



## REGULAR ARTICLE

## INDIVIDUAL OR GROUP-BASED APPROACH TO THE ASSESSMENT OF PRESCHOOL CHILDREN: A COMPARISON USING THE INTERGROWTH-21<sup>ST</sup> NEURODEVELOPMENT ASSESSMENT (INTER-NDA)

JOHANNA SLIM<sup>1</sup>, JOSE VILLAR<sup>2,3</sup>, GABRIELA GUERRERO VARELA<sup>1</sup>, FRANCISCA HERNANDEZ CASTILLO<sup>1</sup>, MARIA DE LA LUZ LOZADA GUZMÁN<sup>1</sup>, ANGÉLICA BUCHÁN DURÁN<sup>1</sup>, LEILA CHEIKH ISMAIL<sup>4,2</sup>, SANDY SAVINI<sup>2</sup>, PILAR VAZQUEZ ARANGO<sup>2</sup>, ALAN STEIN<sup>5</sup>, STEPHEN KENNEDY<sup>2,3</sup>, MICHELLE FERNANDES<sup>6,2\*</sup>

<sup>1</sup>Programa de Educacion Inicial, Fundación Carlos Slim, Mexico City, Mexico

<sup>2</sup>Nuffield Department of Obstetrics and Gynaecology, John Radcliffe Hospital, University of Oxford, Oxford, United Kingdom

<sup>3</sup>Oxford Maternal and Perinatal Health Institute, Green Templeton College, University of Oxford, Oxford, United Kingdom

<sup>4</sup>Clinical Nutrition and Dietetics Department, College of Health Sciences, University of Sharjah, Sharjah, UAE

<sup>5</sup>Department of Psychiatry, Warneford Hospital, University of Oxford, Oxford, United Kingdom

<sup>6</sup>Department of Paediatrics, Southampton Children's Hospital, University of Southampton, Southampton, United Kingdom

## INTRODUCTION

It has been estimated that 250 million preschool children in low-and middle-income countries are at risk of not achieving their developmental potential [1]. The first step in addressing this issue is the accurate identification of children at risk of developmental disturbances. Most assessments of early child development (ECD) are complex and targeted at the individual, including the Bayley Scales of Infant Development [2], the Griffiths Scales of Child Development [3] and the Denver Development Screening Test [4]. There is limited information on 'small group-based' approaches to ECD measurement as a strategy to increase coverage and it is not known whether assessing children in small groups is feasible and comparable to individual assessment.

Concerns about the reliability of developmental scores obtained through group-based ECD assessments arise because of inter-child interference, disruption and mimicry. Scoring multiple children simultaneously in an unbiased format can be challenging. It may be possible, however, to implement ECD assessments in small groups in settings such as preschools where the children are already familiar with the assessor, the environment and other participants.

The INTERGROWTH-21<sup>st</sup> Neurodevelopment Assessment (INTER-NDA) is a 53-item ECD assessment developed by The International Fetal and Newborn Growth Consortium

for the 21<sup>st</sup> Century (INTERGROWTH-21<sup>st</sup>) Project [5, 6]. The INTER-NDA measures cognition, language (expressive and receptive), motor skills (fine and gross), behavior (positive, negative and global), attention and socio-emotional reactivity in 22 to 26 months old children. It consists of directly administered, concurrently observed and caregiver-reported items, scored on a 5-point scale. It was developed for, and implemented in, the INTERGROWTH-21<sup>st</sup> Project on an individual child basis.

During the piloting of the INTER-NDA in preschools in Mexico City, it was suggested that a small group strategy might be more appropriate for large-scale dissemination through the educational system and for achieving large coverage as a first level-screening program. We therefore designed this study, in the context of the INTERGROWTH-21<sup>st</sup> Project global dissemination program, with the aim of comparing INTER-NDA scores obtained from the individual and group approaches after controlling for age, sex, nutritional status and location of the school.

## MATERIALS AND METHODS

## Location

The study was carried out between March and June 2015 in four Centros de Cuidado y Atención Infantil of the Mexican *Sistema Nacional para el Desarrollo Integral de la Familia* (DIF) (Casita de Susi, Yoltzin, Mundo de Andi

Received 27 March 2018; Accepted 21 May 2018

\*Corresponding Author

Michelle Fernandes

Department of Paediatrics, Southampton Children's Hospital, University of Southampton, Southampton, United Kingdom

Email: [m.c.fernandes@soton.ac.uk](mailto:m.c.fernandes@soton.ac.uk)

©This article is open access and licensed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted, use, distribution and reproduction in any medium, or format for any purpose, even commercially provided the work is properly cited. Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made.

and CBI). They are located in Mexico City catering for children of lower-middle socio-economic status who participated in the study. All the teachers were staff of the Casa Telmex-Centro Histórico, qualified in preschool education through a degree from the institution conducting this study, the Programama de Educación Inicial, Fundacion Carlos Slim, a private educational service committed to promoting the preschool education of Mexican children.

### Recruitment

Children were recruited into the study if they: (i) were aged 22 to 26 months; (ii) were healthy at the time of the assessment; (iii) had been enrolled in the preschool for a minimum of 6 months (to ensure they were familiar to their peers and teachers); (iv) were not previously exposed to neurodevelopmental testing, and (v) were native in Mexican Spanish.

### Methods

The INTER-NDA's scoring system is an objective report of the child's performance rather than subjective judgment by the assessor. The assessment was designed for use in international settings with emphasis on avoiding the use of culture-specific items. It has good inter-rater and test-retest reliability ( $k=0.70$ , 95%CI 0.47-0.88;  $k=0.79$ , 95%CI 0.48-0.96)[5]. The administration and scoring of the INTER-NDA follow a standardized protocol ([www.intergrowth21.org.uk](http://www.intergrowth21.org.uk)). The INTER-NDA takes 15-20 min to complete in its original individual format.

The individual assessment protocol of the INTER-NDA was modified (by MF) to ensure that groups of three children could be assessed simultaneously. This involved INTER-NDA items being presented one at a time to each child, ensuring that each child was presented with different items during each presentation cycle. The sequence of presentation of cognitive, language and fine motor items (items 1-21 of the INTER-NDA) for each of the three children in a group was designed so that (i) all items were eventually presented to all the children and (ii) once an item in a cycle was presented to any one child, it would not be presented to the other children until at least two cycles comprising different items were completed. The rationale was to reduce the ability of the second child to remember how to solve a particular task after witnessing the first child's performance. Care was taken to ensure that items, which follow on from each other (for example, the puzzle board and reverse puzzle board, and the naming and matching of colored cubes) were not affected. Children were encouraged to complete gross motor items together, before the conclusion of the assessment. Caregiver reported and behavior related items were completed by the teachers, after the cognitive, language and motor items were administered.

The INTER-NDA was translated into Mexican Spanish following a standardized translation and back-translation protocol (by SS, GGV and FHC)[7]. Eight preschool teachers (two from each participating preschool) were trained and standardized in the INTER-NDA during a 3-day training session (by MF and SS) that included both individual and group assessments. Teachers were supported by the technical staff responsible for developmental evaluation of children of the Sistema Nacional para el Desarrollo Integral de la Familia (DIF) of Mexico.

The weight, length and head circumference of the children were measured according to anthropometric protocols of

the INTERGROWTH-21<sup>st</sup> Project[8]. Weight was measured using a portable electronic scale (Seca) with taring capability and calibrated to 0.1 kg. Length was measured in cm to the last completed mm using the Harpenden Portable Stadiometer. The equipment was calibrated before measuring each child. A 0.7-cm-wide, flat paper tape (range, 0–200 cm, calibrated to 1 mm) was used to measure head circumference. Two sets of measurements for weight, length and head circumference were taken and recorded by two trained preschool teachers. The preschool teachers were standardized and trained by the INTERGROWTH-21<sup>st</sup> Project's lead anthropometrist (LCI).

Forty-two children were selected from the four preschools and divided into six groups. Each group consisted of two girls and a boy, or two boys and a girl. All assessments were carried out in a preschool classroom. In the first part of the assessment, the teacher administered the INTER-NDA according to the group assessment protocol described above to a group of three children seated at a table. A second teacher was seated non-intrusively in the room, and recorded the performance of each child on a score sheet.

In the second part of the comparison, the second teacher assessed children individually, without other children in the room. At the end of the final assessment, the child's weight, length and head circumference were recorded.

The individual and group assessments were conducted a day apart. For the first three groups of children, the group assessment was conducted on day 1 and the individual assessment on day 2; this order was reversed for the remaining three groups of children. All assessments were conducted in Mexican Spanish. The results were not used for any clinical or academic evaluation of children and were analyzed anonymously without any link or report to the school record of the children.

The authorities with legal responsibility for; and the head of the institution of; the Centros de Cuidado y Atención Infantil of the Sistema Nacional para el Desarrollo Integral de la Familia, Mexico City, Mexico, reviewed the project and provided written approval for its conduct. The investigators then had a detailed discussion with the teaching staff and parents/guardians. The teachers themselves obtained written informed consent from the parents/guardians of all participating children.

### Statistical analysis

Descriptive statistics for each INTER-NDA domain, i.e. cognition, gross motor, fine motor, expressive language, receptive language, positive behavior, negative behavior, global behavior, attention and socio-emotional reactivity were calculated for each child for the group and individual assessments. To determine whether there was consistency between scores obtained from group and individual assessments, continuous correlations were calculated for each INTER-NDA domain. To determine whether significant differences in INTER-NDA domain scores existed between individual and group assessments, we carried out paired t tests. Due to the similarity in scores for some INTER-NDA domains, we did not use intra-class correlation coefficients between group and individual scores, as they are known to function best in situations of high heterogeneity in the data [9].

To determine agreement between INTER-NDA domain scores obtained from group and individual assessments a

Bland-Altman analysis was carried out using the recommended strategy [9, 10], i.e. (i) independent sample t-tests to assess whether there was a difference between group and individual INTER-NDA domain scores within subjects; (ii) biases and limits of agreement statistics; (iii) Bland-Altman plots to identify whether INTER-NDA domain scores differed systematically between the group and individual assessments, and (iv) linear regression analyses of the relationship between the difference score and mean of the group and individual assessments.

Descriptive statistics were calculated for weight, length, head circumference and age at the time of assessment. A covariate analysis was carried out to determine whether weight, length, head circumference, child age and sex, and location of the preschool were associated with mean INTER-NDA scores for group and individual assessments separately. T tests, ANOVAs and continuous correlations were used to examine the effect of: (i) sex; (ii) location of preschool, and (iii) age and anthropometry respectively on INTER-NDA scores.

A hierarchical linear regression analysis was conducted to examine associations between type of assessment (group or individual) and INTER-NDA domain scores using potential confounders as covariates. For each INTER-NDA domain, the analysis consisted of four models. In model 1, unadjusted associations between type of assessment and INTER-NDA domain scores are presented. In model 2, the association is further adjusted for the age and sex of the children. In model 3, the association is adjusted for the factors in model 2 and the nutritional status of the children (weight, length and head circumference). In the final model, the association is adjusted for the factors in model 3 together with the location of the preschool.

## RESULTS

Of the 42 children (mean age 2.08 y, SD 0.29) assessed using individual assessments in the study, 26 were girls and 16 were boys. Six of these children were not available for the group assessment; therefore, the study groups

consisted of 36 children organized into 12 triads. Ten triads consisted of 2 girls and a boy, and 2 triads consisted of 2 boys and a girl. All children were native in Mexican Spanish and spoke no other languages.

The sequence of the INTER-NDA group assessment for a group of three children is presented in Supporting Information 1. The forms for each child within a group are presented in Supporting Information 2-4. The INTER-NDA form for individual assessment is presented in Supporting Information 5.

The mean weight (kg), length (cm) and head circumference (cm) for the 42 children were 12.06 (1.59), 85.04 (5.23) and 46.68 (3.17) for boys and 11.35 (1.60), 83.44 (4.06) and 45.18 (4.69) for girls, respectively. These mean values corresponded, for both boys and girls, to the 25<sup>th</sup>-50<sup>th</sup> centile, 15<sup>th</sup>-25<sup>th</sup> centile and 5<sup>th</sup>-15<sup>th</sup> centile for weight, length and head circumference respectively on the WHO Child Growth Standards [11].

The mean INTER-NDA domain scores for the sample for group and individual assessments are presented in table 1, along with the results of the correlational analysis and paired t tests. The results of the correlational analysis found that the mean INTER-NDA domain scores from group and individual assessments were significantly highly correlated for 9 of the 10 domains ( $r=0.35$  to  $1.00$ ,  $p=0.03$  to  $<0.001$ ), with actual scores being identical in five domains.

The only domain where the group and individual assessment scores were not significantly correlated was receptive language ( $r=0.25$ ,  $p=0.14$ ). Paired t tests did not find any significant differences in INTER-NDA domain scores between group and individual assessments on any domains. The difference between individual and group scores on the fine motor domain approached significance (individual mean 1.46, SD 0.65; group mean 1.24, SD 0.27;  $p=0.05$ ); however, for all other domains the scores were very similar.

**Table 1: INTER-NDA domain scores according to method of assessment, correlation analysis between group and individual domain scores and group-individual comparisons**

INTER-NDA domain	Scores		Correlation Analysis		Paired t test	
	Individual assessment	Group assessment	Pearson correlation (r)	P value	Mean difference	P value
	Mean (SD)	Mean (SD)				
<b>Cognition</b>	1.73 (0.41)	1.87 (0.18)	0.57**	<0.001	0.13	0.25
<b>Gross Motor</b>	1.08 (0.49)	1.37 (1.07)	1.00**	<0.001	0.28	0.14
<b>Fine Motor</b>	1.24 (0.27)	1.46 (0.65)	0.35*	0.03	0.22	0.05
<b>Expressive Language</b>	2.44 (0.76)	2.56 (0.86)	0.76**	<0.001	0.12	0.51
<b>Receptive Language</b>	1.96 (1.02)	2.00 (1.15)	0.25	0.14	0.04	0.88
<b>Positive Behavior</b>	0.88 (0.35)	0.88 (0.36)	1.00**	<0.001	0.00	1.00
<b>Negative Behavior</b>	0.15 (0.28)	0.15 (0.28)	1.00**	<0.001	0.00	1.00
<b>Global Behavior</b>	-0.72 (0.43)	-0.72 (0.44)	1.00**	<0.001	0.00	1.00
<b>Attention</b>	0.61 (0.34)	0.61 (0.34)	1.00**	<0.001	0.00	1.00
<b>Socio-emotional reactivity</b>	0.51 (0.29)	0.50 (0.30)	1.00**	<0.001	0.00	1.00

\* $p<0.05$ , \*\* $p<0.001$

The results of the Bland-Altman analysis are presented in table 2 and fig. 1. Independent sample t tests showed no statistically significant differences in INTER-NDA domain scores based on the method of measurement, i.e. group or individual assessment. The analysis indicated no bias (0%) in the domains of behavior (positive, negative and global) and attention (hence, plots corresponding to fig. 1, for these domains are not shown). Bias was very low in the domains of expressive language (2.2%), receptive language (2.9%) and socio-emotional reactivity (0.04%). Bias was moderate in the domains of cognition (27.0%), gross motor skills (16.1%) and fine motor skills (14.3%).

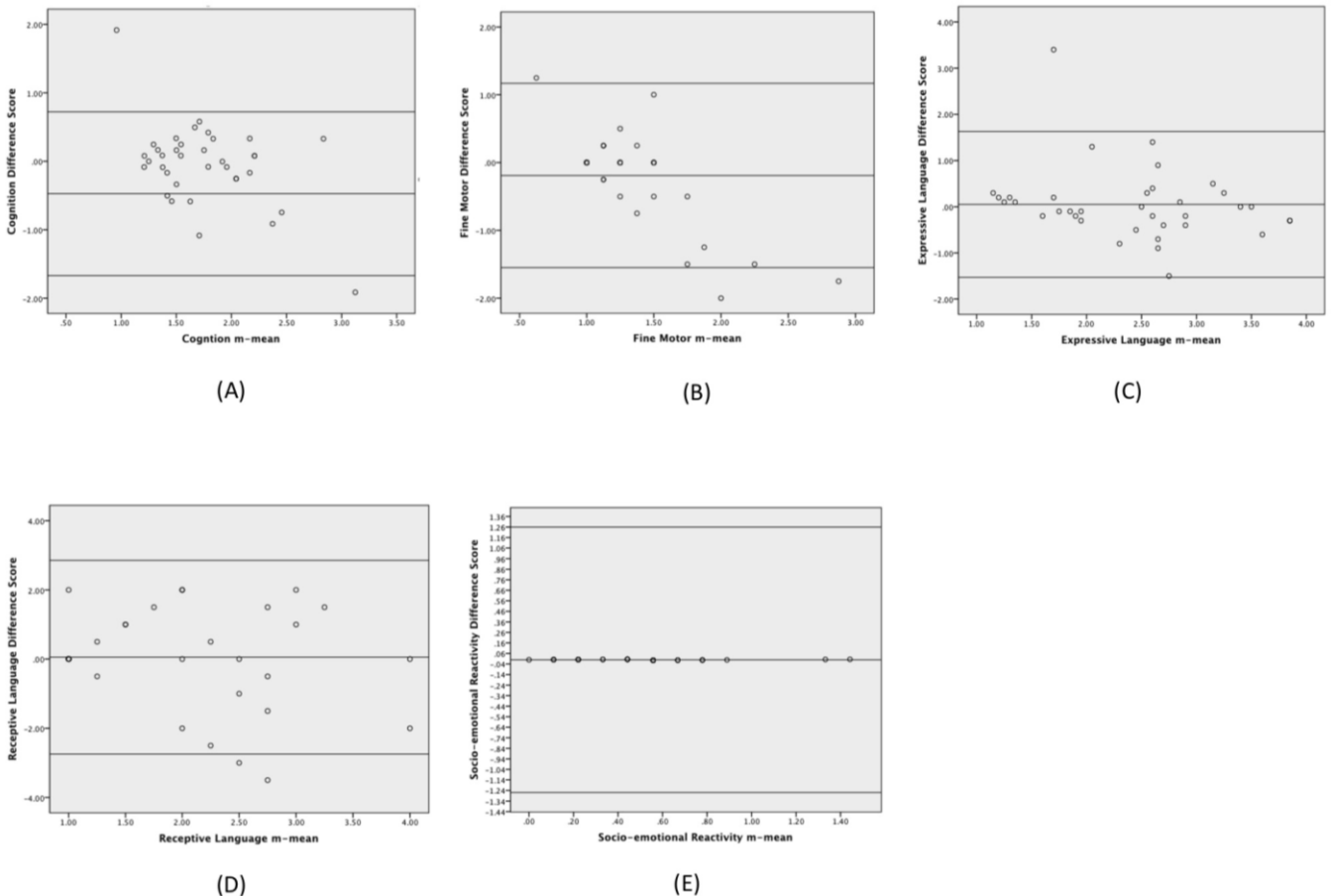
The results of the linear regression showed a significant linear association between group and individual scores on these domains. Taken together, these results suggest that the cognition, gross and fine motor scores for group and individual assessments are positively correlated but not numerically in agreement. Scores on all other domains are numerically in agreement. This is further illustrated in the Bland-Altman plots (fig. 1).

For all plots, the central horizontal line represents the mean difference, and the two other horizontal lines represent the upper and lower limits of agreement, respectively. The sample size was 36 for all plots. Examples of the variability observed in the Bland Altman plots are shown for (A) cognition, (B) fine motor, (C) expressive language, (D)

receptive language, and (E) socio-emotional reactivity domains. No plots are depicted for behavior (positive, negative and global) and attention because the Bland-Altman analysis indicated no bias at all (0%) in these domains. For gross motor, the scores were identical for 31 of the 36 children; hence, the plot is not presented either.

The results of the exploratory covariate analysis found significant association between INTER-NDA scores and location of preschool, age and anthropometric measures; hence, these were included as covariates in the regression analysis. Although no association with sex was found, sex was included as a covariate in the analysis based on evidence from the literature that neurodevelopment scores can differ between boys and girls [12-14].

Table 3 reports the results of the multiple linear regression analysis examining the association of the mode of the assessment (group or individual) on mean INTER-NDA domain scores after adjusting for age, sex, weight, length, head circumference and preschool location (further information on the covariate analysis is presented in S6). For all domains, there were no significant differences between scores obtained from group and individual assessments. The only near significant difference between group and individual scores was for the gross motor domain, which reached  $p=0.05$  level after adjusting for the confounding variables.



**Fig. 1: Bland-Altman plots for the INTER-NDA cognitive, motor, language and socio-emotional reactivity domains**

**Table 2: Bland-Altman analysis for the comparison between individual and group assessments scores**

INTER-NDA domain	One sample t test			Bland-Altman Statistics			Linear regression (difference scores vs. mean of group and individual scores)	
	Mean difference	SD difference	Sig.	Bias (%)	Lower Limit of Agreement	Upper limit of agreement	B	p
Cognition	-0.47	0.59	0.64	27.02	-1.67	0.72	-0.61	0.003*
Gross Motor	-0.19	1.19	0.33	16.10	-2.57	2.19	-1.43	<0.001**
Fine Motor	-0.19	0.68	0.09	14.28	-1.55	1.17	-1.23	<0.001**
Expressive Language	0.05	0.79	0.69	2.16	-1.53	1.63	-0.25	0.16
Receptive Language	0.06	1.40	0.81	2.90	-2.74	2.85	-0.28	0.30
Positive Behavior	0.00	0.00	n/a	0.00	n/a	n/a	n/a	n/a
Negative Behavior	0.00	0.00	n/a	0.00	n/a	n/a	n/a	n/a
Global Behavior	0.00	0.00	n/a	0.00	n/a	n/a	n/a	n/a
Attention	0.00	0.00	n/a	0.00	n/a	n/a	n/a	n/a
Socio-emotional reactivity	0.0002	0.003	0.63	0.04	-1.26	1.26	0.002	0.27

\*p<0.05, \*\*p<0.001. n/a = analysis not applicable as values are identical.

**Table 3: Comparison between individual and group assessments scores: Multiple variable regression analysis**

INTER-NDA domain	Unadjusted		Adjusted for age and sex		Adjusted for age, sex and nutritional status		Adjusted for age, sex, nutritional status and preschool location	
	B (SE)	p	B (SE)	p	B (SE)	p	B (SE)	p
<b>Cognition</b>	-1.62 (1.49)	0.28	-1.32 (1.42)	0.35	-1.26 (1.34)	0.35	-1.27 (1.35)	0.35
<b>Gross Motor</b>	-0.79 (0.39)	0.04*	-0.80 (0.39)	0.05	-0.78 (0.39)	0.05	-0.79 (0.39)	0.05
<b>Fine Motor</b>	-0.92 (0.49)	0.07	-0.87 (0.49)	0.08	-0.86 (0.48)	0.08	-0.87 (0.47)	0.07
<b>Expressive Language</b>	-1.37 (2.19)	0.54	-0.73 (1.77)	0.68	-0.76 (1.73)	0.66	-0.72 (1.67)	0.67
<b>Receptive Language</b>	-0.19 (0.52)	0.71	-0.11 (0.51)	0.83	-0.14 (0.49)	0.78	-0.14 (0.49)	0.79
<b>Positive Behavior</b>	-0.02 (0.37)	0.96	0.01 (0.38)	0.97	0.03 (4.02)	0.94	0.03 (0.38)	0.94
<b>Negative Behavior</b>	0.03 (0.12)	0.79	0.04 (0.12)	0.77	0.04 (0.12)	0.78	0.03 (0.12)	0.78
<b>Global Behavior</b>	0.02 (0.11)	0.86	0.02 (0.11)	0.89	0.01 (0.11)	0.90	0.01 (0.11)	0.91
<b>Attention</b>	-0.04 (0.37)	0.91	0.02 (0.36)	0.96	0.02 (0.36)	0.95	0.02 (0.36)	0.95
<b>Socio-emotional reactivity</b>	0.01 (0.57)	0.98	0.02 (0.58)	0.97	0.06 (0.55)	0.90	0.07 (0.55)	0.90

All are Unstandardized beta coefficients, \*p<0.05

**DISCUSSION**

Through several complementary statistical strategies, we have demonstrated consistent similarities and lack of differences between group and individual INTER-NDA domain scores. Scores for group and individual assessments were significantly correlated for all domains, except receptive language. There were no significant differences

between scores obtained from group and individual assessments following inter-group comparisons. The results of the Bland-Altman analysis showed agreement between group and individual scores for the language, behavior, attention and socio-emotional reactivity domains, as well as consistency (but not agreement) between group and individual scores for the cognitive and motor domains. None

of the differences between the two assessment strategies examined in the Bland Altman analysis were statistically significant. Adjusting for the age, sex, nutritional status of the children and preschool location did not change these results. Hence, we conclude there is strong preliminary evidence that the INTER-NDA may be used to assess ECD outcomes in groups of three children within a preschool setting, giving test scores comparable to those obtained from individual assessment.

Although no statistically significant differences between group and individual scores were detected, the scores for cognitive, language and motor domains were higher for the group assessment than those for individual children. This finding may reflect the better performance of children when assessed in a group or an imitation effect.

Although there are no previous reports of group ECD assessments, the group-based approach has been applied, to good effect, in the implementation of ECD interventions such as play therapy, physical education and cognitive behavior therapy (CBT) among children with Asperger syndrome, language disorders and anxiety [15-17]. These studies have shown significant improvement in development skill scores among children who received group-based therapies[15-17]. The present study is, to our knowledge, the first to apply a group strategy to ECD assessment. Moreover, group and individual assessments were conducted by pre-school teachers with a secondary education degree, specifically trained and standardized in how to administer and score the INTER-NDA.

Importantly, the INTER-NDA could easily be adapted for group assessment because of a number of features: (i) it is easy and quick to administer; (ii) its items are free from cultural and gender bias; (iii) it is based on objective reporting (rather than subjective judgment) of the child's performance, and (iv) each item is reported on a 5-point scale, which includes options for 'no attempt' and 'unable to assess' [5]. Nevertheless, our group assessment protocol has been applied only to groups of three children; in its current form, it may not be applicable to larger groups.

Our study is limited in that the teacher who carried out the individual assessment was present in the room during the group assessment and was, therefore, not blind to the child's performance during the group assessment. Six of the children participating in the individual assessments did not return for the group assessment resulting in an imbalance of male-female ratios in the triads, meaning that an analysis by sex is beyond the scope of this study. Children were assessed on the INTER-NDA in two different formats within a 2-day period. It is possible that repeating the same items within a short span of time could result in familiarity and learning biases during subsequent assessments. In an effort to minimize these effects, we introduced variations in the order of testing between the group and individual assessments; however, the effects of these biases cannot be wholly eliminated.

From an implementation perspective, the preschool teachers neither reported difficulty with the administration of items to three children during the group assessment, nor did they report interference between children. They reported that children tended to encourage each other during the group assessment, and that this expedited the child's assessment on expressive language and gross motor items. The overall impression of the observers was that children tended to be more

reserved during individual, compared to group, assessment. The individual and group assessments took approximately 15 and 40 min, respectively. An optimistic interpretation of this feedback might suggest that assessments in the preschool environments, with peers, are closer to the real-life context of children. We believe that it is important, in the group assessment, for children to be assessed by a person, and in the company of peers, with whom they are already familiar. The preschool may, therefore, provide an ideal setting for group-based ECD assessment by teachers.

Our study was conducted in Mexico among lower-middle class children. In the situation commonly encountered globally, where resources for ECD assessment and intervention are limited, it may be possible to harness the expertise of preschool teachers to enable preschools to function as population-level sites for multi-domain ECD assessment (i.e., beyond that of routine observation of gross motor skills). This may provide a possible solution to one of the rate-limiting steps in population-based ECD assessment, i.e. its dependence on specialized personnel.

In conclusion, we have shown that INTER-NDA domain scores obtained following group and individual assessment of 22 to 26 months old preschool children are comparable. Furthermore, we have demonstrated that is feasible for preschool teachers to administer both group and individual INTER-NDA assessments. These results, if replicated, could strengthen the INTER-NDA's ability to be used as a rapid, scalable ECD assessment tool for field research projects and first level screening strategy at population level.

#### ACKNOWLEDGEMENT

The authors are grateful to the members of the INTERGROWTH-21<sup>st</sup> Neurodevelopment scientific advisory panel for their intellectual and technical contribution to the INTER-NDA. The authors gratefully acknowledge the parents, teachers and children participating in this study. This study was supported by INTERGROWTH-21<sup>st</sup> grant 49038 from the Bill and Melinda Gates Foundation to the University of Oxford.

#### AUTHORS CONTRIBUTIONS

Conceived and designed the study: JS. Performed the study: SS LCI MF PVA MF GGV FC MLLG ABD JS. Analyzed the data: MF JV AS. Contributed reagents/materials/analysis tools: AS SK. Wrote the paper: MF JV AS SK with JS and GGV.

#### COMPETING INTERESTS

The authors have read the Journal's policy and declare the following competing interests: G. Guerrero Varela, F. Hernandez Castillo, M. de la Luz Lozada Guzmán and A. Buchán Durán are employed by Programa Educación Inicial, Fundacion C. Slim, Mexico. L. Cheikh Ismail and M Fernandes are members of the Editorial Board of the Journal. This does not alter the authors' adherence to the IJGD's policies on sharing data and materials.

#### REFERENCES

1. Black MM, Walker SP, Fernald LCH, Andersen CT, Digirolamo AM, Lu C, *Et al.* Early Childhood Development Coming Of Age: Science Through The Life Course. *Lancet.* 2016;389(10064):77-90. Doi: 10.1016/S0140-67361389-7.

2. Bayley N. Bayley Scales Of Infant And Toddler Development, Third Edition. San Antonio, TX: Pearson Education Inc.; 2006.
3. Griffiths R. The Abilities Of Babies: A Study In Mental Measurement. New York, NY, US: Mcgraw-Hill; 1954. 229 P.
4. Frankenburg WK, Dodds JB. The Denver Developmental Screening Test. *J Pediatr.* 1967;71:181-91. Doi: 10.1016/S0022-347680070-2
5. Fernandes M, Stein A, Newton CRJ, Ismail LC, Kihara M, Wulff K, *Et al.* The INTERGROWTH-21<sup>st</sup> Project Neurodevelopment Package: A Novel Method For The Multi-Dimensional Assessment Of Neurodevelopment In Pre-School Age Children *Plos ONE.* 2014;9(11):E113360. Epub 25 November 2014. Doi: 10.1371/Journal.Pone.0113360.
6. Villar J, Altman DG, Purwar M, Noble JA, Knight HE, Ruyan P, *Et al.* The Objectives, Design And Implementation Of The INTERGROWTH-21<sup>st</sup> Project. *BJOG* 2013;120:9-26. Doi: 10.1111/1471-0528.12047.
7. Harkness J, Pennell B, Villar A, Gebler N, Aguilar-Gaxiola S, Bilgen I. Translation Procedures And Translation Assessment In The World Mental Health Survey Initiative. The WHO World Mental Health Surveys: Global Perspectives On The Epidemiology Of Mental Disorders. 2008:91-113.
8. International Fetal And Newborn Growth Standards For The 21<sup>st</sup> Century Anthropometry Handbook [Electronic]. Oxford, UK2012. Available From: <https://www.medscinet.net/intergrowth/patientinfodocs/anthropometry> Handbook April 2012. Pdf.
9. Bland JM, Altman DG. A Note On The Use Of The Intraclass Correlation Coefficient In The Evaluation Of Agreement Between Two Methods Of Measurement. *Comput Biol Med.* 1990;20:337-40. Doi: 10.1016/0010-482590013-F.
10. Martin Bland J, Altman D. Statistical Methods For Assessing Agreement Between Two Methods Of Clinical Measurement *Lancet.* 1986;327(8476):307-10. Doi: 10.1016/S0140-673690837-8.
11. Who Multicentre Growth Reference Study Group. WHO Child Growth Standards Based On Length/Height, Weight And Age. *Acta Pædiatr Suppl.* 2006;95:76-85. Doi: 10.1111/J.1651-2227.2006.Tb02378.X.
12. Kochanska G, Murray KT, Harlan ET. Effortful Control In Early Childhood: Continuity And Change, Antecedents, And Implications For Social Development. *Dev Psychol.* 2000;36:220-32. Doi: 10.1037/0012-1649.36.2.220
13. Huttenlocher J, Haight W, Bryk A, Seltzer M, Lyons T. Early Vocabulary Growth: Relation To Language Input And Gender. *Dev Psychol.* 1991;27:236-48. Doi: 10.1037/0012-1649.27.2.236
14. Thomas JR, French KE. Gender Differences Across Age In Motor Performance: A Meta-Analysis. *Psychol Bull.* 1985;98:260-82. Doi: 10.1037/0033-2909.98.2.260
15. Beaumont R, Sofronoff K. A Multi-Component Social Skills Intervention For Children With Asperger Syndrome: The Junior Detective Training Program. *J Child Psychol Psychiatry.* 2008;49:743-53. Doi: 10.1111/J.1469-7610.2008.01920.X
16. Rintala P, Pienimäki K, Ahonen T, Cantell M, Kooistra L. The Effects Of A Psychomotor Training Programme On Motor Skill Development In Children With Developmental Language Disorders. *Hum Mov Sci.* 1998;17(4-5):721-37. Doi: 10.1016/S0167-945700021-9.
17. Monga S, Young A, Owens M. Evaluating A Cognitive Behavioral Therapy Group Program For Anxious Five To Seven Year Old Children: A Pilot Study. *Depress Anxiety.* 2009;26:243-50. Doi: 10.1002/Da.20551

**Supplementary Files**

**S1 INTER-NDA sequence for group assessment**

This order of items is designed specifically for the assessment of 3 children simultaneously by a single assessor and as single scorer. This proforma is not suitable for group assessments involving more than 3 children.

In the first sequence i.e. sequence no. 1-21, the order of the items is different for different children – hence the assessor must pay more attention to the administration of these items and also practice this part of the assessment more until the assessor is fluent in the administration of the items in this sequence. The assessor **MUST** assess all children in this sequence and never change this sequence. The scorer must also pay attention to this sequence. Sequence numbers 22-53 are not administered but either maternal report or concurrently observed items, and so these can be scored simultaneously for all children.

Sequence of administration	Child 1	Child 2	Child 3
	Item number	Item number	Item number
1	1	2	3
2	4	5	8
3	2	3	1
4	5	8	4
5	3	1	2
6	8	4	5
7	6	7	9
8	10	11	15
9	7	9	6
10	11	15	10
11	9	6	7
12	15	10	11
13	12	13	14
14	16	17	30
15	13	14	12
16	17	30	16
17	14	12	13
18	30	16	17
19	19	20	21
20	20	21	19
21	21	19	20
22	18	18	18
23	22	22	22
24	23	23	23
25	24	24	24
26	25	25	25
27	26	26	26
28	27	27	27
29	28	28	28
30	29	29	29
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53



**S2 INTER-NDA assessment form – for child 1 in a group**

**Child 1 – GROUP ASSESSMENT**

Name: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Study Number: \_\_\_\_\_  
 Assessor: \_\_\_\_\_  
 Scorer: \_\_\_\_\_

The INTERGROWTH-21 <sup>st</sup> Neurodevelopment Assessment (INTER-NDA)						
No.	Item	Observed performance				
1	Builds a tower of 5 cubes ( <i>trials=3, demonstration=3</i> )	5 cubes	3-4 cubes	2 cubes	No attempt	Unable to assess
4	Hands the examiner one cube when asked to do so (Examiner says “Please give me one cube” & keeps palm open for 5 seconds after child has handed over 1 cube) ( <i>trials=1, demonstration=0</i> )	Hands only one block within 5 seconds	Hands only one block in more than 5 seconds	Hands two or more blocks	Does not hand any block / No attempt	Unable to assess
2	Names 4 colours when asked to do so ( <i>trials=1, demonstration=0</i> )	Names 4 colours	Names 3 colours	Names 1 or 2 colours	Does not name any colour	Unable to assess
5	Puts the spoon in the cup when asked to do so ( <i>trials=5, demonstration=0</i> )	Puts the spoon in cup in $\leq 3$ trials	Puts the spoon in cup in 4-5 trials	Takes the spoon or the cup but does not complete action	No attempt	Unable to assess
3	Matches 3 cubes of same colours when requested to do so ( <i>trials=1, demonstration=1 of one colour</i> )	Matches 3 colours	Matches 2 colours	Matches 1 colour	Does not match any colour	Unable to assess
8	Points correctly when asked “Where is the door/entrance to the room?” ( <i>trials=5, demonstration=0</i> )	Identifies door correctly in $\leq 3$ trials	Identifies door correctly in 4-5 trials	Attempts, but does not identify door	No attempt	Unable to assess
6	Matches shapes on board ( <i>trials=5, demonstration=partial – removal only</i> )	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess
10	Drinks water from cup/bottle/sippy cup when placed in front of child ( <i>trials=1, maternal recall if observation not possible</i> )	Drinks water from cup/sippy cup without spilling	Drinks clumsily & spills	Attempts but unsuccessful	No attempt	Unable to assess
7	Matches shapes on rotated board ( <i>trials=5, demonstration =partial – removal only</i> )	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess

11	Looks towards an object located across the room when pointed at by the examiner ( <i>trials=5</i> )	Looks or points at object in $\leq 3$ trials	Looks or points at object in 4-5 trials	Looks at the wrong object, or attempts but cannot identify object	No attempt	Unable to assess
9	Puts a raisin precisely inside a small opening in a bottle ( <i>trials=1, demonstration=1; test both hands</i> )	Precise release of raisin into bottle with each hand	Clumsy release, raisin falls out of bottle with one or more hand	Attempts but unsuccessful release with one or more hand	No attempt	Unable to assess
15	Imitates straight horizontal scribble ( <i>trials=5, demonstration=5</i> )	$\leq 3$ trials	4-5 trials; with difficulty	Attempts (hold crayon)	Cannot hold crayon	Unable to assess
12	Pretends to drink from a toy cup when placed in front of him/her ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
16	Identifies glitter bracelet under correct washcloth ( <i>trials=5, demonstration=0, test both sides</i> )	Finds bracelet correctly in $\leq 2$ trails on both sides	Find bracelet correctly in 3 trials or on one side only	Find bracelet correctly in 4-5 trials or on one side only	Does not find bracelet or no attempt	Unable to assess
13	Able to make a cup of tea with the toy tea set when requested by examiner (Examiner says "Can you make a cup of tea?") ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously, with pouring motion	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
17	Correctly identifies object groups using plurals ( <i>concurrent observation</i> )	Uses 5 plurals	Uses 3-4 plurals	Uses 1-2 plurals	Does not use any plurals	Unable to assess
14	Feeds doll when requested to (Examiner says "Can you give the dolly some tea?") ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
30	Combines word and gesture when asked ( <i>trials=3, Do Not demonstrate, use different example if mother says child does not know the one you are asking</i> )	Combines word and gesture completely and appropriately	Combines word and gesture completely but inappropriately	Combines word and gesture incompletely and inappropriately	None	Unable to assess
19	Runs ( <i>maternal recall</i> )	Runs steadily	Attempts	Walks only	Walks with support	Unable to assess
20	Throws a ball very near ( <i>trials=1, demonstration=1, test both hands</i> )	Good release	Unsteady release	Attempts	No attempt	Unable to assess
21	Kicks ball ( <i>maternal recall</i> )	Kicks ball with knee flexed	Runs after ball & attempts kicking it	Walks and touches ball with foot	No attempt	Unable to assess
18	Asks for toilet by gesture or verbally ( <i>maternal recall</i> )	Always	Occasionally	Partial (only for bowel movement)	Never	Unable to assess
22	Climbs upstairs holding rail, 2 feet/stair or in adult fashion ( <i>maternal recall</i> )	Climbs stairs alone steadily	Climb stairs alone unsteadily	Climbs stairs with help (uses railing, holds adult's hand)	No attempt	Unable to assess
23	Uses 2-4 syllable babble such as dada, mama but not specifically to anything or any person ( <i>concurrent observation</i> )	Spontaneously	Mimics	1 syllable babble e.g. ba, ma, da	None	Unable to assess
24	Use two words together ( <i>concurrent observation</i> )	Two words, appropriate use	Two words, inappropriate use	One word, appropriate use	No attempt	Unable to assess

25	Indicates by gesture to say no ( <i>maternal recall if not observed during assessment</i> )	Indicates verbally or by definite gesture all the time	Indicates verbally or by definite gesture some of the time	Attempts, but incomplete indication	No attempt	Unable to assess
26	Use of a pronoun e.g. me, my, she, he, it, I ( <i>concurrent observation</i> )	≥1 pronoun in correct context	≥1 pronoun, incorrect use	Use of proper names, but not pronouns	No use	Unable to assess
27	How many words does the child use during the assessment other than mama/dada ( <i>concurrent observation</i> )	≥8 words	6-7 words	4-5 words	≤3 words	Unable to assess
28	How many sentences of 3 words or more does the child use during the assessment? ( <i>concurrent observation</i> )	≥2	1	≥1 two word utterance	None	Unable to assess
29	In how many instances does the child follow on a topic of conversation providing new information? ( <i>concurrent observation</i> )	At least one, using ≥ 2 words, proving correct information	At least one, uses single words, provides correct information	Uses any number of words, provides incorrect information	Does not follow up on conversations	Unable to assess
What is the child's native (first) language?						
What is the language in which the assessment is being conducted?						
Does the child speak/understand any languages other than his/her native (first) language?						
<b>How often were the following behaviours in the child during the assessment?</b>						
31	Positive Affect	Never or rarely	Some of the time	Most of the time		
32	Exploration	Never or rarely	Some of the time	Most of the time		
33	Ease of engagement	Never or rarely	Some of the time	Most of the time		
34	Cooperativeness	Never or rarely	Some of the time	Most of the time		
35	Adaptability to change	Never or rarely	Some of the time	Most of the time		
36	Distractibility	Never or rarely	Some of the time	Most of the time		
37	Negative affect	Never or rarely	Some of the time	Most of the time		
<b>Caregiver Reported Child Behaviour Questionnaire</b>						
Instructions to caregiver: Please fill in this form to reflect your view of your child's behaviour, even if others do not agree						
38	Likes playing with other children	Not true	Sometimes true	Often true		
39	Can't concentrate, can't pay attention for long	Not true	Sometimes true	Often true		
40	Can't sit still, restless or hyperactive	Not true	Sometimes true	Often true		
41	Disturbed by any change in routine	Not true	Sometimes true	Often true		
42	Nervous movements or twitching	Not true	Sometimes true	Often true		
43	Shows panic for no good reason	Not true	Sometimes true	Often true		
44	Poorly coordinated or clumsy	Not true	Sometimes true	Often true		
45	Quickly shifts from one activity to another	Not true	Sometimes true	Often true		
46	Rapid shifts between sadness and excitement	Not true	Sometimes true	Often true		
47	Sudden changes in mood or feelings	Not true	Sometimes true	Often true		
48	Sulks a lot	Not true	Sometimes true	Often true		

49	Upset by new people or situations	Not true	Sometimes true	Often true
50	Wanders away	Not true	Sometimes true	Often true
51	Whining	Not true	Sometimes true	Often true
52	Worries	Not true	Sometimes true	Often true
53	Responds well to affection	Not true	Sometimes true	Often true
<b>END</b>				

**S3 INTER-NDA assessment form – for child 2 in a group**

**Child 2 – GROUP ASSESSMENT**

Name: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Study Number: \_\_\_\_\_  
 Assessor: \_\_\_\_\_  
 Scorer: \_\_\_\_\_

The INTERGROWTH-21 <sup>st</sup> Neurodevelopment Assessment (INTER-NDA)						
No.	Item	Observed performance				
2	Names 4 colours when asked to do so ( <i>trials=1, demonstration=0</i> )	Names 4 colours	Names 3 colours	Names 1 or 2 colours	Does not name any colour	Unable to assess
5	Puts the spoon in the cup when asked to do so ( <i>trials=5, demonstration=0</i> )	Puts the spoon in cup in $\leq 3$ trials	Puts the spoon in cup in 4-5 trials	Takes the spoon or the cup but does not complete action	No attempt	Unable to assess
3	Matches 3 cubes of same colours when requested to do so ( <i>trials=1, demonstration=1 of one colour</i> )	Matches 3 colours	Matches 2 colours	Matches 1 colour	Does not match any colour	Unable to assess
8	Points correctly when asked “Where is the door/entrance to the room?” ( <i>trials=5, demonstration=0</i> )	Identifies door correctly in $\leq 3$ trials	Identifies door correctly in 4-5 trials	Attempts, but does not identify door	No attempt	Unable to assess
1	Builds a tower of 5 cubes ( <i>trials=3, demonstration=3</i> )	5 cubes	3-4 cubes	2 cubes	No attempt	Unable to assess
4	Hands the examiner one cube when asked to do so (Examiner says “Please give me one cube” & keeps palm open for 5 seconds after child has handed over 1 cube) ( <i>trials=1, demonstration=0</i> )	Hands only one block within 5 seconds	Hands only one block in more than 5 seconds	Hands two or more blocks	Does not hand any block / No attempt	Unable to assess
7	Matches shapes on rotated board ( <i>trials=5, demonstration =partial – removal only</i> )	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess
11	Looks towards an object located across the room when pointed at by the examiner ( <i>trials=5</i> )	Looks or points at object in $\leq 3$ trials	Looks or points at object in 4-5 trials	Looks at the wrong object, or attempts but cannot identify object	No attempt	Unable to assess
9	Puts a raisin precisely inside a small opening in a bottle ( <i>trials=1, demonstration=1; test both hands</i> )	Precise release of raisin into bottle with each hand	Clumsy release, raisin falls out of bottle with one or more hand	Attempts but unsuccessful release with one or more hand	No attempt	Unable to assess
15	Imitates straight horizontal scribble ( <i>trials=5, demonstration=5</i> )	$\leq 3$ trials	4-5 trials; with difficulty	Attempts (hold crayon)	Cannot hold crayon	Unable to assess

6	Matches shapes on board ( <i>trials=5, demonstration=partial – removal only</i> )	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess
10	Drinks water from cup/bottle/sippy cup when placed in front of child ( <i>trials=1, maternal recall if observation not possible</i> )	Drinks water from cup/sippy cup without spilling	Drinks clumsily & spills	Attempts but unsuccessful	No attempt	Unable to assess
13	Able to make a cup of tea with the toy tea set when requested by examiner (Examiner says “Can you make a cup of tea?”) ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously, with pouring motion	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
17	Correctly identifies object groups using plurals ( <i>concurrent observation</i> )	Uses 5 plurals	Uses 3-4 plurals	Uses 1-2 plurals	Does not use any plurals	Unable to assess
14	Feeds doll when requested to (Examiner says “Can you give the dolly some tea?”) ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
30	Combines word and gesture when asked ( <i>trials=3, Do Not demonstrate, use different example if mother says child does not know the one you are asking</i> )	Combines word and gesture completely and appropriately	Combines word and gesture completely but inappropriately	Combines word and gesture incompletely and inappropriately	None	Unable to assess
12	Pretends to drink from a toy cup when placed in front of him/her ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
16	Identifies glitter bracelet under correct washcloth ( <i>trials=5, demonstration=0, test both sides</i> )	Finds bracelet correctly in $\leq 2$ trails on both sides	Find bracelet correctly in 3 trials or on one side only	Find bracelet correctly in 4-5 trials or on one side only	Does not find bracelet or no attempt	Unable to assess
20	Throws a ball very near ( <i>trials=1, demonstration=1, test both hands</i> )	Good release	Unsteady release	Attempts	No attempt	Unable to assess
21	Kicks ball ( <i>maternal recall</i> )	Kicks ball with knee flexed	Runs after ball & attempts kicking it	Walks and touches ball with foot	No attempt	Unable to assess
19	Runs ( <i>maternal recall</i> )	Runs steadily	Attempts	Walks only	Walks with support	Unable to assess
18	Asks for toilet by gesture or verbally ( <i>maternal recall</i> )	Always	Occasionally	Partial (only for bowel movement)	Never	Unable to assess
22	Climbs upstairs holding rail, 2 feet/stair or in adult fashion ( <i>maternal recall</i> )	Climbs stairs alone steadily	Climb stairs alone unsteadily	Climbs stairs with help (uses railing, holds adult’s hand)	No attempt	Unable to assess
23	Uses 2-4 syllable babble such as dada, mama but not specifically to anything or any person ( <i>concurrent observation</i> )	Spontaneously	Mimics	1 syllable babble e.g. ba, ma, da	None	Unable to assess
24	Use two words together ( <i>concurrent observation</i> )	Two words, appropriate use	Two words, inappropriate use	One word, appropriate use	No attempt	Unable to assess

25	Indicates by gesture to say no ( <i>maternal recall if not observed during assessment</i> )	Indicates verbally or by definite gesture all the time	Indicates verbally or by definite gesture some of the time	Attempts, but incomplete indication	No attempt	Unable to assess
26	Use of a pronoun e.g. me, my, she, he, it, I ( <i>concurrent observation</i> )	≥1 pronoun in correct context	≥1 pronoun, incorrect use	Use of proper names, but not pronouns	No use	Unable to assess
27	How many words does the child use during the assessment other than mama/dada ( <i>concurrent observation</i> )	≥8 words	6-7 words	4-5 words	≤3 words	Unable to assess
28	How many sentences of 3 words or more does the child use during the assessment? ( <i>concurrent observation</i> )	≥2	1	≥1 two word utterance	None	Unable to assess
29	In how many instances does the child follow on a topic of conversation providing new information? ( <i>concurrent observation</i> )	At least one, using ≥ 2 words, proving correct information	At least one, uses single words, provides correct information	Uses any number of words, provides incorrect information	Does not follow up on conversations	Unable to assess
What is the child's native (first) language?						
What is the language in which the assessment is being conducted?						
Does the child speak/understand any languages other than his/her native (first) language?						
<b>How often were the following behaviours in the child during the assessment?</b>						
31	Positive Affect	Never or rarely	Some of the time	Most of the time		
32	Exploration	Never or rarely	Some of the time	Most of the time		
33	Ease of engagement	Never or rarely	Some of the time	Most of the time		
34	Cooperativeness	Never or rarely	Some of the time	Most of the time		
35	Adaptability to change	Never or rarely	Some of the time	Most of the time		
36	Distractibility	Never or rarely	Some of the time	Most of the time		
37	Negative affect	Never or rarely	Some of the time	Most of the time		
<b>Caregiver Reported Child Behaviour Questionnaire</b>						
Instructions to caregiver: Please fill in this form to reflect your view of your child's behaviour, even if others do not agree						
38	Likes playing with other children	Not true	Sometimes true	Often true		
39	Can't concentrate, can't pay attention for long	Not true	Sometimes true	Often true		
40	Can't sit still, restless or hyperactive	Not true	Sometimes true	Often true		
41	Disturbed by any change in routine	Not true	Sometimes true	Often true		
42	Nervous movements or twitching	Not true	Sometimes true	Often true		
43	Shows panic for no good reason	Not true	Sometimes true	Often true		
44	Poorly coordinated or clumsy	Not true	Sometimes true	Often true		
45	Quickly shifts from one activity to another	Not true	Sometimes true	Often true		
46	Rapid shifts between sadness and excitement	Not true	Sometimes true	Often true		
47	Sudden changes in mood or feelings	Not true	Sometimes true	Often true		
48	Sulks a lot	Not true	Sometimes true	Often true		
49	Upset by new people or situations	Not true	Sometimes true	Often true		
50	Wanders away	Not true	Sometimes true	Often true		

51	Whining	Not true	Sometimes true	Often true
52	Worries	Not true	Sometimes true	Often true
53	Responds well to affection	Not true	Sometimes true	Often true
<b>END</b>				

**S4 INTER-NDA assessment form – for child 3 in a group**

**Child 3 – GROUP ASSESSMENT**

Name: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Study Number: \_\_\_\_\_  
 Assessor: \_\_\_\_\_  
 Scorer: \_\_\_\_\_

<b>The INTERGROWTH-21<sup>st</sup> Neurodevelopment Assessment (INTER-NDA)</b>						
<b>No.</b>	<b>Item</b>	<b>Observed performance</b>				
3	Matches 3 cubes of same colours when requested to do so ( <i>trials=1, demonstration=1 of one colour</i> )	Matches 3 colours	Matches 2 colours	Matches 1 colour	Does not match any colour	Unable to assess
8	Points correctly when asked “Where is the door/entrance to the room?” ( <i>trials=5, demonstration=0</i> )	Identifies door correctly in ≤3 trials	Identifies door correctly in 4-5 trials	Attempts, but does not identify door	No attempt	Unable to assess
1	Builds a tower of 5 cubes ( <i>trials=3, demonstration=3</i> )	5 cubes	3-4 cubes	2 cubes	No attempt	Unable to assess
4	Hands the examiner one cube when asked to do so (Examiner says “Please give me one cube” & keeps palm open for 5 seconds after child has handed over 1 cube) ( <i>trials=1, demonstration=0</i> )	Hands only one block within 5 seconds	Hands only one block in more than 5 seconds	Hands two or more blocks	Does not hand any block / No attempt	Unable to assess
2	Names 4 colours when asked to do so ( <i>trials=1, demonstration=0</i> )	Names 4 colours	Names 3 colours	Names 1 or 2 colours	Does not name any colour	Unable to assess
5	Puts the spoon in the cup when asked to do so ( <i>trials=5, demonstration=0</i> )	Puts the spoon in cup in ≤3 trials	Puts the spoon in cup in 4-5 trials	Takes the spoon or the cup but does not complete action	No attempt	Unable to assess
9	Puts a raisin precisely inside a small opening in a bottle ( <i>trials=1, demonstration=1; test both hands</i> )	Precise release of raisin into bottle with each hand	Clumsy release, raisin falls out of bottle with one or more hand	Attempts but unsuccessful release with one or more hand	No attempt	Unable to assess
15	Imitates straight horizontal scribble ( <i>trials=5, demonstration=5</i> )	≤3 trials	4-5 trials; with difficulty	Attempts (hold crayon)	Cannot hold crayon	Unable to assess
6	Matches shapes on board ( <i>trials=5, demonstration=partial – removal only</i> )	All shapes in ≤3 trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess



10	Drinks water from cup/bottle/sippy cup when placed in front of child ( <i>trials=1, maternal recall if observation not possible</i> )	Drinks water from cup/sippy cup without spilling	Drinks clumsily & spills	Attempts but unsuccessful	No attempt	Unable to assess
7	Matches shapes on rotated board ( <i>trials=5, demonstration =partial – removal only</i> )	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess
11	Looks towards an object located across the room when pointed at by the examiner ( <i>trials=5</i> )	Looks or points at object in $\leq 3$ trials	Looks or points at object in 4-5 trials	Looks at the wrong object, or attempts but cannot identify object	No attempt	Unable to assess
14	Feeds doll when requested to (Examiner says “Can you give the dolly some tea?”) ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
30	Combines word and gesture when asked ( <i>trials=3, Do Not demonstrate, use different example if mother says child does not know the one you are asking</i> )	Combines word and gesture completely and appropriately	Combines word and gesture completely but inappropriately	Combines word and gesture incompletely and inappropriately	None	Unable to assess
12	Pretends to drink from a toy cup when placed in front of him/her ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
16	Identifies glitter bracelet under correct washcloth ( <i>trials=5, demonstration=0, test both sides</i> )	Finds bracelet correctly in $\leq 2$ trails on both sides	Find bracelet correctly in 3 trials or on one side only	Find bracelet correctly in 4-5 trials or on one side only	Does not find bracelet or no attempt	Unable to assess
13	Able to make a cup of tea with the toy tea set when requested by examiner (Examiner says “Can you make a cup of tea?”) ( <i>trials=2, demonstration=1 if not spontaneous on first attempt</i> )	Spontaneously, with pouring motion	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
17	Correctly identifies object groups using plurals ( <i>concurrent observation</i> )	Uses 5 plurals	Uses 3-4 plurals	Uses 1-2 plurals	Does not use any plurals	Unable to assess
21	Kicks ball ( <i>maternal recall</i> )	Kicks ball with knee flexed	Runs after ball & attempts kicking it	Walks and touches ball with foot	No attempt	Unable to assess
19	Runs ( <i>maternal recall</i> )	Runs steadily	Attempts	Walks only	Walks with support	Unable to assess
20	Throws a ball very near ( <i>trials=1, demonstration=1, test both hands</i> )	Good release	Unsteady release	Attempts	No attempt	Unable to assess
18	Asks for toilet by gesture or verbally ( <i>maternal recall</i> )	Always	Occasionally	Partial (only for bowel movement)	Never	Unable to assess
22	Climbs upstairs holding rail, 2 feet/stair or in adult fashion ( <i>maternal recall</i> )	Climbs stairs alone steadily	Climb stairs alone unsteadily	Climbs stairs with help (uses railing, holds adult’s hand)	No attempt	Unable to assess

23	Uses 2-4 syllable babble such as dada, mama but not specifically to anything or any person ( <i>concurrent observation</i> )	Spontaneously	Mimics	1 syllable babble e.g. ba, ma, da	None	Unable to assess
24	Use two words together ( <i>concurrent observation</i> )	Two words, appropriate use	Two words, inappropriate use	One word, appropriate use	No attempt	Unable to assess
25	Indicates by gesture to say no ( <i>maternal recall if not observed during assessment</i> )	Indicates verbally or by definite gesture all the time	Indicates verbally or by definite gesture some of the time	Attempts, but incomplete indication	No attempt	Unable to assess
26	Use of a pronoun e.g. me, my, she, he, it, I ( <i>concurrent observation</i> )	≥1 pronoun in correct context	≥1 pronoun, incorrect use	Use of proper names, but not pronouns	No use	Unable to assess
27	How many words does the child use during the assessment other than mama/dada ( <i>concurrent observation</i> )	≥8 words	6-7 words	4-5 words	≤3 words	Unable to assess
28	How many sentences of 3 words or more does the child use during the assessment? ( <i>concurrent observation</i> )	≥2	1	≥1 two word utterance	None	Unable to assess
29	In how many instances does the child follow on a topic of conversation providing new information? ( <i>concurrent observation</i> )	At least one, using ≥ 2 words, proving correct information	At least one, uses single words, provides correct information	Uses any number of words, provides incorrect information	Does not follow up on conversations	Unable to assess
What is the child's native (first) language?						
What is the language in which the assessment is being conducted?						
Does the child speak/understand any languages other than his/her native (first) language?						
<b>How often were the following behaviours in the child during the assessment?</b>						
31	Positive Affect	Never or rarely	Some of the time	Most of the time		
32	Exploration	Never or rarely	Some of the time	Most of the time		
33	Ease of engagement	Never or rarely	Some of the time	Most of the time		
34	Cooperativeness	Never or rarely	Some of the time	Most of the time		
35	Adaptability to change	Never or rarely	Some of the time	Most of the time		
36	Distractibility	Never or rarely	Some of the time	Most of the time		
37	Negative affect	Never or rarely	Some of the time	Most of the time		
<b>Caregiver Reported Child Behaviour Questionnaire</b>						
Instructions to caregiver: Please fill in this form to reflect your view of your child's behaviour, even if others do not agree						
38	Likes playing with other children	Not true	Sometimes true	Often true		
39	Can't concentrate, can't pay attention for long	Not true	Sometimes true	Often true		
40	Can't sit still, restless or hyperactive	Not true	Sometimes true	Often true		
41	Disturbed by any change in routine	Not true	Sometimes true	Often true		
42	Nervous movements or twitching	Not true	Sometimes true	Often true		
43	Shows panic for no good reason	Not true	Sometimes true	Often true		
44	Poorly coordinated or clumsy	Not true	Sometimes true	Often true		

45	Quickly shifts from one activity to another	Not true	Sometimes true	Often true
46	Rapid shifts between sadness and excitement	Not true	Sometimes true	Often true
47	Sudden changes in mood or feelings	Not true	Sometimes true	Often true
48	Sulks a lot	Not true	Sometimes true	Often true
49	Upset by new people or situations	Not true	Sometimes true	Often true
50	Wanders away	Not true	Sometimes true	Often true
51	Whining	Not true	Sometimes true	Often true
52	Worries	Not true	Sometimes true	Often true
53	Responds well to affection	Not true	Sometimes true	Often true
<b>END</b>				

### S5 INTER-NDA assessment form – individual assessment

Name of child: \_\_\_\_\_

Date of birth: \_\_\_/\_\_\_/\_\_\_\_\_

Date of assessment: \_\_\_/\_\_\_/\_\_\_\_\_

Name of assessor: \_\_\_\_\_

No.	Item	Observed Performance				
1	<b>Builds a tower of 5 cubes</b> (trials=3, demonstration=3)	5 cubes	3-4 cubes	2 cubes	No attempt	Unable to assess
2	<b>Names 4 colours when asked to do so</b> (trials=1, demonstration=0)	Names 4 colours	Names 3 colours	Names 1 or 2 colours	Does not name any colour	Unable to assess
3	<b>Matches 3 cubes of same colours when requested to do so</b> (trials=1, demonstration=1 of one colour)	Matches 3 colours	Matches 2 colours	Matches 1 colour	Does not match any colour	Unable to assess
4	<b>Hands the examiner one cube when asked to do so (Examiner says “Please give me one cube” &amp; keeps palm open for 5 seconds after child has handed over 1 cube)</b> (trials=1, demonstration=0)	Hands only one block within 5 seconds	Hands only one block in more than 5 seconds	Hands two or more blocks	Does not hand any block / No attempt	Unable to assess
5	<b>Puts the spoon in the cup when asked to do so</b> (trials=5, demonstration=0)	Puts the spoon in cup in $\leq 3$ trials	Puts the spoon in cup in 4-5 trials	Takes the spoon or the cup but does not complete action	No attempt	Unable to assess
6	<b>Matches shapes on board</b> (trials=5, demonstration=partial – removal only)	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess

7	<b>Matches shapes on rotated board</b> <i>(trials=5, demonstration=partial – removal only)</i>	All shapes in $\leq 3$ trials	All shapes with repeated demonstration i.e. 4-5 trials	One or two shapes in 4-5 trials	No attempt	Unable to assess
8	<b>Points correctly when asked “Where is the door/entrance to the room?”</b> <i>(trials=5, demonstration=0)</i>	Identifies door correctly in $\leq 3$ trials	Identifies door correctly in 4-5 trials	Attempts, but does not identify door	No attempt	Unable to assess
9	<b>Puts a raisin precisely inside a small opening in a bottle</b> <i>(trials=1, demonstration=1, test both hands)</i>	Precise release of raisin into bottle with each hand	Clumsy release, raisin falls out of bottle with one or more hand	Attempts but unsuccessful release with one or more hand	No attempt	Unable to assess
10	<b>Drinks water from cup/bottle/sippy cup when placed in front of child</b> <i>(trials=1, demonstration=0; maternal recall if observation not possible)</i>	Drinks water from cup/sippy cup without spilling	Drinks clumsily & spills	Attempts but unsuccessful	No attempt	Unable to assess
11	<b>Looks towards an object located across the room when pointed at by the examiner</b> <i>(trials=5)</i>	Looks or points at object in $\leq 3$ trials	Looks or points at object in 4-5 trials	Looks at the wrong object, or attempts but cannot identify object	No attempt	Unable to assess
12	<b>Pretends to drink from a toy cup when placed in front of him/her</b> <i>(trials=2, demonstration=1 if not spontaneous on first attempt)</i>	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
13	<b>Able to make a cup of tea with the toy tea set when requested by examiner (Examiner says “Can you make a cup of tea?”)</b> <i>(trials=2, demonstration=1 if not spontaneous on first attempt)</i>	Spontaneously, with pouring motion	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
14	<b>Feeds doll when requested to (Examiner says “Can you give the dolly some tea?”)</b> <i>(trials=2, demonstration=1 if not spontaneous on first attempt)</i>	Spontaneously	After 1 demonstration	Partial attempt after 1 demonstration	No attempt	Unable to assess
15	<b>Imitates straight horizontal scribble</b> <i>(trials=5, demonstration=5)</i>	$\leq 3$ trials	4-5 trials; with difficulty	Attempts (hold crayon)	Cannot hold crayon	Unable to assess
16	<b>Identifies glitter bracelet under correct washcloth</b> <i>(trials=5, demonstration=0, test both sides)</i>	Finds bracelet correctly in $\leq 2$ trails on both sides	Find bracelet correctly in 3 trials or on one side only	Find bracelet correctly in 4-5 trials or on one side only	Does not find bracelet or no attempt	Unable to assess

17	<b>Correctly identifies object groups using plurals</b> (concurrent observation)	Uses 5 plurals	Uses 3-4 plurals	Uses 1-2 plurals	Does not use any plurals	Unable to assess
18	<b>Asks for toilet by gesture or verbally</b> (maternal recall)	Always	Occasionally	Partial (only for bowel movement)	Never	Unable to assess
19	<b>Runs</b> (maternal recall)	Runs steadily	Attempts	Walks only	Walks with support	Unable to assess
20	<b>Throws a ball very near</b> (trials=1, demonstration=1; test both hands)	Good release	Unsteady release	Attempts	No attempt	Unable to assess
21	<b>Kicks ball</b> (maternal recall)	Kicks ball with knee flexed	Runs after ball & attempts kicking it	Walks and touches ball with foot	No attempt	Unable to assess
22	<b>Climbs upstairs holding rail, 2 feet/stair or in adult fashion</b> (maternal recall)	Climbs stairs alone steadily	Climbs stairs alone unsteadily	Climbs stairs with help (uses railing, holds adult's hand)	No attempt	Unable to assess
23	<b>Uses 2-4 syllable babble such as dada, mama but not specifically to anything or any person</b> (concurrent observation)	Spontaneously	Mimics	1 syllable babble e.g. ba, ma, da	None	Unable to assess
24	<b>Use two words together</b> (concurrent observation)	Two words, appropriate use	Two words, inappropriate use	One word, appropriate use	No attempt	Unable to assess
25	<b>Indicates by gesture to say no</b> (concurrent observation or maternal recall)	Indicates verbally or by definite gesture all the time	Indicates verbally or by definite gesture some of the time	Attempts, but incomplete indication	No attempt	Unable to assess
26	<b>Use of a pronoun e.g. me, my, she, he, it, I</b> (concurrent observation)	≥1 pronoun in correct context	≥1 pronoun, incorrect use	Use of proper names but not pronouns	No use	Unable to assess
27	<b>How many words does the child use during the assessment other than mama/dada</b> (concurrent observation)	≥8 words	6-7 words	4-5 words	≤3 words	Unable to assess
28	<b>How many sentences of 3 words or more does the child use during the assessment?</b> (concurrent observation)	≥2	1	≥1 two word utterance	None	Unable to assess
29	<b>In how many instances does the child follow on a topic of conversation providing new information?</b> (concurrent observation)	At least one, using ≥ 2 words, providing correct information	At least one, uses single words, provides correct information	Uses any number of words, provides incorrect information	Does not follow up on conversations	Unable to assess

30	<b>Combines word and gesture when asked</b> <i>(Do not demonstrate, trials=3, use different example if mother says child does not know the one you are asking)</i>	Combines word and gesture completely and appropriately	Combines word and gesture completely but inappropriately	Combines word and gesture incompletely and inappropriately	Does not combine a word and gesture	Unable to assess
----	---	--	--	--	-------------------------------------	------------------

What is the child's native (first) language? \_\_\_\_\_

What is the language in which the assessment is being conducted? \_\_\_\_\_

Does the child speak/understand any languages other than his/her native (first) language? \_\_\_\_\_

How often were the following behaviours in the child during the assessment?				
31	<b>Positive Affect</b>	Never or rarely	Some of the time	Most of the time
32	<b>Exploration</b>	Never or rarely	Some of the time	Most of the time
33	<b>Ease of engagement</b>	Never or rarely	Some of the time	Most of the time
34	<b>Cooperativeness</b>	Never or rarely	Some of the time	Most of the time
35	<b>Adaptability to change</b>	Never or rarely	Some of the time	Most of the time
36	<b>Distractibility</b>	Never or rarely	Some of the time	Most of the time
37	<b>Negative Affect</b>	Never or rarely	Some of the time	Most of the time

Additional information:

### **S6 Note on Covariate Analysis**

Covariate analysis, for group assessments, revealed (i) no significant association with sex (ii) significant differences in cognition scores between the preschools Yoltzin and Mundo de Andi ( $F=3.45$ ,  $p=0.03$ ) and in expressive language scores between Casita de Susi, Mundo de Andi and CBI ( $F=4.16$ ,  $p=0.01$ ) (iii) Significant associations between expressive language and receptive language scores, and age and head circumference of the child at the time of assessment (For Age:  $r=0.46$ ,  $p<0.001$ ,  $r=0.34$ ,  $p=0.04$  respectively; For Head Circumference:  $r=0.44$ ,  $p<0.001$ ,  $r=0.38$ ,  $p=0.02$ ). No significant associations were found between INTER-NDA domain scores and weight or length of the child at the time of the assessment. Covariate analysis, for individual assessments, revealed (i) no significant association with sex ( $t = -0.75$  to  $1.52$ ,  $p = 0.14$  to  $0.93$ ) (ii) significant differences in cognition scores between the preschools Yoltzin and Mundo de Andi ( $F=3.21$ ,  $p=0.02$ ) (iii) Significant associations between expressive language and age of the child ( $r = -0.54$ ,  $p<0.001$ ). No significant associations were found between INTER-NDA domain scores and weight, length or head circumference. Based on the analysis above, location of preschool, age of the child and anthropometry were included as covariates in the regression analysis. Although no association with sex was found in our study, sex was included as a covariate in the analysis based on evidence from previous literature that neurodevelopment scores differ between boys and girls.