TPM®

JOINT FACTOR STRUCTURE OF THE WISC-III AND K-ABC FOR JAPANESE MALTREATED CHILDREN: A PRELIMINARY INVESTIGATION

KOHSKE OGATA
OSAKA PREFECTURAL GOVERNMENT KISHIWADA CHILD-FAMILY CENTER

Joint factors in intelligence measure batteries, including the Wechsler Intelligence Scale for Children (WISC)-Revised and Kaufman Assessment Battery for Children (K-ABC), have been analyzed in previous research. In order to elaborate and expand the Cattell-Horn-Carroll (CHC) theory, it is important to confirm the factor structures of intelligence using diverse racial and clinical populations. The present study examined the factor structures of the WISC-III and K-ABC in 105 maltreated Japanese children (41 girls and 64 boys, aged 6 to 12 years). Confirmatory factor analysis revealed the theory-driven, seven-factor model for all 23 subtests. The seven factors and almost all paths could be interpreted theoretically as Gf, Gc, Gv, Gsm, Gs, Gq, and Grw.[1] Results indicated that CHC theory could be applied to describe the structure of intelligence in maltreated Japanese children. The current findings contribute to the literature on CHC theory, by elaborating and expanding the theory to include more diverse populations.

Key words: WISC-III; K-ABC; Child maltreatment; Joint factor analysis; CHC theory.

Correspondence concerning this article should be addressed to Kohske Ogata, Osaka Prefectural Government Kishiwada Child-Family Center, 7-30 Miyamae-cho, Kishiwada City, Osaka, Japan. Email: koh-ske@sakai.zaq.ne.jp

Intelligence testing has been a focus of psychometrics since its inception. Psychometricians have studied the factor structure of intelligence using a variety of techniques. Joint factor analysis is a useful methodology that employs two or more cognitive measures simultaneously.

Joint factor analyses of the Wechsler Intelligence Scale for Children (WISC)-Revised and the Kaufman Assessment Battery for Children (K-ABC) (Kaufman & McLean, 1986, 1987; Keith & Novak, 1987; Kline, Guilmette, Snyder, & Castellanos, 1992; Meesters, van Gastel, Ghys, & Merckelbach, 1998) have extracted several factors. Kaufman and McLean (1986) studied 198 children who were referred for, or diagnosed with, learning disabilities. Their analyses indicated the emergence of a Reading Ability factor. Meesters et al. (1998) investigated correlations between WISC-R and K-ABC subtests in 101 children referred for learning disabilities. A considerable overlap between the two instruments was found; in addition, factor structures of both the WISC-R and the K-ABC were similar to those found for standardization samples. In general, theoretical models obtained using joint factor analyses have been replicated with clinical samples, especially in children with learning disabilities.

In recent years, maltreated children, as well as those who have learning disabilities, have been increasingly reported to have a specific intellectual profile (Frankel, Boestch, & Harmon, 2000; Nolin & Ethier, 2007; Ogata, 2011, 2012). Several subtest scores and certain ranges of abilities have been identified as specific traits of maltreated children in this research. Frankel et

al. (2000) examined subtest profiles on the Wechsler Preschool and Primary Scale of Intelligence-Revised for maltreated preschoolers. They reported higher scores on Picture Completion compared with the mean of all subtests. Ogata (2011, 2012) replicated the finding of Frankel et al. for maltreated Japanese children using the WISC-III. Nolin and Ethier (2007) reported that neglected children scored higher on problem-solving, abstraction, and planning abilities than a non-neglected comparison group. Other studies have shown a relationship between maltreatment of children and learning difficulties (Frisch & Rhoads, 1982; Sullivan & Knutson, 2000), including an unbalanced profile of cognitive abilities. These findings indicate the need to investigate the structure of intelligence in maltreated children.

The cross-battery assessment based on the Cattell-Horn-Caroll (CHC) theory has been widely available around the world to evaluate the cognitive strengths and weaknesses of clinically referred children, especially those with specific learning difficulties (Flanagan, Ortiz, & Alfonso, 2013). However, the CHC theory is based on multiple factor-analytical studies. Therefore, it is necessary to confirm the factor structures of the CHC before applying the theory to diverse racial and clinical populations, different from Western populations. The purpose of the current study was to examine the intelligence structure of maltreated Japanese children, in order to expand the literature on the CHC theory, and to facilitate expanded application of the theory to more diverse populations.

METHOD

In Japan, Child Guidance Centers are public institutions staffed by experts which have the social responsibility of responding to reports of child abuse and neglect, similar to Child Protective Services in the USA. This study analyzed data from intelligence tests administered to maltreated children who were reported to, and protected by, Child Guidance Centers. Informed consent was obtained from parents and/or children themselves before they were tested. Data were obtained from 2007 to 2010 fiscal years in the Osaka prefecture, a region of Japan that has eight Child Guidance Centers serving approximately nine million people. During the data-collection process, some reported cases of child abuse and/or neglect were excluded from the final samples because they were not substantiated as child maltreatment after investigation by Child Guidance Centers.

Participants

Participants included in the final sample were 105 maltreated children aged 6 to 12 years (41 girls and 64 boys). The mean age in months was 115.9 (SD = 24.8 months). Almost all participants were elementary school students. The types of child maltreatment officially recorded by the Child Guidance Center were physical abuse, sexual abuse, psychological abuse, and neglect. All cognitive measures were obtained after the children had been placed under temporary protection from the alleged maltreatment. The psychological testing was therefore administered in child welfare institutions; all children were tested individually.

Measures

The batteries used to measure cognitive functioning in the present study have adequate psychometric properties. The WISC-III Japanese version (Wechsler, 1991/1998) was standardized for 1,125 Japanese children aged from 5 years and 0 months to 16 years and 11 months. For subtests, test-retest reliability coefficients ranged from .89 to .54, and split-half reliability coefficients ranged from .87 to .64. In these analyses, scaled scores of all subtests were used. The K-ABC Japanese version (Kaufman & Kaufman, 1983/1993) was standardized for 1,680 Japanese children aged 2 years and 6 months to 12 years and 11 months. On subtests, test-retest reliability coefficients ranged from .97 to .78, and split-half reliability coefficients ranged from .96 to .62. In these analyses, scaled scores of all subtests were used.

RESULTS AND DISCUSSION

Descriptive statistics were first examined. Mean IQ was 90.2 (*SD* = 15.0) on the Mental Processing Composite scale of the K-ABC and 83.6 (*SD* = 16.1) for full-scale IQ on the WISC-III. The participants' level of psychometric intelligence was from average to low average, reflecting partial to borderline intellectual functioning.

Next, bivariate analyses were calculated. Correlation coefficients among all subtests and observed means and standard deviations for scaled scores are shown in Table 1.

Finally, on the basis of the CHC theory, confirmatory joint factor analyses for K-ABC and WISC-III data were performed using structural equation modeling. A seven-factor model was set a priori. In addition, paths were drawn and/or removed repeatedly until the goodness-of-fit indices reached an acceptable level, CFI > .90; RMSEA < .08 (Hoe, 2008). Figure 1 shows the final path diagram of the hierarchical intelligence structure.

Figure 1 indicates that hierarchical seven-factor models were fit for all subtests on the K-ABC and WISC-III. In previous research (Kaufman & McLean, 1986, 1987; Keith & Novak, 1987; Kline et al., 1992; Meesters et al., 1998), the WISC-R was used to analyze joint factor structures. There is a difference between the WISC-R and WISC-III in terms of factor model, because the WISC-R has three factors comprising 10 subtests while the WISC-III has four factors comprising 12 subtests. Furthermore, the present results may differ from prior findings in that the current model adopted the CHC framework to analyze the structure of intelligence.

This analysis indicated that three of 23 subtests had two paths from broad ability factors, including Symbol Search in WISC-III, Spatial Memory, and Hand Movement in K-ABC. All the remaining subtests loaded to each single factor. Moreover, only two correlations were permitted in this model. These results indicated a relatively simple structure in accordance with the CHC framework.

Gf, Gc, Gq, and Grw were readily interpretable by the CHC framework, whereas Gs, Gv, and Gsm[1] did not have a simple interpretation. Block Design, Object Assembly, Picture Completion, Spatial Memory, Symbol Search, Hand Movement, and Gestalt Closure loaded on to Gv. Symbol Search test was originally a measure of Gs in the WISC-III. However, the loading on the Gv was interpretable because the subtest was a visual task. In addition, Hand Movement was originally a measure of Gsm in the K-ABC and was interpretable because the subtest needs visual

TPM Vol. 22, No. 4, December 2015
477-483

TABLE 1
Correlations and descriptive statistics

Subtest	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	*M*	*SD*
K-ABC																								
1:Hand Movements																							8.6	3.5
2:Gestalt Closure	.21																						9.4	3.0
3:Number Recall	.62	.23																					8.4	3.3
4:Triangles	.47	.30	.42																				7.9	3.0
5:Word Order	.50	.10	.60	.47																			8.7	2.8
6:Matrix Analogies	.51	.16	.45	.52	.58																		7.9	2.8
7:Spatial Memory	.58	.34	.42	.44	.42	.49																	8.7	3.1
8:Arithmetic-K	.57	.11	.53	.47	.53	.58	.45																85.4	16.3
9:Riddles	.56	.38	.46	.45	.49	.58	.48	.65															91.1	17.1
10:Reading/Decoding	.42	.17	.50	.49	.45	.36	.27	.57	.43														91.7	19.7
11:Reading/Understanding	.50	.28	.49	.39	.42	.44	.37	.61	.56	.67													89.7	14.9
WISC-III																								
12:Picture Completion	.35	.41	.24	.33	.16	.29	.32	.17	.32	.16	.20												7.7	2.7
13:Information	.44	.29	.51	.54	.41	.49	.40	.65	.70	.54	.51	.32											7.6	2.9
14:Coding	.53	.19	.36	.37	.33	.31	.45	.38	.36	.33	.31	.28	.31										8.5	3.2
15:Similarities	.45	.44	.41	.47	.31	.41	.38	.47	.61	.48	.53	.36	.56	.27									7.4	3.4
16:Picture Arrangement	.43	.36	.39	.38	.36	.38	.45	.47	.59	.29	.44	.40	.42	.44	.40								7.7	3.2
17:Arithmetic-W	.47	.23	.46	.50	.46	.58	.43	.71	.62	.45	.53	.31	.66	.32	.49	.41							7.8	3.7
18:Block Design	.45	.45	.44	.66	.44	.53	.54	.42	.47	.37	.50	.51	.50	.38	.52	.51	.47						8.0	3.1
19:Vocabulary	.36	.35	.37	.34	.30	.32	.37	.58	.59	.44	.55	.27	.54	.30	.58	.41	.64	.38					7.6	3.0
20:Object Assembly	.36	.31	.37	.54	.33	.36	.36	.34	.41	.19	.36	.38	.39	.25	.40	.53	.33	.63	.28				7.2	3.4
21:Comprehension	.39	.38	.38	.24	.23	.24	.39	.48	.52	.28	.48	.21	.42	.35	.42	.48	.45	.32	.58	.32			8.1	3.0
22:Symbol Search	.60	.27	.42	.42	.35	.40	.68	.40	.37	.29	.34	.39	.35	.63	.40	.40	.39	.55	.38	.32	.30		8.2	3.4
23:Digit Span	.59	.10	.63	.48	.59	.52	.31	.59	.46	.58	.43	.23	.51	.40	.38	.36	.52	.40	.36	.29	.37	.45	8.2	2.8

Note. Arithmetic-K represents the subtest of Arithmetic in K-ABC, Arithmetic-W represents the subtest of Arithmetic in WISC-III. Arithmetic-K, Riddles, Reading/Decoding, and Reading/Understanding have $M = 100$ and $SD = 15$; the remainder has $M = 10$ and $SD = 3$.

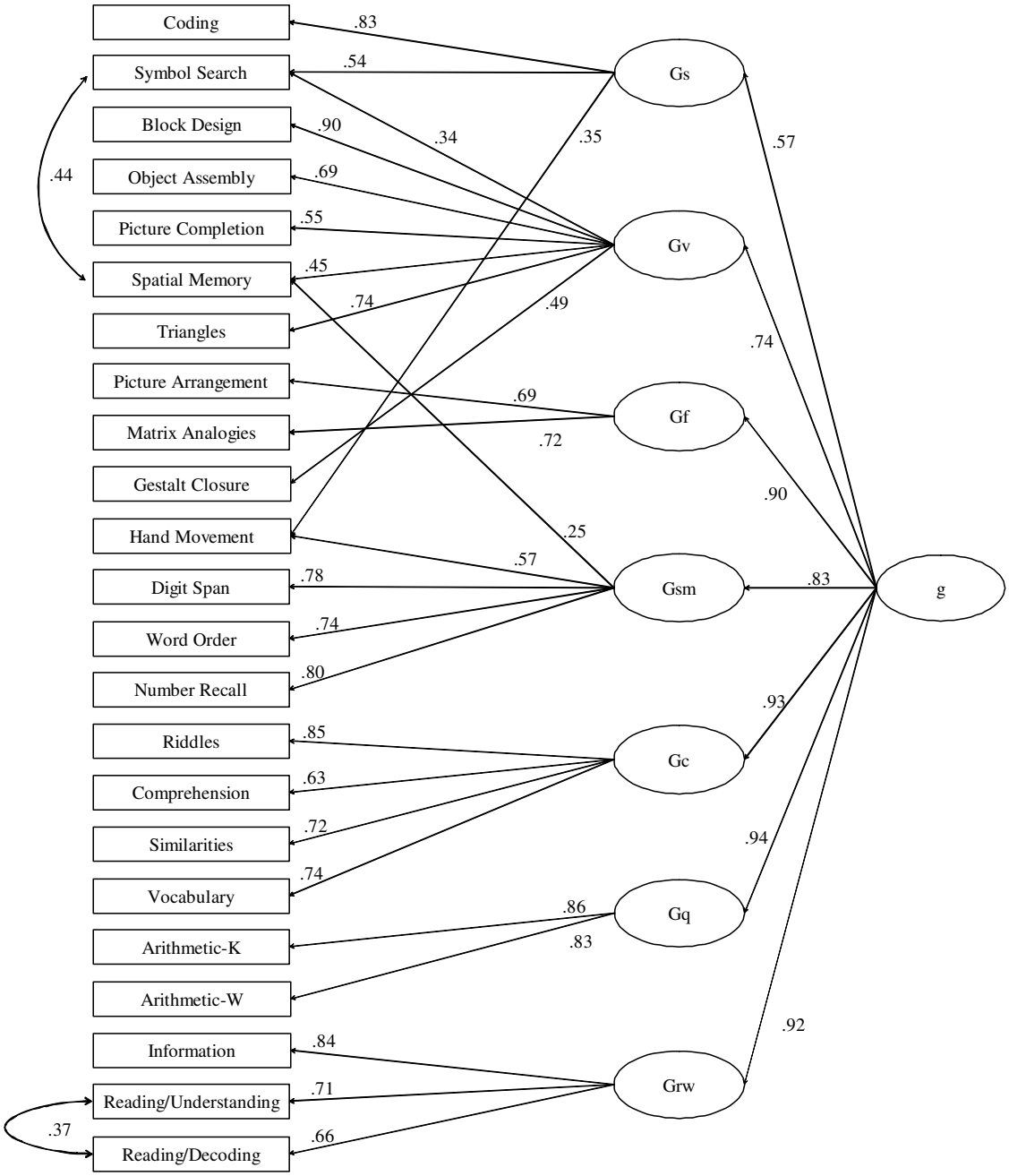

FIGURE 1
Intelligence structure of maltreated children using K-ABC and WISC-III:
Path coefficients were all significant ($p < .05$) and all were standardized scores.
Comparative fit index = .913; root mean square error of approximation = .071.
Arithmetic-K represents the subtest of Arithmetic in K-ABC, Arithmetic-W represents the subtest of Arithmetic in WISC-III.
For the meaning of Gs, Gv, Gf, Gsm, Gc, Gq, Grw, see Note 1.

processing to complete. Gestalt Closure test was originally a measure of simultaneous processing in the K-ABC and was not incorporated into the CHC framework. However, this subtest can be

naturally associated with visual processing. Reynolds, Keith, Fine, Fisher, and Low (2007) examined the factor structure of KABC-II and indicated that the Gestalt Closure and Hand Movement subtests were not simple loading onto a single broad ability. In particular, their analysis indicated the loading of the Gestalt Closure test on Gv and Gc factors; therefore the present result regarding the Gv factor could be interpretable through the CHC theory. Hand Movement, Digit Span, Word Order, Number Recall, and Spatial Memory loaded onto Gsm, and four subtests with the exception of Spatial Memory were theoretically interpretable. Spatial Memory is a visual memory task related to short-term memory and visual processing, in particular visual scanning. Thus, it is not difficult to interpret the path from Gv to Spatial Memory. However, it is difficult to interpret the results of Gs factor.

Coding, Symbol Search, and Hand Movement loaded onto Gs. Both Coding and Symbol Search theoretically loaded onto Gs, but K-ABC does not have a Gs factor in the original model. Hand Movement may not theoretically relate to Gs, because time was not measured in the test administration; thus the relations between Hand Movement and Gs factor were the most difficult to interpret through the CHC theory. Reynolds et al. (2007) indicated that Hand Movement loaded on Gsm and Gf, but not on Gs. There might be a common factor related to visuomotor coordination in Coding, Symbol Search, and Hand Movement. It might be possible to explain the present observation that associates the Gs factor with Hand Movement, from the perspective of the visuomotor coordination. The finding suggests that maltreated children might use multiple abilities to perform the Hand Movement test, similar to processing speed task. DePrince, Weinzierl, and Combs (2009) examined the executive functioning of maltreated children and demonstrated a principal component comprised of working memory and processing speed, loading above .60, suggesting the similarity between the two tasks for children with histories of abuse and neglect. It is suggested that further studies are needed to investigate the relations between child maltreatment and cognitive abilities using factor-analytical studies.

The present study has several limitations. The principal weakness, again attributable to the preliminary nature of the investigation, is the small sample size. A larger sample size is required to examine whether or not maltreatment of children has strong effects on their intelligence structure, and, if so, to what extent it influences and alters this structure. Because revised editions of the WISC and K-ABC are now available in Japan, joint factor analyses using the WISC-IV (since 2010) and KABC-II (since 2013) would contribute to the body of literature on intelligence and psychometrics.

The results of this study suggest that the structure of intelligence in maltreated Japanese children might be nearly consistent with the model derived from the CHC theory, although there remains a partial difficulty in explaining the path from Gs to Hand Movement. It is concluded that the findings of this study contribute to the CHC literature and elaborate and expand the applicability of the CHC model for populations consisting of maltreated Japanese children.

NOTE

1. Gf = fluid reasoning; Gc = crystalized intelligence; Gv = visual processing; Gsm = short-term memory; Gs = processing speed; Gq = quantitative knowledge; Grw = reading and writing.

REFERENCES

DePrince, A. P., Weinzierl, K. M., & Combs, M. D. (2009). Executive function performance and trauma exposure in a community sample of children. *Child Abuse & Neglect*, *33*, 353-361. doi:10.1016/j.chiabu.2008.08.002

Flanagan, D. P., Ortiz, S. O., & Alfonso, V. C. (2013). *Essentials of cross-battery assessment* (3rd ed.). Hoboken, NJ: John Wiley & Sons.

Frankel, K. A., Boestch, E., & Harmon, R. J. (2000). Elevated picture-completion scores: A possible indicator of hypervigilance in maltreated preschoolers. *Child Abuse & Neglect*, *24*, 63-70. doi:10.1016/S0145-2134(99)00110-6

Frisch, L. E., & Rhoads, F. A. (1982). Child abuse and neglect in children referred for learning evaluation. *Journal of Learning Disabilities*, *15*, 583-586.

Hoe, S. L. (2008). Issues and procedures in adopting structural equation modeling technique. *Journal of Applied Quantitative Methods*, *3*, 76-83.

Kaufman, A. S., & Kaufman, N. L. (1993). *Interpretive manual for the Kaufman Assessment Battery for Children* (T. Matsubara, K. Fujita, H. Maekawa, & T. Ishikuma, Trans.). Circle Pines, MN: American Guidance Service. (Original work published 1983).

Kaufman, A. S., & McLean, J. E. (1986). K-ABC/WISC-R factor analysis for a learning disabled population. *Journal of Learning Disabilities*, *19*, 145-153. doi:10.1177/002221948601900303

Kaufman, A. S., & McLean, J. E. (1987). Joint factor analysis of the K-ABC and WISC-R with normal children. *Journal of School Psychology*, *25*, 105-118. doi:10.1016/0022-4405(87)90020-3

Keith, T. Z., & Novak, C. G. (1987). Joint factor structure of the WISC-R and K-ABC for referred school children. *Journal of Psychoeducational Assessment*, *5*, 370-386. doi:10.1177/073428298700500407

Kline, R. B., Guilmette, S., Snyder, J., & Castellanos, M. (1992). Relative cognitive complexity of the Kaufman Assessment Battery for Children (K-ABC) and the WISC-R. *Journal of Psychoeducational Assessment*, *10*, 141-152. doi:10.1177/073428299201000207

Meesters, C., van Gastel, N., Ghys, A., & Merckelbach, H. (1998). Factor analyses of WISC-R and K-ABC in a Dutch sample of children referred for learning disabilities. *Journal of Clinical Psychology*, *54*, 1053-1061. doi:10.1002/(SICI)1097-4679(199812)54:8<1053::AID-JCLP5>3.0.CO;2-4

Nolin, P., & Ethier, L. (2007). Using neuropsychological profiles to classify neglected children with or without physical abuse. *Child Abuse & Neglect*, *31*, 631-643. doi:10.1016/j.chiabu.2006.12.009

Ogata, K. (2011). Intellectual profile of sexually abused children in Japan: An analysis of WISC-III subtests compared with physically abused, neglected, and non-maltreated children. *Psychology (Psych)*, *2*, 169-172. doi:10.4236/psych.2011.23027

Ogata, K. (2012). Relationships among child maltreatment, picture completion test, and posttraumatic symptoms: Two examinations using WISC-III for Japanese children. *Psychology (Psych)*, *3*, 601-605. doi:10.4236/psych.2012.38090

Reynolds, M. R., Keith, T. Z., Fine, J. G., Fisher, M. E., & Low, J. A. (2007). Confirmatory factor structure of the Kaufman Assessment Battery for Children: Consistency with Cattell-Horn-Carroll theory. *School Psychology Quarterly*, *22*, 511-539. doi:10.1037/1045-3830.22.4.511

Sullivan, P. M., & Knutson, J. F. (2000). Maltreatment and disabilities: A population-based epidemiological study. *Child Abuse & Neglect*, *24*, 1257-1273. doi:10.1016/S0145-2134(00)00190-3

Wechsler, D. (1998). *Manual for the Wechsler Intelligence Scale for Children* (3rd ed.) (H. Azuma, K. Ueno, K. Fujita, H. Maekawa, T. Ishikuma, & H. Sano, Trans.). New York, NY: The Psychological Corporation. (Original work published 1991).