reported by Carter et al., (1998).

All in all, we conclude that TRAS has the potential to serve as an alternative to more comprehensive language assessment tools for children with ASD.

Study limitations
We acknowledge that our study is limited by the lack of direct access to information on the intellectual abilities of the participants. Research has shown, however, that Adaptive Behavior correlates well with IQ in children with ASD (Carter et al., 1998). It is therefore reasonable to believe that a majority of the participants of the current study had a mild to moderate degree of intellectual disability. Hence, the present study could be seen as implying the usefulness of TRAS for a subgroup of children with ASD, namely for those with low intellectual functioning. However, as TRAS was originally developed for and validated with children without a specific diagnosis such as ASD and intellectual disability, it is unlikely that it would be an effective means of language assessment for children with no diagnosis, or both diagnoses, but not for those diagnosed only with ASD.

Another limitation of the study is the high attrition rate, only half of the recruited children having been assessed at all time points. However, we see no indication that these limitations would have a major impact on the conclusions of the study.

Suggestions for future research
The results of the current study indicate that TRAS is sensitive enough to measure change over time and that it measures some of the same abilities as Vineland-II. While Vineland-II might be a more sensitive tool, TRAS has the added benefit of being available for use by preschool personnel in direct, daily contact with the children who might benefit from the discovery of deficits in the areas of language and social development. To further our understanding of the utility of TRAS, we suggest two future avenues of research: (1) investigation of the potential for TRAS to identify children that might be in need of an autism assessment; and (2) the utility of TRAS to identify and specify targets for treatment. Both questions can be investigated both using TRAS by itself, or by comparing TRAS to existing measures such as VB-MAPP or ABLLS (in which case the measures should be compared both for ease of use, and validity). We make the first suggestion as parents can sometimes be resistant to the idea that their child is in need of an autism assessment. If TRAS can be shown to accurately identify children in need of assessment, it might also make such a need more easily communicated to and accepted by parents. Also, the TRAS “circle” (Figs. 5–7) presents results in a way which make them easily communicated to parents, as well as to professionals who make decisions regarding the need for further assessment, without the need for prior experience with the tool. We make the second suggestion because if TRAS is useful as a tool to identify and specify targets for treatment it will provide preschool personnel and therapists with data that can serve as a common ground for communicating about a child’s abilities and needs. This might in turn make treatment more readily available and speed up its initialization, which has the potential of leading to improved long-term outcomes.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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