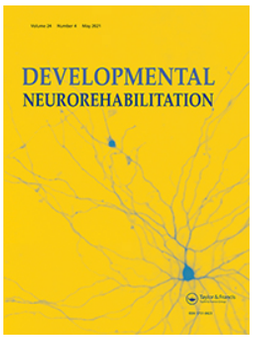

Developmental Neurorehabilitation

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ipdr20

Development and pilot evaluation of the Cognition domain of the Hong Kong Comprehensive Assessment Scales for Toddlers

Cynthia Leung, Tamis Pin, Andrew Siu, Alma Au, Carol To, Sing Kai Lo, Becky Chan, Kelly Lau, Theresa Ng, Cyrus Chan, Catherine Lam & Florence Lee

To cite this article: Cynthia Leung, Tamis Pin, Andrew Siu, Alma Au, Carol To, Sing Kai Lo, Becky Chan, Kelly Lau, Theresa Ng, Cyrus Chan, Catherine Lam & Florence Lee (2021) Development and pilot evaluation of the Cognition domain of the Hong Kong Comprehensive Assessment Scales for Toddlers, Developmental Neurorehabilitation, 24:4, 244-255, DOI: 10.1080/17518423.2020.1858459

To link to this article: https://doi.org/10.1080/17518423.2020.1858459

Published online: 23 Dec 2020.

DEVELOPMENTAL NEUROREHABILITATION
2021, VOL. 24, NO. 4, 244–255
https://doi.org/10.1080/17518423.2020.1858459

Taylor & Francis
Taylor & Francis Group

Development and pilot evaluation of the Cognition domain of the Hong Kong Comprehensive Assessment Scales for Toddlers

Cynthia Leung[a], Tamis Pin[a], Andrew Siu[a], Alma Au[a], Carol To[b], Sing Kai Lo[c], Becky Chan[d], Kelly Lau[d], Theresa Ng[d], Cyrus Chan[d], Catherine Lam[d], and Florence Lee[d]

[a]The Hong Kong Polytechnic University; [b]The University of Hong Kong; [c]The Education University of Hong Kong; [d]Hong Kong SAR Government

ABSTRACT

Purpose: To describe the development of the Cognition domain of the Hong Kong Comprehensive Assessment Scales for Toddlers (HKCAS-T).

Methods: Participants included 345 toddlers aged 18–41 months, with 258 recruited from Maternal and Child Health Centers (MCHCs) and 87 with cognitive delay recruited from Child Assessment Centers (CACs). They were individually administered the 83-item pilot version by medical practitioners or educational psychologists between 2017 and 2019 in MCHCs and CACs in Hong Kong.

Results: Rasch analysis results supported the unidimensionality of the pilot version, after removing six items. Analysis of covariance results indicated that both the 83-item version and the 77-item version could differentiate between children of different age groups, and children with typical development from children with cognitive delay. Internal consistency and interrater reliability were 0.90 or above.

Conclusions: The Cognition domain of the HKCAS-T is a promising developmental assessment tool for the assessment of toddlers. Cognition assessment, preschool, Chinese

ARTICLE HISTORY
Received June 02, 2020
Revised October 19, 2020
Accepted November 28, 2020

KEYWORDS
Cognition assessment; preschool; Chinese

Early identification and intervention for childhood developmental problems are crucial in the period of rapid brain growth in young children. To provide a comprehensive assessment for infants and toddlers, different professionals are often involved, with each professional performing assessment on their respective professional domains. This practice, however, is resource intensive and logistically complicated. Furthermore, with each professional performing assessment on his/her own domain, there is no comprehensive overview of the child's ability, strength, and weakness. A comprehensive assessment tool encompassing all major aspects of child development will be more efficient.

Developmental assessment of infants and toddlers mainly employs tests originally developed in English, such as Griffiths Scale of Child Development, 3rd edition (Griffiths III), Merrill-Palmer-Revised Scales of Development (M-P-R), Bayley Scales of Infant and Toddler Development, third edition (Bayley-III), and Stanford Binet Intelligence Scale – Fifth edition (SB-5).[1–4] Norms on these tests for the non-English-speaking population are not always available, and the cultural appropriateness of these tests for non-English-speaking children is unknown. Childhood development can be influenced by many factors such as parenting style, environmental stimulation, socioeconomic status, ethnicity, and country, and these factors need to be taken into consideration in assessing the validity of an assessment tool for a given child population.[5] Even if these tests were translated into another language, the cultural equivalence is still a concern. In a study on item equivalence of the English and Chinese versions of a cognitive test for Chinese and American children, differential item functioning was found in 59% of the items. Further analyses indicated that language features such as vocabulary and cultural familiarity were possible sources of differential item functioning. Moreover, there was low agreement between the judgment of experts and the differential item functioning results on the equivalence of the translated items.[6] The development of a culturally appropriate assessment tool can help to address these research and service gaps.

The Hong Kong Situation

Maternal and Child Health Centers (MCHCs) provide free universal health services for children aged 0 to 5 years who are Hong Kong residents. In Hong Kong, about 90% of all newborn children are registered with MCHCs. The health service is provided through an Integrated Child Health and Development Program which comprises three components, namely, parenting, immunization, and developmental surveillance. Through the developmental surveillance component, children suspected to have developmental delay will be referred to Child Assessment Service (CAS) for further assessment. CAS provides assessment service to young children suspected to have developmental problems so as to provide rehabilitation service to them. In CAS, children are assessed by pediatricians using the Chinese version of the Griffiths Mental Development Scales (GDS-C).[5] Those diagnosed as developmental delay (test scores more than two standard deviations below the mean as significant delay; test scores between one and two standard

CONTACT Cynthia Leung cynthia.leung@vu.edu.au Department of Applied Social Sciences, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong.

This article has been republished with minor changes. These changes do not impact the academic content of the article.

deviations below the mean as mild delay) will then be referred for rehabilitation services either at preschools or training centers. The decision on the mode of training and intensity of training will depend on the severity of the delay as reflected by the assessment results.

The GDS-C is the most widely used developmental assessment scale for young children in Hong Kong. It was normed based on children from urban cities in China and Hong Kong. However, GDS-C was based on the Griffiths Mental Development Scales Extended Revised (GMDS-ER), rather than the most updated Griffiths III. Furthermore, there was no information on the item equivalence or differential item functioning of the English and Chinese versions. Although the M-P-R and Bayley-III were rated as good and adequate in a number of evaluation criteria for English-speaking preschoolers,[7] there are no local norms for Hong Kong Chinese children. It would be ideal to have an updated and locally developed, validated, and standardized comprehensive assessment tool for accurate and reliable diagnosis of local young children so that rehabilitation service can be started early.

In 2014, The Hong Kong Comprehensive Assessment Scales for Preschool Children (HKCAS-P) was launched.[8] The scales target Chinese-speaking children aged 3 years 4 months to 6 years 3 months and consist of six scales, Cognition, Language, Social cognition, Visual perception, Fine motor and Gross motor scales, plus an Early Literacy and Numeracy scale for children aged 4 years and above. Age-standardized scores are available for each scale as well as the Mental Composite (Cognition, Language, Social cognition and Visual perception scales), Motor Composite (Fine motor and Gross motor scales), and Full Scale Composite. The test could be administered by pediatricians and clinical/educational psychologists who have completed accredited training by the Department of Health, Hong Kong. However, this test does not cover younger toddlers and there is currently no locally developed tool for toddlers.

To provide a comprehensive assessment tool for Chinese-speaking children aged 18 months to 41 months, the Hong Kong Comprehensive Assessment Scales for Toddlers (HKCAS-T) was being developed. The tool consisted of four domains: Cognition, Language and communication, Fine motor, and Gross motor. This paper focused on the Cognition domain.

The Cognition Domain

Cognition refers to the thoughts and ways of information processing.[9] In terms of the cognitive development of toddlers, they are moving from the sensorimotor stage to the pre-operational stage.[10] Symbolic play emerges during this period and toddlers begin to understand symbols and language. In the development of the items of the Cognition domain, we took reference from the Cattell–Horn–Carroll theory because many assessment tools, including the Wechsler scales, are consistent with this theory.[11–13] According to the Cattell–Horn–Carroll theory, distinctive human abilities can be grouped into three strata levels. The first stratum includes over 70 narrow abilities such as numeracy and reading comprehension, etc. There are 10 broad abilities under the second stratum, namely, 'fluid intelligence, quantitative knowledge, crystallized intelligence, reading and writing, short-term memory, visual processing, auditory processing, long-term storage and retrieval, processing speed, decision speed and reaction time.'[11](p189) The third stratum comprises the g factor or general intelligence.

Using the second stratum as a reference framework, two clinical psychologists, an educational psychologist and a developmental behavioral pediatrician developed an initial pool of test items. All of them have many years of clinical experience in working with young children in child assessment service. There were 105 items tapping fluid intelligence (e.g., sequential reasoning), quantitative knowledge, crystallized intelligence (e.g., general information), visual processing (e.g., visual perceptual integration) and visual memory. The visual stimuli of the items were designed by an artist taking reference to the local context. The initial pool of items was administered to 28 toddlers aged 16 months to 43 months by the two clinical psychologists involved in the development of test items. Based on the results from these children, items that could not distinguish between age groups were eliminated, resulting in a final pool of 83 items.

The Present Study

This study aimed to examine the psychometric properties of the pilot version of the Cognition domain of the HKCAS-T. Rasch analysis was used to examine the difficulty level of the items and its measurement properties. In terms of measurement properties, the concept of undimensionality is important. If we are to sum up the item scores to form a total score, it is important that all items are measuring a single construct. The infit and outfit statistics in Rasch analysis, as well as the principal component analysis (PCA) of the residuals, were used to examine unidimensionality.[14] The Wright map was used to find out whether the items could target the ability levels of the children.[14] In terms of construct validity, the items' ability to differentiate between children with or without cognitive delay and children of different age groups were examined.[9] Based on the Rasch analysis results and the items' ability to differentiate between children with or without cognitive delay and children of different age groups, the scale could be refined and modified. In terms of reliability, internal consistency and interrater reliability were examined.

It was hypothesized that:

(1) The Cognition domain of the HKCAS-T would be able to differentiate children from different age groups, in the sense that older children would attain higher scores than younger children.
(2) The Cognition domain of the HKCAS-T would be able to differentiate children with typical development from those with cognitive delay, in the sense that the former group would attain higher scores than the latter group.

Methods

Participants

The study population was children aged 18 months to 41 months registered at MCHCs. Out of the 31 MCHCs in the territory, five

MCHCs were selected in four districts (out of 18 districts throughout Hong Kong) with different socioeconomic status as measured by median monthly household income (the highest, the lowest, the 6th and the 12th) based on the most recent household statistics.[15] Children suspected of developmental problems based on MCHC records (e.g., referral by MCHC nurses to MCHC doctors for further assessment, referral to CAS for assessment, or confirmed diagnosis from CAS) were excluded. Sex, age groups, and geographical areas were used for stratification in sampling. Simple random sampling was applied for selection in each 3-month stratum. A total of 2,632 children aged 18 months to 41 months were invited for participation between August 2017 and October 2018, and 258 children completed the assessment. The response rate was 9.8%. There were 16 boys and 16 girls in each 3-month age group, except for the 39–41 month group which consisted of 16 boys and 18 girls (MCHC sample).

In addition, participants were recruited from children who attended CAS for assessment during the research period. Children aged 18 months to 41 months who were diagnosed as having a delay in one or more areas of development (at least one to two standard deviations below the mean on standardized tests such as GDS-C) by individual Child Assessment Center (CAC) pediatricians were invited to participate. Out of 1,218 invitation letters sent, parents of 114 children consented to participate. The response rate was 9.4%. Among them, there were 87 children (8–15 children from each 3-month group) diagnosed with cognitive delay (at least one to two standard deviations below the mean on standardized tests such as GDS-C) by CAC pediatricians (CAS sample).

The sample size calculation was based on the sample size required for Rasch analysis, and the sample size required to compare the scores of children with typical development versus children with cognitive delay, and comparison across age groups. In Rasch analysis, a sample size of 250 is adequate for assessing item characteristics.[16] For comparison between two groups, assuming that children with cognitive delay will be at least one to two standard deviations below the mean in developmental assessment (assuming the mean of children with cognitive delay to be ≤80 on standardized assessment where mean = 100 and *sd* = 15), a sample size of 10 per age group is adequate for comparison between children with typical development versus children with cognitive delay (power = 0.80, $\alpha = 0.05$) for each 3-month age group. For comparison between eight age groups, the sample size for comparison between eight groups is 240 (power = 0.80, $\alpha = 0.05$) assuming a medium effect size.

Measures

The HKCAS-T was administered individually to the participating children. For the Cognition domain, it consists of 83 items. The sequential reasoning items require children to point to the correct answer among three or four pictures. The quantitative knowledge items require children to do some simple counting with objects. The general information items include basic color and shape concepts, and pointing to named familiar pictures and common symbols. The visual perceptual integration items include tasks such as putting blocks together according to a stimulus design, and assembling jigsaw puzzles. The visual memory items include finding a hidden object hidden by the field tester before the child and tapping objects after a particular pattern demonstrated by the field tester. As most items are straightforward in terms of attainment or nonattainment (e.g., pointing to the named picture stimulus or objects correctly), all items are scored as 1 (attained) or 0 (not attained) to achieve a uniform rating scale. The assessment is conducted in Cantonese which is the major language used by the Hong Kong population, spoken by 88.9% of the population at home.[17]

Procedures

Toddlers in the specified age groups were identified from the MCHC register. A research officer randomly selected the children using random numbers generated by the SPSS complex samples function. Invitation letters and consent forms with reply paid envelopes were then sent to the parents of the selected children. Upon receiving the signed consent forms, a research assistant contacted the parents by phone to work out the dates, times, and venues of assessment. This process continued until the target of 64 children per geographical district (4 boys and 4 girls in each age group) was reached.

For the children recruited through CAS, invitation letters and consent forms with reply paid envelopes were sent to the parents of eligible children (at least one to two standard deviations below the mean on standardized assessment such as GDS-C) to invite them to participate. Upon securing parent consent, a research assistant contacted the parents to arrange dates, times, and venues of assessment.

The children were assessed on the pilot HKCAS-T by two medical practitioners and four educational psychologists in MCHCs or CACs. These field testers were trained by the professionals who developed the test items to ensure that the field testers could administer and score the test according to protocol. This study was approved by the Ethics Committee of the Department of Health, Hong Kong SAR Government.

Data Analysis

Rasch analysis was used to examine the unidimensionality and difficulty level of the items, as well as the targeting of items. Reliability (internal consistency) was assessed using KR-20. Inter-rater reliability was assessed using Kappa. Analysis of covariance (ANCOVA) was used to investigate whether the items could differentiate children from different age groups, controlling for covariates. Independent *t*-test/ANCOVA was used to examine whether the items could differentiate children with a cognitive delay from children with typical development, controlling for covariates where appropriate.

Results

Rasch Analysis

Infit and outfit mean square statistics were used to examine the unidimensionality of the Cognition domain items. Using the cutoff of 0.60 and 1.40, there were four items (items 1, 21, 65, and 66) with infit/outfit statistics outside the recommended

range.[14] When these items were removed, it was found that the infit/outfit statistics of item 23 was outside the recommended range. After removing item 23, the infit/outfit statistics of item 22 was outside the recommended range and this item was also removed. The infit statistics of the 77 remaining items were within the recommended range (Table 1). More attention should be paid to infit values.[14] The person reliability of the 83-item version was 0.97 and the person separation was 5.90. The item reliability of the 83-item version was 0.99 and the item separation was 11.11. The person reliability of the 77-item version was 0.97 and the person separation was 5.67. The item reliability of the 77-item version was 0.99 and the item separation was 11.22.

Another way to examine unidimensionality is to inspect the PCA of the residuals. The criteria for unidimensionality are (i) the variance explained by measures should be at least 40%; (ii) the variance explained by the first principal component of the residuals should be less than 15%; and (iii) the ratio of variance in measures to variance in the first principal component of the residuals should be at least 3:1.[18] With the original version with 83 items, PCA of the residuals indicated that the variance explained by measures was 58.2%. The variance explained by the first principal component of the residuals was 3.9%. The ratio of variance in measures to variance in the first principal component of the residuals was 14.92:1. For the 77-item version, PCA of the residuals indicated that the variance explained by measures was 58.7%. The variance explained by the first principal component of the residuals was 4.3%. The ratio of variance in measures to variance in the first principal component of the residuals was 13.65:1. For both versions, all three criteria were fulfilled, supporting the unidimensionality of the scale.

Item difficulty and targeting were examined using the Wright map. The Wright map distribution of both the 83-item version (Figure 1) and 77-item version (Figure 2) suggested that the Cognition domain items could target the ability range of the children, though there were fewer items at the high and the low end.

Analysis by Age Groups

There were no significant differences in demographic characteristics among the age groups except language used by the children at home, $\chi^2(14) = 23.92$, $p = .047$. Apart from the oldest and youngest age groups, and the 24–26 months group, all children used Cantonese at home. In the oldest age group, two children used Mandarin at home. Two children in the 18–20 months group, and one child in the 24–26 months group used English at home. The demographic characteristics of the children are shown in Table 2.

ANCOVA was used to analyze the age group difference in HKCAS-T Cognition domain scores. As there was a difference in the language spoken at home by age groups, two dummy variables were created (English versus others, Cantonese versus others) and they were used as covariates in the analysis on age group differences. The independent variable was age groups and the dependent variable was HKCAS-T Cognition domain scores. As two comparisons were made, the Bonferroni adjusted alpha level was 0.025. The results were significant

Table 1. Infit and outfit statistics of the cognition domain items.

	83-item version			77-item version		
Item	Measure	Infit	Outfit	Measure	Infit	Outfit
1	−4.52	1.95	9.90		Deleted	
2	−6.09	0.74	3.08	−6.85	0.76	6.05
3	−6.48	1.00	1.93	−7.31	1.13	3.11
4	−6.28	1.30	4.93	−7.07	1.39	9.38
5	−2.47	0.77	0.51	−2.75	0.81	0.54
6	−2.26	0.74	0.57	−2.52	0.78	1.44
7	−2.30	0.59	0.30	−2.56	0.61	0.30
8	−2.09	0.68	0.39	−2.34	0.71	0.39
9	0.37	1.07	0.97	0.24	1.11	1.04
10	0.40	0.80	0.61	0.27	0.83	0.62
11	0.40	0.88	0.66	0.27	0.90	0.68
12	0.65	0.92	0.87	0.52	0.94	0.94
13	0.32	0.93	0.80	0.18	0.97	0.82
14	0.48	0.95	0.96	0.35	0.98	1.03
15	0.37	0.95	0.87	0.24	0.98	0.92
16	0.43	0.92	0.79	0.29	0.94	0.78
17	0.51	0.66	0.44	0.38	0.68	0.45
18	2.08	0.66	0.38	1.98	0.65	0.37
19	3.14	0.78	0.40	3.07	0.79	0.39
20	3.05	0.65	0.31	2.98	0.64	0.29
21	−3.51	1.49	3.43		Deleted	
22	−3.22	1.28	2.44		Deleted	
23	−4.44	1.35	2.77		Deleted	
24	0.93	0.76	0.51	0.81	0.78	0.52
25	0.93	0.91	0.70	0.81	0.92	0.70
26	2.21	0.77	0.52	2.12	0.78	0.51
27	3.70	0.89	0.55	3.64	0.90	0.55
28	4.90	1.00	0.74	4.86	1.01	0.78
29	−3.39	0.82	0.65	−3.76	0.85	0.72
30	−3.70	0.67	0.49	−4.11	0.73	0.61
31	−3.39	0.89	0.62	−3.76	0.97	0.72
32	−3.39	0.76	0.55	−3.76	0.76	0.61
33	−3.28	0.71	0.54	−3.63	0.73	0.61
34	−4.12	0.76	0.57	−4.58	0.82	0.76
35	−3.11	0.73	0.53	−3.45	0.74	0.59
36	−3.57	0.75	0.53	−3.96	0.80	0.63
37	−0.66	1.05	0.96	−0.83	1.10	1.02
38	−1.12	1.12	1.16	−1.31	1.18	1.28
39	0.76	1.06	1.56	0.64	1.10	1.78
40	1.88	0.84	0.59	1.78	0.86	0.60
41	−0.42	1.18	2.00	−0.58	1.22	2.60
42	1.04	0.86	0.91	0.93	0.88	0.97
43	1.81	0.98	1.12	1.72	1.01	1.15
44	1.66	1.20	1.31	1.56	1.24	1.52
45	3.24	1.23	1.20	3.18	1.26	1.24
46	−0.02	1.10	1.37	−.17	1.14	1.88
47	1.27	1.30	1.69	1.16	1.34	1.84
48	−1.32	1.15	1.00	−1.52	1.23	1.16
49	2.21	1.01	0.74	2.12	1.03	0.76
50	1.63	1.19	1.01	1.53	1.21	1.05
51	−0.66	0.80	0.65	−0.83	0.84	0.67
52	−2.80	1.21	5.08	−3.11	1.39	7.06
53	−1.71	1.06	1.17	−1.93	1.13	1.32
54	−1.42	0.77	0.74	−1.63	0.81	0.77
55	0.23	1.22	1.97	0.09	1.26	2.58
56	−2.26	0.99	0.77	−2.52	1.05	0.89
57	1.13	1.07	1.18	1.01	1.08	1.14
58	0.96	1.01	0.85	0.84	1.02	0.84
59	0.48	0.95	0.90	0.35	0.98	0.97
60	2.66	1.05	0.69	2.58	1.07	0.71
61	2.39	0.82	0.55	2.30	0.82	0.57
62	1.63	0.87	0.60	1.53	0.89	0.61
63	1.19	0.96	0.79	1.07	0.98	0.82
64	3.40	1.01	0.72	3.34	1.03	0.71
65	0.54	1.42	1.65		Deleted	
66	1.13	1.46	1.63		Deleted	
67	1.42	0.86	0.68	1.31	0.90	0.70
68	0.59	1.09	0.94	0.47	1.14	1.05
69	−0.13	1.12	1.23	−0.28	1.16	1.41
70	0.93	1.30	1.75	0.81	1.34	1.99
71	0.46	0.79	0.58	0.32	0.80	0.56
72	0.09	0.72	0.57	−0.05	0.73	0.57
73	0.34	0.82	0.69	0.21	0.82	0.69

(*Continued*)

Table 1. (Continued).

	83-item version			77-item version		
Item	Measure	Infit	Outfit	Measure	Infit	Outfit
74	1.51	1.03	1.76	1.40	1.05	1.77
75	1.21	1.08	1.13	1.10	1.10	1.37
76	2.82	1.04	0.92	2.75	1.06	0.94
77	2.91	1.15	0.85	2.84	1.17	0.90
78	2.11	0.95	0.58	2.02	0.97	0.59
79	3.19	1.01	0.89	3.12	1.03	0.95
80	2.01	1.14	0.94	1.91	1.17	1.00
81	3.19	1.15	1.17	3.12	1.18	1.19
82	2.70	1.27	1.02	2.62	1.31	1.03
83	2.50	1.28	1.05	2.42	1.31	1.05

for the 83-item version, F (7, 248) = 70.89, $p < .001$ and the 77-item version, F (7, 248) = 72.77, $p < .001$. Pairwise comparison (with Bonferroni adjustment) indicated that the mean scores of each age group differed significantly from other age groups, except the immediately adjacent age groups. The results are shown in Table 3.

Analysis by Developmental Status

For the analyses in this section, due to multiple comparisons, the Bonferroni adjusted alpha level was 0.0016. Independent *t*-tests indicated that there were significant differences between the children with cognitive delay (CAS sample) and those with typical development (MCHC sample) in all but one age group, with the latter group attaining higher scores. The sensitivity and specificity values and the areas under the curve were above 0.70 in most age groups, except the 36–38 months and 30–32 months groups. The details are in Table 4.

There were some demographic differences between children with cognitive delay and those with typical development in some age groups. The details are in Table 5. These demographic variables were treated as covariates within the specific age groups in the ANCOVA analyses on the difference in Cognition domain scores between children with cognitive delay and children with typical development.

For the 39–41 months, 33–35 months, 27–29 months, 24–26 months, and 21–23 months groups, ANCOVA results were significant for the 83-item version and the 77-item version. In all cases, the scores of the cognitive delay group were lower than that of the typical development group. However, ANCOVA results were not significant for the 36–38 months, 30–32 months, and 18–20 months groups for the 83-item version and the 77-item version. The details are in Table 4.

Reliability

The reliability (KR-20) estimates of the 83-item version and the 77-item version of the Cognition Domain were both 0.97. The interrater reliability (Kappa) between field testers ranged from 0.90 to 1.00.

Discussion

In terms of the measurement properties of the Cognition domain, Rasch analysis results supported the unidimensionality of the scale. Unidimensionality is important in test development because we can only understand the nature of the test if we can isolate the one dimension that is being measured.[19] The scores of the items could then be meaningfully summed up to form a total score as they all measure one dimension. For item difficulty and targeting, the Wright map indicated that the scale could target the abilities of the children though there were fewer items at either end of the ability range. This suggested that the range of test items was age-appropriate for children aged 18–41 months.

Regarding construct validity, Hypothesis 1 on the differentiation of children from different age groups was largely supported. The overall ANCOVA results were significant for both the 83-item version and 77-item version. The Cognition domain could differentiate children from different age groups, except the adjacent age groups. The overall pattern indicated that older children attained higher scores than younger children. The lack of differentiation in the adjacent age groups might be due to two reasons. First, there were not enough items to map out the differences between the two adjacent age groups. Second, the items might not be sensitive enough to detect the differences. In one of the validation studies of the Bayley III, there were decreases in scores over adjacent older age groups in some cases, though the decreases were not significant.[20] However, in our present study, there was a consistent trend of an increase in scores across age groups, with older children attaining higher scores. Hypothesis 2 on the differentiation of children with typical development versus those with cognitive delay was largely supported. In most age groups, children with cognitive delay scored significantly below their age peers with typical development. The sensitivity and specificity values and areas under the curve were satisfactory. This provided some evidence that the tool could be used to identify children with cognitive delay.

For reliability, the internal consistency (KR-20) of both the 83-item version and 77-item version was above .90. Interrater reliability was also above .90.

The Cognition domain of the HKCAS-T is the first attempt of the research team to develop an indigenous psychometric tool for assessment of the cognitive functioning of toddlers in a Chinese community. In addition to testing for differences in age and developmental status, Rasch analysis, one of the strictest item response theory models, has been used to improve the precision and quality of the instrument. By including only items which fit the Rasch model, the precision of measurement of a test can be improved.[21] The results of the present study indicated satisfactory psychometric properties in terms of unidimensionality, item difficulty, reliability, and validity. As it is not a translation from tests developed in other languages, there are no issues about item equivalence or differential item functioning because of different language versions. It is hoped that with the use of the tool, professionals can provide a reliable assessment of the cognitive strength and deficits of toddlers, so that rehabilitation service can be given as early as possible. The tool could potentially be useful in epidemiological or research studies to map out the distribution of children's development. It could also be a useful tool for the evaluation of the effectiveness of early intervention programs, and to track the development of children.

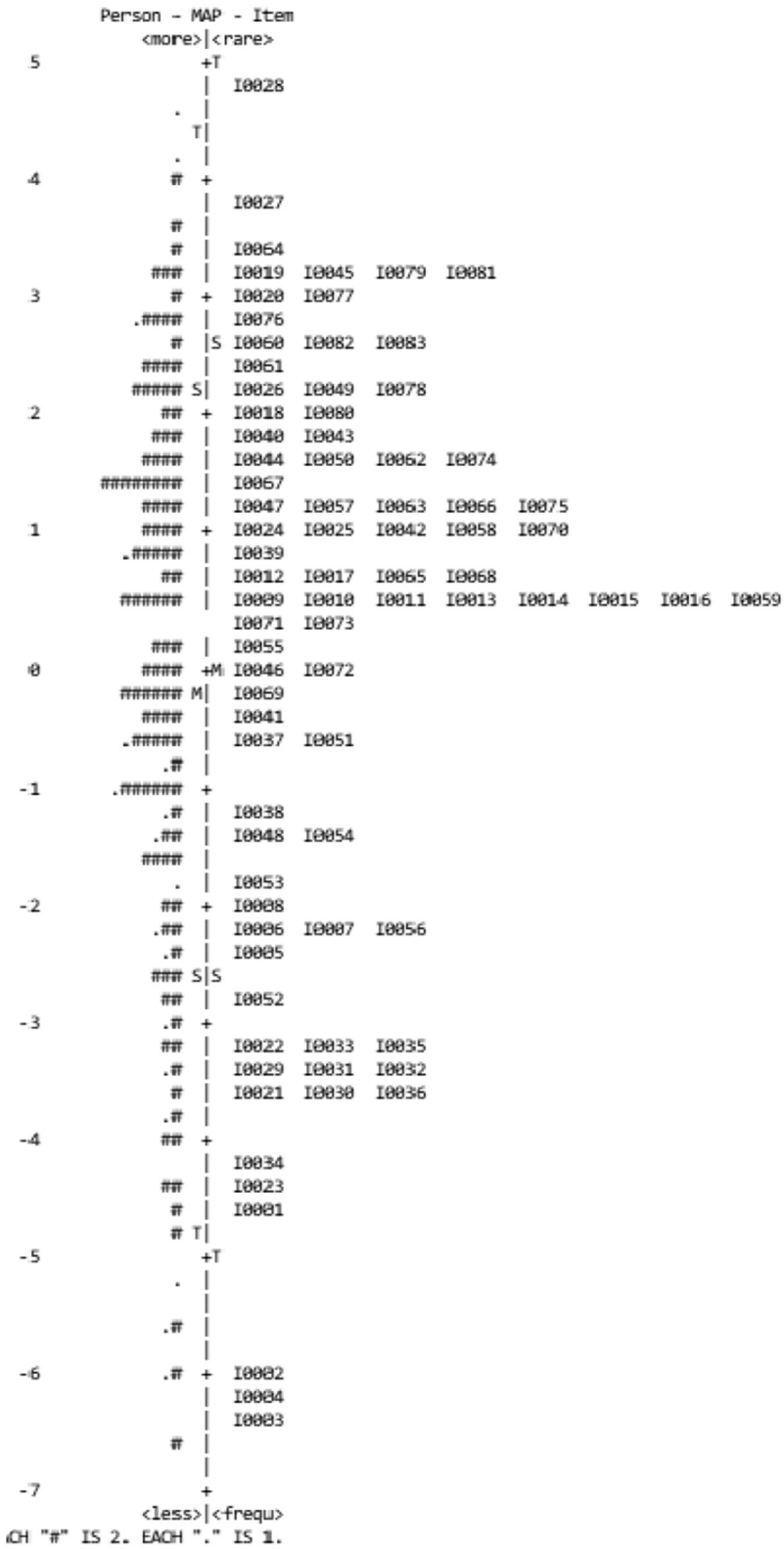

Figure 1. Wright map for 83 items.

Limitations

First, the response rate was low and this might affect the representativeness of the sample. A large majority (82.9% in the MCHC sample and 65.8% in the CAS sample) of the sample reported household income above HK$20,000 and the median household income in Hong Kong is HK$26,500. It is likely that children from low-income families were less well represented in the sample. Second, due to difficulties in recruitment, the number of children with cognitive delay was less than that based on our initial sample size estimation in some age groups, and this might have affected the power of the study. Third, though the Cognition domain items could differentiate children from different age groups and children with different

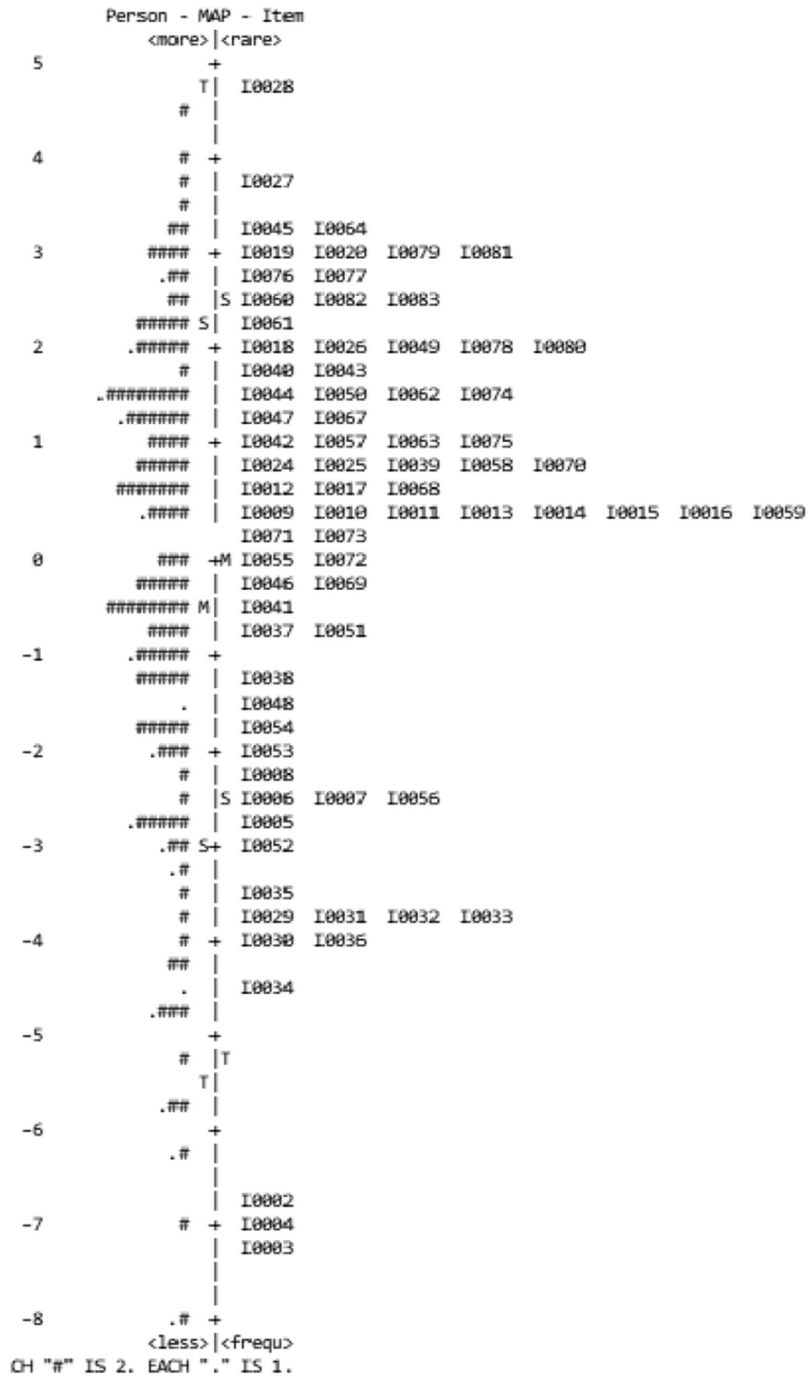

Figure 2. Wright map for 77 items.

developmental status, there is still no information whether it correlates with other existing measures of child cognitive development. A second study is being planned to examine the correlation of the Cognition domain items with existing measures such as M-P-R.[2] Fourth, the predictive validity and the test-retest reliability of the Cognition domain have not been investigated. Fifth, the rating system was dichotomous (attained versus not attained) and no partial credit was given to children with emerging skills. These children could have been disadvantaged in the assessment of their skills. A future revision of the test should consider the use of the partial credit system. Sixth, the HKCAS-T field testers were aware of the developmental status of the participants (cognitive delay or not) and this might have affected their handling of the children and assessment results.

Conclusions

There is initial evidence that the Cognition domain of the Hong Kong Comprehensive Assessment Scales for Toddlers

Table 2. Demographic characteristics of participants.

	MCHC sample (n = 258)	CAS sample (n = 87)	Significance
Sex of child – boy	128 (49.6%)	61 (70.1%)	χ^2 (1) = 11.04,
Sex of child – girl	130 (50.4%)	26 (29.9%)	p = .001
Child's education – no schooling	137 (53.1%)	39 (44.8%)	χ^2 (1) = 1.78,
Child's education – preschool	121 (46.9%)	48 (55.2%)	p = .182
Language used – Cantonese	251 (98.0%)	82 (96.5%)	χ^2 (2) = 1.36,
Language used – Mandarin	2 (0.8%)	2 (2.4%)	p = .507
Language used – English	3 (1.2%)	1 (1.2%)	
Family type – nuclear	161 (62.4%)	55 (63.2%)	χ^2 (1) = 0.02,
Family type – others	97 (37.6%)	32 (36.8%)	p = .892
Marital relationship – married	238 (92.2%)	75 (86.2%)	χ^2 (1) = 2.82,
Marital relationship – single/separated/divorced/widowed	20 (7.8%)	12 (13.8%)	p = .093
Mother's education – ≤ 9 years	44 (17.3%)	22 (28.9%)	χ^2 (1) = 5.01,
Mother's education – > 9 years	211 (82.7%)	54 (71.1%)	p = .025
Father's education – ≤ 9 years	30 (11.8%)	18 (24.3%)	χ^2 (1) = 7.18,
Father's education – > 9 years	224 (88.2%)	56 (75.7%)	p = .007
Family income – ≤ HK$19,999	43 (17.1%)	26 (34.2%)	χ^2 (1) = 10.22,
Family income – ≥ HK$20,000	208 (82.9%)	50 (65.8%)	p = .001
Child's age (months)	30.01 (6.92)	31.06 (6.95)	t (343) = 1.22, p = .222
Child's length of residence in Hong Kong (months)	29.08 (7.70)	28.82 (9.60)	t (270) = 0.21, p = .832
Mother's length of residence in Hong Kong (years)	27.87 (12.33)	23.32 (15.35)	t (296) = 2.51, p = .013
Father's length of residence in Hong Kong (years)	35.51(8.81)	37.15 (13.37)	t (277) = 1.13, p = .259
Number of siblings	1.60 (0.65)	1.78 (0.82)	t (331) = 2.08, p = .038

Table 3. Mean and standard deviation scores by age group.

Age group	n	Mean	Standard deviation	Group differences
83-item version				
(1) 18–20 months	32	11.38	5.93	(1) versus (2), (3), (4), (5), (6), (7), (8)
(2) 21–23 months	32	23.69	13.99	(2) versus (1), (4), (5), (6), (7), (8)
(3) 24–26 months	32	27.69	9.96	(3) versus (1), (4), (5), (6), (7), (8)
(4) 27–29 months	32	38.53	8.45	(4) versus (1), (2), (3), (6), (7), (8)
(5) 30–32 months	32	42.59	12.52	(5) versus (1), (2), (3), (6), (7), (8)
(6) 33–35 months	32	52.66	13.98	(6) versus (1), (2), (3), (4), (5), (8)
(7) 36–38 months	32	54.03	13.68	(7) versus (1), (2), (3), (4), (5)
(8) 39–41 months	34	62.59	11.13	(8) versus (1), (2), (3), (4), (5), (6)
77-item version				
(1) 18–20 months	32	8.66	5.37	(1) versus (2), (3), (4), (5), (6), (7), (8)
(2) 21–23 months	32	19.84	12.86	(2) versus (1), (4), (5), (6), (7), (8)
(3) 24–26 months	32	23.63	9.49	(3) versus (1), (4), (5), (6), (7), (8)
(4) 27–29 months	32	34.03	8.09	(4) versus (1), (2), (3), (6), (7), (8)
(5) 30–32 months	32	37.81	12.34	(5) versus (1), (2), (3), (6,), (7), (8)
(6) 33–35 months	32	47.72	13.34	(6) versus (1), (2), (3), (4), (5), (8)
(7) 36–38 months	32	49.31	13.09	(7) versus (1), (2), (3), (4), (5)
(8) 39–41 months	34	57.68	10.41	(8) versus (1), (2), (3), (4), (5), (6)

Table 4. Diagnostic accuracy and comparison between the MCHC sample and CAS sample.

Age group	MCHC sample		CAS sample		Cutoff score	Sensitivity	Specificity	Area under curve	t and p value	F and p value
83-item version										
	n	Mean (sd)	n	Mean (sd)						
18–20 months	32	11.38 (5.93)	8	2.75 (2.31)	3.5	0.75	0.94	0.93	t (38) = 4.00, p < .001	F (1, 33) = 4.67, p = .035
21–23 months	32	23.69 (13.99)	12	2.42 (2.27)	5.5	0.92	0.91	0.96	t (42) = 5.21, p < .001	F (1, 33) = 18.29, p < .001
24–26 months	32	27.69 (9.96)	9	9.22 (8.36)	14.5	0.89	0.94	0.93	t (39) = 5.07, p < .001	F (1, 38) = 24.45, p < .001
27–29 months	32	38.53 (8.45)	10	13.50 (10.80)	22.5	0.90	1.00	0.97	t (40) = 7.65, p < .001	F (1, 40) = 58.46, p < .001
30–32 months	32	42.59 (12.52)	12	25.17 (14.11)	34.5	0.67	0.66	0.80	t (42) = 3.97, p < .001	F (1, 38) = 8.49, p = .006
33–35 months	32	52.66 (13.98)	9	22.44 (9.40)	41.0	1.00	0.84	0.93	t (39) = 5.30, p < .001	F (1, 32) = 14.74, p = .001
36–38 months	32	54.03 (13.68)	12	41.08 (17.73)	51.5	0.67	0.56	0.71	t (42) = 2.58, p = .014	F (1, 39) = 2.76, p = .105
39–41 months	34	62.59 (11.13)	15	35.40 (16.43)	52.0	0.80	0.85	0.91	t (47) = 6.78, p < .001	F (1, 44) = 37.41, p < .001
77-item version										
18–20 months	32	8.66 (5.37)	8	1.25 (2.05)	2.0	0.75	0.94	0.93	t (38) = 3.80, p = .001	F (1, 33) = 3.37, p = .075
21–23 months	32	19.84 (12.86)	12	1.58 (1.88)	4.5	0.92	0.91	0.96	t (42) = 4.86, p < .001	F (1, 33) = 15.24, p < .001
24–26 months	32	23.63 (9.49)	9	7.33 (6.89)	12.5	0.89	0.91	0.93	t (39) = 4.79, p < .001	F (1, 38) = 22.05, p < .001
27–29 months	32	34.03 (8.09)	10	10.50 (9.74)	18.0	0.90	1.00	0.97	t (40) = 7.65, p < .001	F (1, 40) = 58.57, p < .001
30–32 months	32	37.81 (12.34)	12	22.42 (12.96)	31.0	0.67	0.59	0.79	t (42) = 3.64, p = .001	F (1, 38) = 6.79, p = .013
33–35 months	32	47.72 (13.34)	9	22.44 (9.40)	36.5	1.00	0.84	0.93	t (39) = 5.30, p < .001	F (1, 32) = 15.04, p < .001
36–38 months	32	49.31 (13.09)	12	36.75 (17.04)	46.5	0.67	0.59	0.70	t (42) = 2.61, p = .013	F (1, 39) = 2.93, p = .095
39–41 months	34	57.68 (10.41)	15	31.80 (15.60)	47.5	0.80	0.83	0.91	t (47) = 6.85, p < .001	F (1, 44) = 38.73, p < .001

Table 5. Demographic Characteristics of the MCHC Sample and CAS Sample by Age Group

	MCHC sample	CAS sample	Significance
18 – 20 months	(*n* = 32)	(*n* = 8)	
Sex of child – boy	16 (50.0%)	5 (62.5%)	χ^2 (1) = 0.40,
Sex of child – girl	16 (50.0%)	3 (37.5%)	*p* = 0.698
Cognitive delay between 1 to 2 sd	NA	5 (62.5%)	NA
Cognitive delay > 2 sd	NA	3 (37.5%)	NA
Child's education – no schooling	27 (84.4%)	6 (75.0%)	χ^2 (1) = 0.39,
Child's education – preschool	5 (15.6%)	2 (25.0%)	*p* = 0.611
Language used – Cantonese	29 (93.5%)	6 (100.0%)	χ^2 (1) = 0.41,
Language used – English	2 (6.5%)	0 (0.0%)	*p* = 1.000
Family type – nuclear	19 (59.4%)	5 (62.5%)	χ^2 (1) = 0.03,
Family type – others	13 (40.6%)	3 (37.5%)	*p* = 1.000
Marital relationship – married	28 (87.5%)	6 (75.0%)	χ^2 (1) = 0.78,
Marital relationship – single/separated/divorced/widowed	4 (12.5%)	2 (25.0%)	*p* = 0.580
Mother's education – ≤ 9 years	7 (22.6%)	0 (0.0%)	χ^2 (1) = 1.13,
Mother's education – > 9 years	24 (77.4%)	4 (100.0%)	*p* = 0.562
Father's education – ≤ 9 years	6 (19.4%)	0 (0.0%)	χ^2 (1) = 0.93,
Father's education – > 9 years	25 (80.6%)	4 (100.0%)	*p* = 1.000
Family income – ≤ HK$19,999	4 (13.3%)	0 (0.0%)	χ^2 (1) = 0.90,
Family income – ≥ HK$20,000	26 (86.7%)	6 (100.0%)	*p* = 1.000
Child's age (months)	19.50 (8.23)	20.49 (0.64)	*t* (38) = 3.16,
			p = 0.003
Child's length of residence in Hong Kong (months)	19.32 (1.01)	17.17 (5.53)	*t* (35) = 2.11,
			p = 0.384
Mother's length of residence in Hong Kong (years)	27.34 (11.99)	22.00 (19.00)	*t* (30) = 0.70,
			p = 0.489
Father's length of residence in Hong Kong (years)	34.85 (7.08)	39.00 (20.52)	*t* (28) = 0.78,
			p = 0.442
Number of siblings	1.42 (0.56)	2.33 (0.52)	*t* (35) = 3.68,
			p = 0.001
21 –23 months	(*n* = 32)	(*n* = 12)	
Sex of child – boy	16 (50.0%)	9 (75.0%)	χ^2 (1) = 2.22,
Sex of child – girl	16 (50.0%)	3 (25.0%)	*p* = 0.136
Cognitive delay between 1 to 2 sd	NA	8 (66.7%)	NA
Cognitive delay > 2 sd	NA	4 (33.3%)	NA
Child's education – no schooling	29 (90.6%)	10 (83.3%)	χ^2 (1) = 0.46
Child's education – preschool	3 (9.4%)	2 (16.7%)	*p* = 0.603
Language used – Cantonese	32 (100.0%)	11 (91.7%)	χ^2 (1) = 2.73,
Language used – Mandarin	0 (0.0%)	1 (8.3%)	*p* = 0.273
Family type – nuclear	21 (65.6%)	6 (50.0%)	χ^2 (1) = 0.90,
Family type – others	11 (34.4%)	6 (50.0%)	*p* = 0.489
Marital relationship – married	29 (90.6%)	11 (91.7%)	χ^2 (1) = 0.01,
Marital relationship – single/separated/divorced/widowed	3 (9.4%)	1 (8.3%)	*p* = 1.000
Mother's education – ≤ 9 years	5 (15.6%)	1 (10.0%)	χ^2 (1) = 0.20,
Mother's education – > 9 years	27 (84.4%)	9 (90.0%)	*p* = 1.000
Father's education – ≤ 9 years	7 (21.9%)	1 (11.1%)	χ^2 (1) = 0.52,
Father's education – > 9 years	25 (78.1%)	8 (88.9%)	*p* = 0.659
Family income – ≤ HK$19,999	4 (12.9%)	4 (36.4%)	χ^2 (1) = 2.90,
Family income – ≥ HK$20,000	27 (87.1%)	7 (63.6%)	*p* = 0.174
Child's age (months)	22.86 (0.85)	22.50 (0.91)	*t* (42) = 1.24,
			p = 0.222
Child's length of residence in Hong Kong (months)	22.41 (1.02)	22.38 (0.74)	*t* (35) = 0.10,
			p = 0.921
Mother's length of residence in Hong Kong (years)	28.21 (11.23)	26.78 (18.23)	*t* (35) = 0.27,
			p = 0.777
Father's length of residence in Hong Kong (years)	33.67 (8.15)	44.00 (14.46)	*t* (34) = 2.69,
			p = 0.011
Number of siblings	1.50 (0.84)	1.73 (0.79)	*t* (41) = 0.79,
			p = 0.437
24 – 26 months	(*n* = 32)	(*n* = 9)	
Sex of child – boy	16 (50.0%)	5 (55.6%)	χ^2 (1) = 0.09,
Sex of child – girl	16 (50.0%)	4 (44.4%)	*p* = 1.00
Cognitive delay between 1 to 2 sd	NA	3 (33.3%)	NA
Cognitive delay > 2 sd	NA	6 (66.7%)	NA
Child's education – no schooling	22 (68.8%)	5 (55.6%)	χ^2 (1) = 0.54,
Child's education – preschool	10 (31.3%)	4 (44.4%)	*p* = 0.692
Language used – Cantonese	31 (96.9%)	9 (100.0%)	χ^2 (1) = 0.29,
Language used – English	1 (3.1%)	0 (0.0%)	*p* = 1.00
Family type – nuclear	17 (53.1%)	6 (66.7%)	χ^2 (1) = 0.52,
Family type – others	15 (46.9%)	3 (33.3%)	*p* = 0.706
Marital relationship – married	32 (100.0%)	9 (100.0%)	NA
Mother's education – ≤ 9 years	6 (18.8%)	1 (14.3%)	χ^2 (1) = 0.08,
Mother's education – > 9 years	26 (81.3%)	6 (85.7%)	*p* = 1.00

(*Continued*)

Table 5. (Continued).

	MCHC sample	CAS sample	Significance
Father's education – ≤ 9 years	2 (6.3%)	1 (14.3%)	χ^2 (1) = 0.52,
Father's education – > 9 years	30 (93.8%)	6 (85.7%)	p = 0.457
Family income – ≤ HK$19,999	4 (12.9%)	1 (11.1%)	χ^2 (1) = 0.02,
Family income – ≥ HK$20,000	27 (87.1%)	8 (88.9%)	p = 1.00
Child's age (months)	25.22 (0.81)	25.69 (0.80)	t (39) = 1.55, p = 0.130
Child's length of residence in Hong Kong (months)	23.82 (5.42)	24.25 (0.50)	t (24) = 0.16, p = 0.877
Mother's length of residence in Hong Kong (years)	28.86 (12.29)	30.00 (15.12)	t (31) = 0.19, p = 0.854
Father's length of residence in Hong Kong (years)	34.63 (14.14)	38.20 (5.07)	t (30) = 0.76, p = 0.452
Number of siblings	1.41 (0.50)	2.33 (0.87)	t (39) = 4.14, p < 0.001
27 - 29 months	(n = 32)	(n = 10)	
Sex of child – boy	16 (50.0%)	8 (80.0%)	χ^2 (1) = 2.80,
Sex of child – girl	16 (50.0%)	2 (20.0%)	p = 0.174
Cognitive delay between 1 to 2 sd	NA	4 (40.0%)	NA
Cognitive delay > 2 sd	NA	6 (60.0%)	NA
Child's education – no schooling	19 (59.4%)	3 (30.0%)	χ^2 (1) = 2.64,
Child's education – preschool	13 (40.6%)	7 (70.0%)	p = 0.152
Language used – Cantonese	31 (100.0%)	10 (100.0%)	NA
Family type – nuclear	20 (62.5%)	3 (30.0%)	χ^2 (1) = 3.25,
Family type – others	12 (37.5%)	7 (70.0%)	p = 0.143
Marital relationship – married	31 (96.9%)	9 (90.0%)	χ^2 (1) = 0.79,
Marital relationship – single/separated/divorced/widowed	1 (3.1%)	1 (10.0%)	p = 0.424
Mother's education – ≤ 9 years	8 (25.8%)	3 (33.3%)	χ^2 (1) = 0.20,
Mother's education – > 9 years	23 (74.2%)	6 (66.7%)	p = 0.686
Father's education – ≤ 9 years	4 (12.9%)	2 (22.2%)	χ^2 (1) = 0.48,
Father's education – > 9 years	27 (87.1%)	7 (77.8%)	p = 0.60
Family income – ≤ HK$19,999	5 (16.1%)	4 (50.0%)	χ^2 (1) = 4.11,
Family income – ≥ HK$20,000	26 (83.9%)	4 (50.0%)	p = 0.065
Child's age (months)	28.42 (0.85)	28.66 (0.57)	t (40) = 0.83, p = 0.413
Child's length of residence in Hong Kong (months)	28.13 (1.39)	28.25 (0.71)	t (30) = 0.24, p = 0.811
Mother's length of residence in Hong Kong (years)	28.70 (12.34)	22.60 (13.55)	t (38) = 1.32, p = 0.194
Father's length of residence in Hong Kong (years)	35.77 (7.97)	30.00 (14.75)	t (36) = 1.50, p = 0.143
Number of siblings	1.74 (0.63)	1.50 (0.53)	t (39) = 1.09, p = 0.281
30 - 32 months	(n = 32)	(n = 12)	
Sex of child – boy	16 (50.0%)	9 (75.0%)	χ^2 (1) = 2.22,
Sex of child – girl	16 (50.0%)	3 (25.0%)	p = 0.136
Cognitive delay between 1 to 2 sd	NA	11 (91.7%)	NA
Cognitive delay > 2 sd	NA	1 (8.3%)	NA
Child's education – no schooling	16 (50.0%)	7 (58.3%)	χ^2 (1) = 0.24,
Child's education – preschool	16 (50.0%)	5 (41.7%)	p = 0.622
Language used – Cantonese	32 (100.0%)	11 (91.7%)	χ^2 (1) = 2.73,
Language used – Mandarin	0 (0.0%)	1 (8.3%)	p = 0.273
Family type – nuclear	23 (71.9%)	10 (83.3%)	χ^2 (1) = 0.15,
Family type – others	9 (28.1%)	2 (16.7%)	p = 1.00
Marital relationship – married	28 (87.5%)	11 (91.7%)	χ^2 (1) = 0.15,
Marital relationship – single/separated/divorced/widowed	4 (12.5%)	1 (8.3%)	p = 1.00
Mother's education – ≤ 9 years	2 (6.5%)	3 (27.3%)	χ^2 (1) = 3.36,
Mother's education – > 9 years	29 (93.5%)	8 (72.7%)	p = 0.103
Father's education – ≤ 9 years	2 (6.7%)	4 (36.4%)	χ^2 (1) = 5.68,
Father's education – > 9 years	28 (93.3%)	7 (63.6%)	p = 0.035
Family income – ≤ HK$19,999	11 (35.5%)	3 (27.3%)	χ^2 (1) = 0.25,
Family income – ≥ HK$20,000	20 (64.5%)	8 (72.7%)	p = 0.723
Child's age (months)	31.30 (0.89)	31.47 (0.77)	t (42) = 0.59, p = 0.460
Child's length of residence in Hong Kong (months)	31.00 (1.10)	28.14 (8.03)	t (31) = 1.83, p = 0.077
Mother's length of residence in Hong Kong (years)	26.18 (13.20)	25.40 (14.22)	t (36) = 0.15, p = 0.879
Father's length of residence in Hong Kong (years)	35.73(7.80)	34.56 (15.56)	t (29) = 0.20, p = 0.844
Number of siblings	1.63 (0.56)	1.67 (0.89)	t (40) = 0.15, p = 0.894
33 – 35 months	(n = 32)	(n = 9)	
Sex of child – boy	16 (50.0%)	6 (66.7%)	χ^2 (1) = 0.79,
Sex of child – girl	16 (50.0%)	3 (33.3%)	p = 0.466

(*Continued*)

Table 5. (Continued).

	MCHC sample	CAS sample	Significance
Cognitive delay between 1 to 2 sd	NA	6 (66.7%)	NA
Cognitive delay > 2 sd	NA	3 (33.3%)	NA
Child's education – no schooling	10 (31.3%)	3 (33.3%)	χ^2 (1) = 0.01,
Child's education – preschool	22 (68.8%)	6 (66.7%)	p = 1.00
Language used – Cantonese	32 (100.0%)	9 (100.0%)	NA
Family type – nuclear	19 (59.4%)	6 (66.7%)	χ^2 (1) = 0.16,
Family type – others	13 (40.6%)	3 (33.3%)	p = 1.00
Marital relationship – married	29 (90.6%)	7 (77.8%)	χ^2 (1) = 1.08,
Marital relationship – single/separated/divorced/widowed	3 (9.4%)	2 (22.2%)	p = 0.299
Mother's education – ≤ 9 years	6 (18.8%)	4 (44.4%)	χ^2 (1) = 2.52,
Mother's education – > 9 years	26 (81.3%)	5 (55.6%)	p = 0.185
Father's education – ≤ 9 years	2 (6.3%)	3 (33.3%)	χ^2 (1) = 4.81,
Father's education – > 9 years	30 (93.8%)	6 (66.7%)	p = 0.061
Family income – ≤ HK$19,999	4 (12.9%)	2 (33.3%)	χ^2 (1) = 1.54,
Family income – ≥ HK$20,000	27 (87.1%)	4 (66.7%)	p = 0.245
Child's age (months)	34.26 (0.73)	34.72 (1.10)	t (39) = 1.46,
			p = 0.152
Child's length of residence in Hong Kong (months)	32.21 (7.38)	34.40 (1.14)	t (32) = 0.66,
			p = 0.517
Mother's length of residence in Hong Kong (years)	30.19 (11.42)	16.00 (14.46)	t (33) = 2.65,
			p = 0.012
Father's length of residence in Hong Kong (years)	36.59 (6.48)	39.80 (5.22)	t (30) = 1.04,
			p = 0.306
Number of siblings	1.50 (0.50)	1.25 (0.46)	t (37) = 1.69, p = 0.100
36 –38 months	(n = 32)	(n = 12)	
Sex of child – boy	16 (50.0%)	10 (83.3%)	χ^2 (1) = 4.01,
Sex of child – girl	16 (50.0%)	2 (16.7%)	p = 0.083
Cognitive delay between 1 to 2 sd	NA	10 (83.3%)	NA
Cognitive delay > 2 sd	NA	2 (16.7%)	NA
Child's education – no schooling	7 (21.9%)	3 (25.0%)	χ^2 (1) = 0.05
Child's education – preschool	25 (78.1%)	9 (75.0%)	p = 1.00
Language used – Cantonese	32 (100.0%)	12 (100.0%)	NA
Family type – nuclear	18 (56.3%)	9 (75.0%)	χ^2 (1) = 1.29,
Family type – others	14 (43.8%)	3 (25.0%)	p = 0.315
Marital relationship – married	29 (90.6%)	10 (83.3%)	χ^2 (1) = 0.46,
Marital relationship – single/separated/divorced/widowed	3 (9.4%)	2 (16.7%)	p = 0.603
Mother's education – ≤ 9 years	7 (21.9%)	5 (45.5%)	χ^2 (1) = 2.26,
Mother's education – > 9 years	25 (78.1%)	6 (54.5%)	p = 0.241
Father's education – ≤ 9 years	5 (15.6%)	3 (30.0%)	χ^2 (1) = 1.02,
Father's education – > 9 years	27 (84.4%)	7 (70.0%)	p = 0.369
Family income – ≤ HK$19,999	7 (21.9%)	6 (54.5%)	χ^2 (1) = 4.14,
Family income – ≥ HK$20,000	25 (78.1%)	5(45.5%)	p = 0.061
Child's age (months)	37.22 (0.90)	37.68 (0.96)	t (42) = 1.47,
Child's length of residence in Hong Kong (months)	36.87 (0.87)	33.13 (12.21)	p = 0.149
			t (29) = 1.51,
			p = 0.142
Mother's length of residence in Hong Kong (years)	23.96 (14.31)	22.80 (16.32)	t (36) = 0.21,
			p = 0.832
Father's length of residence in Hong Kong (years)	38.89 (9.26)	39.22 (14.44)	t (34) = 0.08,
			p = 0.936
Number of siblings	1.74 (0.68)	2.36 (1.03)	t (40) = 2.26, p = 0.029
39 – 41 months	(n = 34)	(n = 15)	
Sex of child – boy	16 (47.1%)	9 (60.0%)	χ^2 (1) = 0.70,
Sex of child – girl	18 (52.9%)	6 (40.0%)	p = 0.404
Cognitive delay between 1 to 2 sd	NA	9 (60.0%)	NA
Cognitive delay > 2 sd	NA	6 (40.0%)	NA
Child's education – no schooling	7 (20.6%)	2 (13.3%)	χ^2 (1) = 0.37,
Child's education – preschool	27 (79.4%)	13 (86.7%)	p = 0.702
Language used – Cantonese	32 (94.1%)	14 (93.3%)	χ^2 (2) = 3.15,
Language used – Mandarin	2 (5.9%)	0 (0.0%)	p = 0.207
Language used – English	0 (0.0%)	1 (6.7%)	
Family type – nuclear	24 (70.6%)	10 (66.7%)	χ^2 (1) = 0.075,
Family type – others	10 (29.4%)	5 (33.3%)	p = 1.00
Marital relationship – married	32 (94.1%)	12 (80.0%)	χ^2 (1) = 2.26,
Marital relationship – single/separated/divorced/widowed	2 (5.9%)	3 (20.0%)	p = 0.160
Mother's education – ≤ 9 years	3 (8.8%)	5 (33.3%)	χ^2 (1) = 4.58,
Mother's education – > 9 years	31 (91.2%)	10 (66.7%)	p = 0.047
Father's education – ≤ 9 years	2 (5.9%)	4 (26.7%)	χ^2 (1) = 4.18,
Father's education – > 9 years	32 (94.1%)	11 (73.3%)	p = 0.062
Family income – ≤ HK$19,999	4 (11.8%)	6 (42.9%)	χ^2 (1) = 5.81,
Family income – ≥ HK$20,000	30 (88.2%)	8 (57.1%)	p = 0.045

(*Continued*)

Table 5. (Continued).

	MCHC sample	CAS sample	Significance
Child's age (months)	40.65 (0.79)	40.58 (0.88)	t (47) = 0.30, p = 0.769
Child's length of residence in Hong Kong (months)	39.26 (5.07)	36.73 (11.56)	t (40) = 0.99, p = 0.327
Mother's length of residence in Hong Kong (years)	29.23 (12.10)	21.51 (15.99)	t (43) = 1.79, p = 0.081
Father's length of residence in Hong Kong (years)	35.61(11.78)	35.31 (12.43)	t (42) = 0.08, p = 0.939
Number of siblings	1.76 (0.75)	1.40 (0.51)	t (46) = 1.67, p = 0.101

is a promising instrument for assessing the cognitive development of toddlers. Though it is originally developed for Chinese toddlers in Hong Kong, it is potentially useful for other Chinese-speaking toddlers in other countries and may also be a useful reference tool for the assessment of toddlers from other ethnic backgrounds.

Funding

This study was funded by the Department of Health, Hong Kong SAR Government.

ORCID

Tamis Pin http://orcid.org/0000-0002-1572-4111
Andrew Siu http://orcid.org/0000-0002-8117-2829

References

1. Green E, Stroud L, Bloomfield S, Cronje J, Foxcroft C, Hurter K, Lane H, Marais R, Marx C, McAlinden P, et al. Griffiths scale of child development. 3rd ed. Oxford (UK): Hogrefe; 2016.
2. Roid GH, Sampers JL. Merrill-palmer–R scales of development. Wood Dale (IL): Stoelting Co; 2004.
3. Bayley N. Bayley scales of infant and toddler development. 3rd ed. San Antonio (TX): Pearson Education, Inc; 2006.
4. Roid GH. Stanford binet intelligence scale. 5th ed. Itasca (IL): Riverside Publishing; 2003.
5. Tso WWY, Wong VCN, Xia X, Faragher B, Li M, Xu X, Ao L, Zhang X, Jiao FY, Du K, et al. The Griffiths development scales-Chinese (GDS-C): a cross-cultural comparison of developmental trajectories between Chinese and British children. Child Care Health Dev. 2018;44:378–83. doi:10.1111/cch.12548.
6. He W, EW W. Item equivalence in English and Chinese translation of a cognitive development test for preschoolers. Int J Test. 2010;10 (1): 80–94. https://doi.org/10.1080/15305050903534738
7. Williams ME, Sando L, Soles TG. Cognitive Tests in Early Childhood J Psychoeduc Asses. 2014;32(5):455–76. doi:10.1177/0734282913517526.
8. Department of Health. Hong Kong comprehensive assessment scales for children. Hong Kong: Child Assessment Service, Department of Health; 2014.
9. Sattler JM. Assessment of children: cognitive foundations. 5th ed. San Diego, USA: Jerome M. Sattler, Publisher, Inc; 2008.
10. Wadsworth BJ. Piaget's theory of cognitive and affective development: foundations of constructivism. White Plains (NY): Longman; 1996.
11. McGrew K. The Cattell-Horn-Carroll theory of theory of cognitive abilities: past, present and future. In: Flanagan DP, Harrison PL, editors. Contemporary intellectual assessment: theories, tests and issues. New York (NY): The Guildford Press; 2005. p. 136–81.
12. Alfonso VC, Flanagan DP, Radwan S. The impact of the Cattell–Horn–Carroll theory on test development and interpretation of cognitive and academic abilities. In: Flanagan DP, Harrison PL, editors. Contemporary intellectual assessment: theories, tests and issues. New York (NY): The Guildford Press; 2005. p. 185–202.
13. Chen HY, Keith TZ, Chen YH, Chang BS. What does the WISC-IV measure? Validation of the scoring and CHC-based interpretative approaches. J Res Edu Sci. 2009;54:85–108.
14. Bond T, Fox CM. Applying the Rasch model: fundamental measurement in the human sciences. 2nd ed. Mahwah (NJ): Lawrence Erlbaum Associates; 2007.
15. Census and Statistics Department. Population and household statistics analysed by district council district 2017. Hong Kong: Census and Statistics Department; 2018.
16. Chen WH, Lenderking W, Jin Y, Wyrwich KW, Gelhorn H, Revicki DA. Is Rasch model analysis applicable in small sample size pilot studies for assessing item characteristics? An example using PROMIS pain behavior item bank data. Qual Life Res. 2014;23(2):485–93. http://www.jstor.com/stable/24726548.
17. Census and Statistics Department. Population by-census: summary results. Hong Kong: Census and Statistics Department; 2017; 2016.
18. McCreary LL, Conrad KM, Conrad KJ, Scott CK, Funk RR, Dennis ML. Using the Rasch measurement model in psychometric analysis of the family effectiveness measure. Nurs Res. 2013;62 (3):149–59. doi:10.1097/NNR.0b013e31828eafe6.
19. Planinic M, Boone WJ, Susac A, Ivanjek L. Rasch analysis in physics education research: why measurement matters. Phys Rev Phys Educ Res. 2019;15(14):020111. doi:10.1103/PhysRevPhysEducRes.15.020111.
20. Huaa J, Lia Y, Yeb K, Mab Y, Lina S, Gub G, Du W. The reliability and validity of Bayley-III cognitive scale in China's male and female children. Early Hum Dev. 2019;129:71–78. doi:10.1016/j.earlhumdev.2019.01.017.
21. Woudstra AJ, Meppelink CS, Pander Maat H, Oosterhaven J, Fransen MP, Dima AL. Validation of the short assessment of health literacy (SAHL-D) and short-form development: Rasch analysis. BMC Med Res Methodol. 2019;19:122. doi:10.1186/s12874-019-0762-4.