

Recent Development of Cognitive and Neuropsychological Assessment in Asian Countries

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There is a growing trend of research in neuropsychological assessment in Asia: The mean number of published studies increased from 1.8 in the 1980s to 16.0 in 2 recent years. About 40% of the studies reviewed concerned test development or adaptation, with the latter greatly outnumbering the former. To facilitate the test selection for clinical use, 36 clinical measures were evaluated based on some statistical criteria. The results showed that only 8 neuropsychological tests (5 Chinese, 2 Korean, and 1 Japanese) met the criteria. Given that Asian and Western populations differ on certain cognitive processes, future development of neuropsychological assessment measures in Asia should move from the adaptation of Western tests toward the construction of original tests with better ecological validity.

Human cognition, according to Neisser (1967), is composed of processes in which a sensory input is transformed, reduced, elaborated, stored, recovered, and used. Although interest in individual differences in cognitive processes can be traced back to philosophers of ancient cultures, the systematic development of psychological tests to assess these processes only began in the early 20th century (Gardner, 1999). Despite its short history, the assessment of cognitive processes is an integral component of psychologists' training and is considered an important service that they can offer to the community (Anastasi & Urbina, 1997).

Binet and Simon (1905) are generally regarded as the developers of the first psychological test of cognitive processes. The success of the Binet–Simon scale in distinguishing mentally retarded children from those with behavioral problems began the testing movement in the West and led to the development of other tests of intelligence (e.g., the Wechsler Adult Intelligence Scale, the Stanford–Binet, Raven's Progressive Matrices). Interest in, and development of, other tests of cognitive processes have been given further impetus in recent years by one of the most rapidly developing areas in psychology, namely, neuropsychology. As a branch of neuropsychology, neuropsychological assessment involves the administration of psychological tests to evaluate the cognitive processes governed by different areas of the brain. Typically, tests are administered to individuals with brain injury (e.g., traumatic brain injury, dementia, cerebral vascular disorder, brain tumor) to

assess brain functions such as attention, perception, memory and learning, language, visuospatial functions, motor functions, intelligence, and executive functions (Lezak, 1995). The growth of neuropsychological assessment is reflected by the large number of neuropsychological tests published in recent years.

Information about the content and psychometric properties of published tests of cognitive processes can be readily found in a number of excellent sources: *Mental Measurements Yearbook* (e.g., Impara & Plake, 1998), *Tests in Print* (e.g., Murphy, Conoley, & Impara, 1994), *Test Critiques* (e.g., Keyser & Sweetland, 1994), *Neuropsychological Assessment* (Lezak, 1995), *A Compendium of Neuropsychological Tests* (Spren & Strauss, 1998). Most, if not all, of the tests included in these sources were developed and are used by psychologists who work in Western societies. There is a dearth of information in the literature on tests of cognitive processes developed and used by psychologists in parts of the world where English is not the principal language, such as many Asian societies. This situation is understandable given that the development of both academic and professional psychology in most Asian countries did not begin until the latter half of the 20th century, and that Asian psychological literature is not readily available to psychologists in the West.

The development of neuropsychological assessment in Asia basically followed the stages of direct translation, adaptation of Western instruments, and the construction of original assessment tools. In China, for instance, although ability testing in the form of civil service examinations dates back to the 7th century, it was only after the opening up of China in the 1980s that the assessment of cognitive processes began to flourish. With increased opportunities to communicate with Western scientific communities, Chinese scientists began to have greater recognition of the importance of neuroscience and its clinical applications, for example, the assessment of cognitive functions for the purposes of diagnosis and treatment.

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During the early stage of the development of neuropsychological assessment, tests were mainly translated and adapted from Western ones. As tests are translated or adapted for use in populations of other cultures, the issue of cross-cultural validity arises. Whereas cross-cultural validity is particularly relevant to verbal tests because of item translation, adaptation of nonverbal tests is generally considered to be easier and involves mainly a translation of the test instructions. Thus, adaptation of nonverbal test items to accommodate cultural differences is usually not carried out. However, the study by Tollman and Msengana (1990) illustrates that this assumption does not always apply. In their study, participants from another culture (*viz.*, Zulu) were found to have considerable difficulty with what seemed to be a relatively simple item (*viz.*, copying a circle inside a parallelogram) in a translated version of Luria's neuropsychological investigation; they were trying to use shaded patterns rather than lines for the task. Other examples include the effects of different language backgrounds on the performance of the Color Trails Test (CTT) and the Trail Making Test (TMT). Whereas CTT is designed as a culture-free analog of TMT (Maj et al., 1993), there were findings showing that performance on TMT-A and CTT-1 were highly correlated for English speakers but not for a group of Hong Kong Chinese (T. M. C. Lee, Cheung, Chan, & Chan, 2000). The authors suggested that the two trail-making tasks were generally fair across Chinese and English, but equivalence between them may be more language-specific. Thus, it appears that our early experience with language may exert subtle effects on the performance of even nonverbal tests. With new findings and greater recognition of the impact of cultural and language differences between the East and West on test performance, Asian scholars began to construct original and ecologically valid assessment tools, and to establish demographically appropriate norms.

Beginning in the latter half of the 20th century, there has been an influx of Asian immigrants to Western countries, and this trend seems to be continuing in the 21st century. Given that psychologists in Western countries are now likely to encounter clients who were born and brought up in Asian cultures, it is important for them to be aware of how cognitive processes are assessed in Asian countries, and what testing instruments are available and suitable for assessing the cognitive strengths and weaknesses of these clients. Moreover, as Asians comprise the majority of the world's population, the valid assessment of Asians is an important topic in psychology.

In this article, we reviewed tests of cognitive processes developed and used by psychologists in a number of Asian regions (*viz.*, China, Hong Kong, India, Japan, Korea, Malaysia, Singapore, Taiwan, Thailand, and the Philippines). We based the review on a search of empirical studies and communication with psychologists who work in these areas. Specifically, we aimed to identify the tests that are used in these Asian regions, whether these tests are translated or adapted from instruments developed in the West, whether local norms have been collected for these tests, and whether the cross-cultural validity of these tests has been evaluated. Through this review, we hoped to come up with some practical information regarding the clinical utility of these tests for psychologists who have the opportunity to conduct neuropsychological assessments with clients who were born and brought up in Asia.

Method

Literature Review

To identify studies that described cognitive and neuropsychological assessment instruments in Asia, we conducted a literature search using the PsycINFO database (from 1887 to March 2002). The key words we used, to be found anywhere in the articles, were Asia* or Hong Kong or China or Chinese or Taiwan or Taiwanese or Korea* or Japan* or Phillipin* or Singapor* or Malaysi* or India or Indian or Indonesi* or Thai* or Burm*, and cognitive assessment or neuropsychological assessment. We selected the terms *cognitive assessment* and *neuropsychological assessment* based on the thesaurus function in PsycINFO. Compared with the term *psychological assessment*, these two terms were more specific, and a search based on these terms should avoid producing an excessive number of hits that are not directly relevant. At the same time, these two terms were comprehensive enough to encompass specific terms such as *tests* and *testing*.

Initially, 213 hits were obtained from the search and we reviewed each of the records and selected for further review those studies that satisfied the following criteria:

1. Studies conducted on participants born and brought up in one or more of the Asian regions specified;
2. Empirical studies (group or case);
3. Studies with adults or children as participants;
4. Studies that reported on the development or adaptation of cognitive or neuropsychological assessment techniques; and
5. Studies that applied cognitive or neuropsychological assessment techniques in research.

A total of 123 studies fulfilled these criteria and are included here in the discussion of cognitive and neuropsychological assessment in Asia.

Test Evaluation

To identify a set of clinically useful neuropsychological tests, we conducted a second screening according to the procedure and criteria listed in the following. Studies included in this screening came from two sources. One source was studies found from the literature review that reported on test development, adaptation or validation. However, some studies were not available for review, including those that were published in the native language of the authors' countries. Another source was through direct communication with psychologists or researchers in the area of neuropsychological assessment. Letters were sent to the psychology departments of major universities in the various Asian regions to inquire about the current practice of neuropsychological assessment in those areas, such as tests commonly used in their regions, whether they were developed or adapted, and whether there were local norms. However, we received only one response that provided information on tests that were used in China and Hong Kong. Altogether, about 40 studies involving 36 neuropsychological assessment instruments were reviewed. The following criteria were used for classifying whether an instrument is clinically valid and useful.

Locally developed tests.

1. Proper procedure had been reported for test development.
2. Tests on validity had been conducted (*e.g.*, convergent or discriminant validity).
3. Normative data were available with a sample size greater than 50.

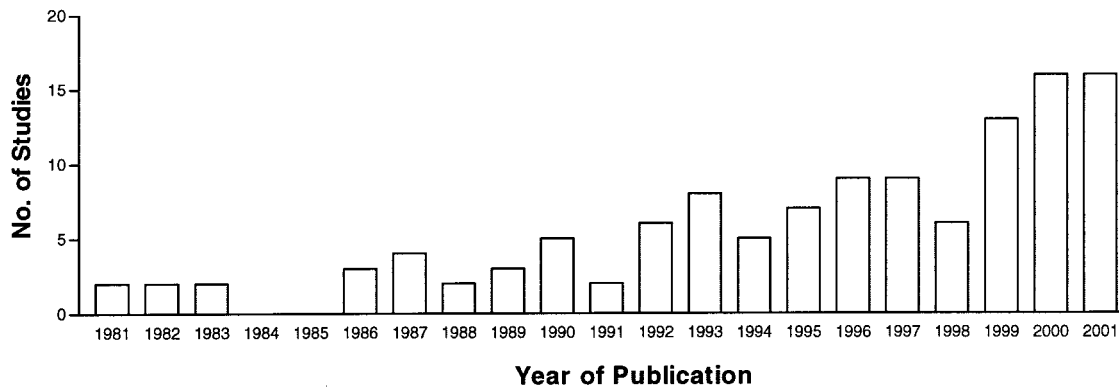


Figure 1. Number of studies reviewed by their year of publication.

Adapted tests. Criteria 1, 2, and 3 above and

4. Translation and cross-checking of translation (e.g., back translation) had been carried out (for verbal tests).
5. Cross-cultural comparison (by empirical studies or by comparing local findings with Western findings) had been conducted to demonstrate the applicability of the test in the local population.

Results

Literature Review

Altogether, 123 studies from the literature search fulfilled our criteria for review. Figure 1 shows the frequencies of these studies according to their year of publication. The first study that fulfilled our criteria was published in 1981. This is later than expected given that the discipline of psychology was established much earlier in some of the Asian countries considered. For example, the national psychological associations in China and Japan were set up as early as 1921 and 1926 (Jing, 2000). This discrepancy could be due to the fact that for a long time, research studies conducted and published by psychologists in East Asia were not readily accessible to psychologists in the West.

It can be seen from Figure 1 that there was an upward trend in the number of studies published in the area of cognitive and neuropsychological assessment in Asia over the last 20 years. In the 1980s, the average number of articles published was fewer than 2.0 per year (1.8). In the 1990s, the average number increased to 7.0, and in 2000 and 2001, the number further increased to 16.0. The increase could be due to the inclusion of some Asian journals in PsycINFO in recent years. Examples of these journals include *Acta Psychologica Sinica*, *Chinese Mental Health Journal*, *Chinese Journal of Clinical Psychology*, *Indian Journal of Clinical Psychology*, *Japanese Journal of Psychology*, *Korean Journal of Clinical Psychology*, *Psychological Science China*, and *Seishin Igaku Clinical Psychiatry*. The increase could also be due to a rise in the number of articles published by Asian psychologists in Western and international journals such as *Advances in Biological Psychiatry*, *Aphasiology*, *Archives of Clinical Neuropsychology*, *Archives of Neurology*, *Behavioral Neurology*, *Brain*, *Brain Injury*, *Brain and Cognition*, *Clinical Gerontologist*, *Clinical Neuropsychologist*, *International Journal of Neuroscience*, *International Psychogeriatrics*, *Journal of Clinical and Experimental*

Neurology, *Neuropsychologia*, *Neuropsychology*, *Journal of the International Neuropsychological Society*, *Journal of Neurology*, *Neurosurgery and Psychiatry*, *Neuropsychology*, and *Schizophrenia Research*.

The studies reviewed were graphed according to geographical locations (see Figure 2).¹ Researchers from Japan, China, and India were the main contributors of these studies (about 75%), followed by researchers from Korea and Hong Kong, who contributed about 20% of the studies. Articles published by researchers from Singapore, Thailand, and Taiwan made up the remainder. The large number of studies published in China and Japan may be due to the comparatively longer history of psychology in these two countries, or to their relatively larger populations (1.2 billion in China and 125 million in Japan), resulting in more psychologists being active in research and test development.

A wide range of neuropsychological assessment instruments was used in the studies reviewed. Table 1 summarizes the tests used according to their geographical locations. Of the studies reviewed, most were group studies (90%) rather than case studies (10%), and most included adults (95%) rather than children (6%) as participants. In Figure 3, the studies reviewed are classified according to their purpose. About half of the studies aimed to use tests to assess cognitive and neuropsychological functions in various clinical conditions such as dementia, stroke, schizophrenia, and the like. For example, in one study from China (Xiao, Li, Chen, Li, & Liu, 2001), researchers compared the performances of a group of geriatric schizophrenic patients, a group of Alzheimer's disease patients, and a group of controls on a number of neuropsychological functions using the Chinese version of the Wechsler Memory Scale (WMS), the Wisconsin Card Sorting Test (WCST), and the Chinese Mini-Mental Status Examination. Although a wide range of clinical areas were examined in the studies reviewed, aging and dementia were the areas most frequently addressed (about 28% of the studies), possibly a reflection of the large size of the aging population in some Asian countries.

There were a small number of studies that aimed to use tests of cognitive and neuropsychological functions and psychophysiological

¹ If the study was conducted by researchers from more than one geographical location, the location was assigned according to the affiliation of the first author.

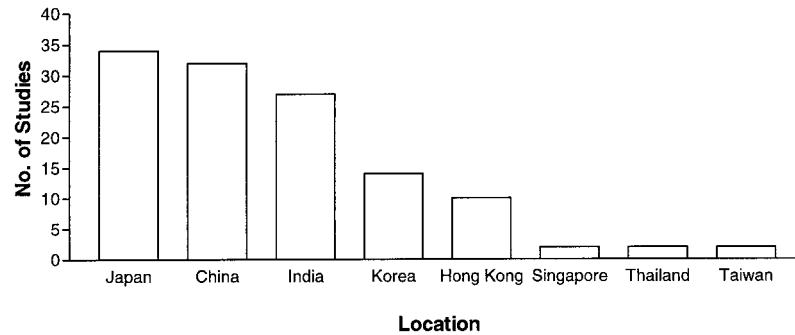


Figure 2. Number of studies reviewed by location.

ical/imaging techniques to clarify brain and behavior relationships. In one of these studies, Iijima, Osawa, Iwata, Miyazaki, and Tei (2000) examined individuals with Parkinson's disease without clinical signs of dementia to evaluate the relationship between the P300 component of event-related potential and prefrontal function as assessed by a modified WCST. It is important to point out that the validity of the findings obtained in this type of study is dependent on the establishment of the cross-cultural validity of the adapted tests.

About 37% of the studies reviewed aimed to evaluate the utility and psychometric properties of cognitive and neuropsychological tests adapted from tests originally developed in Western countries (mainly from the United States). For example, J. K. Kim and Kang (1999) collected norms for a Korean version of the California Verbal Learning Test and evaluated its validity; Chan and Poon (1999) adapted the Category Fluency Test for use in Hong Kong and found that the performance of their participants was similar to that reported in Western countries.

In contrast, a smaller number of studies aimed to develop an original test of cognitive or neuropsychological function. In one of these studies, Xu and Wu (1986) from China developed the Clinical Memory Test, a test with five subtests that included directed memory, paired-associate learning, free recall of pictures, recognition of meaningless figures, and recall of connection between portraits and their characteristics. Another example is the Hong Kong List Learning Test (HKLLT; Chan & Kwok, 1999), which was developed for the assessment of various memory processes. Currently, a group of researchers from Hong Kong and Shanghai are also collaborating to develop a multilingual neuropsychological screening battery.

The cognitive and neuropsychological assessment instruments described in the studies reviewed covered a wide range of functional areas. The greatest number of instruments was used for the screening of dementia, followed by tests of memory and learning, language, and executive functions. As discussed previously, the high demand for assessment tools for older adults is probably due to the large proportion of older adults in the populations of some Asian countries. It should be noted that, unlike their Western counterparts, older adults in Asia have generally received limited formal education. Hence, the dementia rating scales developed in the West may not be suitable for use in some Asian countries, prompting researchers to adapt Western scales for local use. Moreover, because of the large number of tests involving the assessment

of verbal functions, test adaptation or development is necessary due to the difference between English and the Asian languages.

Most of the tests described in the studies were paper-and-pencil tests, but a small number involved computerized testing. For example, in a study conducted in Korea, You, Lee, Jung, and Lee (1998) evaluated the utility of a set of computerized neuropsychological tests (viz., finger tapping, visual continuous, spatial memory, attention switching, and categories) in a group of patients with traumatic brain injury, a group of patients with no brain injury, and a group of normal controls. Given the rapid development in computer hardware and software, it is expected that more and more tests of cognitive and neuropsychological functions will be administered, scored, and interpreted using computers (Kane & Gray, 1997). Finally, it is interesting to note that one of the studies reviewed was in the area of forensic neuropsychological assessment. In that study, Liu, Gao, Li, and Sheng (2001) aimed to evaluate the Forced-Choice Digit Memory Test (Hiscock & Hiscock, 1989) in detecting the dissimulation of memory deficit. Given that the detection of malingering is another area of rapid development, and the development of the legal profession and insurance industry in Asian countries is burgeoning, it is expected that more tests of malingering will be adapted or developed in the near future. Indeed, a comprehensive test of malingering for the Chinese population is currently being developed in Hong Kong.

Test Evaluation

For the purpose of providing some practical information regarding the clinical applicability of the tests reviewed for psychologists working with Asian clients, we selected a set of clinically validated assessment instruments according to the criteria set out earlier. From a total of 36 instruments reviewed, including 30 adapted tests and 6 locally developed tests, only 8 met our criteria: 3 were locally developed and 5 were adapted from Western tests. Table 2 summarizes the information of these 8 clinically validated instruments. It can be seen from the table that these tests were constructed and used in four Asian regions: China, Hong Kong, Japan, and Korea. For Thailand, there were no studies on test development or adaptation included in this review. For India, Taiwan, and Singapore, a total of 2 developed and 5 adapted tests were reviewed, but none of them met all of the criteria.

With regard to the cognitive domains or functional areas covered by these eight instruments, four of them aimed at screening

Table 1
Summary of Tests Used in the Studies Reviewed According to Geographical Locations

Geographical location and test	Geographical location and test	Geographical location and test
China	Hong Kong	Japan continued
Alzheimer's Disease Assessment Scale (Chinese version)	Blessed-Roth Dementia Scale	Rey Auditory-Verbal Learning Test
Aphasia Test	Cantonese Aphasia Test Battery	Rey Figure
Auditory Verbal Memory Test	Category Fluency Test (Chinese version)	The Kana Test
Bender Visual Motor Gestalt Test	Chinese Anomalous Sentence Test	Unilateral Neglect Battery
Benton Line Orientation Test	Chinese version of Alzheimer's Disease Behavioral Pathology Rating Scale	Verbal Fluency Test
Blessed-Roth's Alzheimer's Disease Scale	Chinese version of Mattis Dementia Rating Scale	Verbal Repetition Test
Benton Visual Retention Test	Clock Drawing Test	WAIS
Chinese Neurobehavioral Evaluation 2	Color Trails Test	WAIS-R
Chinese Standard Aphasia Scale	Hong Kong List Learning Test	WCST
Chinese Version Expansive Scale of Dementia	Neuropsychiatric Inventory (Chinese version)	Wechsler Intelligence Scale for Children (WISC; Keio version)
Cognitive Abilities Screening Instrument 2.0	Olfactory Identification Test	WMS
Cognitive Abilities Screening Instrument (designed for cross-cultural studies)	Trail Making Test	Word Fluency Test
Computer Neurobehavioral Test System	India	Taiwan
Digit Symbol	All India Institute of Medical Sciences Comprehensive Neuropsychological Battery in Hindi (Adult Form)	MMSE
Finger Tapping Test	Alzheimer's Disease Assessment Scale-Cognitive Battery for the Screening of Dementia	Neuropsychiatric Inventory Scale (Chinese version)
Grooved Pegboard	Bender Visual Motor Gestalt Test	Random Chinese Word Cancellation Test
Handed Test (handedness)	Expert System for the Diagnosis of Depression and Dementia	Singapore
Hiscock's Forced-Choice Digit Memory Test	MMSE	Early Cognitive Assessment Questionnaire
Halstead-Reitan Neuropsychological Test Battery Chinese revision	Raven's Standard Progressive Matrices	Geriatric Mental State Schedule
Language Ability Test	Selective Reminding Test	Kahn's Short Portable Mental Status Questionnaire
Luria-Nebraska Neuropsychological Battery	Token Test in Kannada	Thailand
Mini-Mental Status Examination (MMSE)	Trail Making Test	Color Trails Test
Chinese MMSE	Wechsler Adult Intelligence Scale (WAIS)	UCLA Auditory Verbal Learning Test
Revised Chinese edition of the HRNB for younger children	Wechsler Intelligence Scale for Children III	
Senile Cognitive Function Scale	WMS	
Sorting Test	Japan	
The Clinical Memory Test	Behavioral Assessment of Dysexecutive Syndrome and other measures of executive function	
Trail Making Test	Benton Visual Retention Test	
Verbal and Visuospatial Speed of Processing and Working Memory	Clock Drawing Test	
Visual Space Test	Coloured Progressive Matrices	
Wechsler Adult Intelligence Scale-Revised (WAIS-R)	Computer-based neurobehavioral evaluation system	
Wisconsin Card Sorting Test (WCST)	Dementia Rating Scale	
Western Aphasia Battery	K. Hasegawa's Dementia Scale	
Wechsler Memory Scale (WMS)	Letter Pick Out Test	
	Line Bisection Test	
	Line Cancellation Test	
	Marianne Frostig Developmental Test of Visual Perception MMSE	
	New Test of Hemisphericity	

for dementia. These included one locally developed test and three adapted tests. The locally developed test was the Unidimensional Scale for Dementia (Kashima et al., 2001) for use with older Japanese adults. The three adapted tests were the Chinese Mini-Mental Status Examination (CMMS; Katzman et al., 1988), the Chinese version of the Mattis Dementia Rating Scale (Chan, Choi, Chiu, & Lam, 2003; Chan, Poon, Choi, & Cheung, 2001), and the Korean Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet (CREAD-K; J. H. Lee et al., 2002). Three of the eight instruments assessed memory, which included the HKLLT (Chan & Kwok, 1999), the Clinical Memory Test (Xu &

Wu, 1986) developed in China, and a Korean version of the California Verbal Learning Test (K-CVLT; J. K. Kim & Kang, 1999). One test, the Category Fluency Test (Chan & Poon, 1999), covered the domain of executive functions.

Of the assessment instruments reviewed, 28 partially fulfilled the criteria we used. There was one adapted test (the Korean version of Mattis Dementia Rating Scale; Chey, 1988) that met all the criteria except that the verification of translation was not specified in the standardization study (Chey, Na, Park, Park, & Lee, 1999). Also, a number of adapted tests fulfilled all the criteria except that cross-cultural comparisons had not been conducted, for

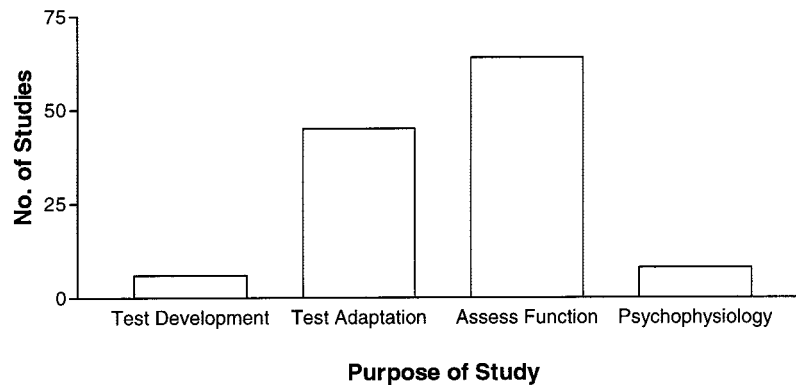


Figure 3. Number of studies reviewed by purpose.

example, a Chinese version of the Alzheimer's Disease Behavioral Pathology Rating Scale (Lam, Tang, Leung, & Chiu, 2001), the Chinese Revision of the Halstead-Reitan Neuropsychological Test Battery for Adults (Gong, 1986), and the Korean version of the Boston Naming Test (K-BNT; H. Kim & Na, 1999). Given that the adaptation of Western tests involves translation, the modification of test items, and sometimes, the administration procedure, it is important to evaluate whether the adapted tests are still valid for use in a different culture using a different language.

Some of the tests reviewed based their development or validation on a small sample or samples that were not representative of the general population. For example, the Cantonese version of the Western Aphasia Battery (Yiu, 1992) involved only 24 control participants, the Olfactory Identification Test (Chan, Tam, Murphy, Chiu, & Lam, 2002) involved only 12 healthy adults and 12 adults with probable Alzheimer's disease, and the Computerized Neurobehavioral Test System (Li et al., 2000) involved only male undergraduate students. As normative data based on restricted samples are likely to limit the clinical applicability of the assessment instruments, it is desirable to construct and validate the instruments using adequately representative and large samples, even for adapted tests.

Assessment Instruments Used for Test Evaluation

Chinese Mini-Mental State (CMMS) Examination (Katzman et al., 1988). This test was adapted from the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). Items from the MMSE were translated and used on the CMMS, except two that required major adaptations. One item was the repetition phrase "no ifs, ands, or buts," which does not have a suitable counterpart in Chinese. An alliteration in Chinese, "44 stone lions," was substituted. The second adaptation was substituting the item "write a sentence" by "say a sentence," as many elderly people in China are unable to write.²

In regard to diagnostic utility, it was found that when using the CMMS alone, the sensitivity and specificity rates for diagnosing dementia in a group of older Shanghai adults were 69.5% and 90.2%, respectively. Together with some other functional measures, the CMMS was found to be among several of the best models that predicted dementia (Hill et al., 1993). A cross-cultural comparison of test performance among older Chinese, Finnish, and U.S. adults found

that the mean scores of the three groups of participants were similar when education level was considered. However, differences in individual items remained, which possibly reflect cultural differences. For example, older Chinese adults were better on recall of objects and poorer on reading, or copying a pentagon (Salmon et al., 1989).

The Clinical Memory Test (Xu & Wu, 1986). This test was developed for the assessment of memory for both clinical and research purposes. It consists of five subtests: paired-association learning, directed memory, free recall of pictures, recognition of meaningless figures, and recall of the connection between portraits and their characteristics. Two alternate forms, A and B, were constructed. The test was administered to 3,310 adults in China (age range = 20–89). Correlation between the two forms was .85; test-retest reliability was reported to be .85 for the total score, and ranged from .54 to .71 for individual subtests.

Validity of the test was supported by differential test performance between left- ($n = 12$) and right- ($n = 13$) brain-damaged participants. Left-brain-damaged individuals were more impaired than right-brain-damaged individuals on paired-association learning, $t = 3.29$, $p < .01$, whereas the reverse pattern was observed for the recognition of meaningless figures, $t = 7.19$, $p < .01$. Moreover, in left-brain-damaged patients, performance on paired-association learning was impaired relative to figure recognition, $t = 5.52$, $p < .001$; this pattern was reversed in right-brain-damaged patients, $t = 5.47$, $p < .001$.

A Chinese version of the Category Fluency Test (Chan & Poon, 1999). Studies have suggested that the Category Fluency Test is a sensitive clinical assessment tool for dementia (Chiu et al., 1997) and schizophrenia (Chen, Lam, Chen, Nguyen, & Chan, 1996) in Hong Kong. This Chinese version of the Category Fluency Test includes the categories of animals and transportation. Normative data were obtained from 316 native Chinese speakers in Hong Kong (age range = 7–95). Chan and Poon found that the results of

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Table 2
 Summary of Neuropsychological Assessment Instruments Classified as Clinically Validated

Geographical location and test	Domain	A or D	Test of validity	Sample characteristics	Cross-cultural comparison
China					
Chinese version of Mini-Mental Status Examination (CMMS; Katzman et al., 1988)	Dementia	A	Use of CMMS and functional scales (Pfeffer Outpatient Disability Scale and Instrumental Activities of Daily Living Scale) to diagnose dementia (Hill et al., 1993)	$N = 2,187$ Age = 65–74 years Education = 0–postcollege level	Compared performance with Finnish ($n = 525$) and U.S. subjects ($n = 90$) (Salmon et al., 1989)
Clinical Memory Test (Xu & Wu, 1986)	Memory	D	Compared performance between right- and left-brain injured pt	$N = 2,161$ (literate) and 1,149 (illiterate) Age = 20–89 years	
Hong Kong					
Category Fluency Test (Chan & Poon, 1999)	Language/executive function	A	Sensitive to dementia (Chiu et al., 1997) and schizophrenia (Chen et al., 1996)	$N = 316$ Age = 7–95 years	Discussed and compared results of Western studies
Chinese version of Mattis Dementia Rating Scale (Chan, Poon, Choi, & Cheung, 2001; Chan, Choi, Chiu, & Lam, 2003)	Dementia	A	Correlated with CMMS; Differentiated between NC and AD pt	$N = 83$ NC and 40 AD pt Age = 72.07 ± 6.31 years (NC), 76.30 ± 7.26 years (pt)	Compared performance with U.S. subjects (Chan, Choi, & Salmon, 2001)
Hong Kong List Learning Test (Chan & Kwok, 1999)	Memory	D	Different performance between NC and schizophrenic pt (Chan et al., 2000); Different performance between NPC pt with TLN and NC, and NPC pt without TLN (Cheung, Chan, Law, Chan, & Tse, 2000); Differentiated between NC and AD pt. mild and moderate AD pt (Au, Chan, & Chiu, 2003); Different performance between NC and ACoA aneurysm pt (Chan, Ho, & Poon, 2002)	$N = 338$ Age = 7–95 years	
Japan					
Unidimensional Scale for Dementia (Kashima et al., 2001)	Dementia	D	Correlated with <i>DSM-III-R</i> grading of dementia severity	$N = 92$ NC, 262 pt Age = 63.5 ± 8.3 years	
Korea					
Korean-California Verbal Learning Test (K-CVLT; Kim & Kang, 1999)	Memory	A	Factor structure revealed a number of theoretically meaningful processes underlying verbal memory	$N = 357$ Age = 20–79 years	Discussed and compared with norms of CVLT
Korean version of the Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet (CERAD-K; J. H. Lee et al., 2002)	Alzheimer's disease	A	Differentiated between NC and demented pt, NC and AD pt; Factor structure revealed factors consistent with the intention and design of the original test	$N = 186$ NC, 106 demented pt Age = 68.4 ± 4.6 years (NC), 70.4 ± 8.1 years (pt)	Discussed and compared results of original CERAD

Note. A = adapted test; D = developed test; pt = patients; NC = normal controls; AD = Alzheimer's disease; NPC = nasopharyngeal carcinoma; TLN = temporal lobe necrosis; ACoA = anterior communicating artery.

their study were consistent with those of Western studies. For example, the number of items generated increased with age in children and adolescents, but subsequently decreased in adults, which was similar to findings in previous studies (Halperin, Healey, Zeitchik, Ludman, & Weisten, 1989; Tomer & Levin, 1993). Participants across all age groups generated more animal than transportation names, which was also consistent with some Western studies (Baldo & Shimamura, 1998; Battig & Montague,

1969). The authors thus suggested that the Category Fluency Test might not be sensitive to cultural differences, and seems to be applicable to Asian societies for clinical use. There was also another set of normative data on older adults in Hong Kong provided by Chiu et al.

The Chinese version of the Mattis Dementia Rating Scale (CDRS; Chan et al., 2003; Chan, Poon, et al., 2001). The CDRS was adapted from the Mattis Dementia Rating Scale (DRS; Mattis,

1988) for the assessment of dementia in Hong Kong. Most of the DRS items were translated and used in the CDRS, except four items that required modification. In the counting task of the Attention subscale, the letter "A" was substituted by the number "7" as most older adults in Hong Kong are not familiar with English alphabets. In the Conceptualization subscale, some wordings were changed for the "Differences" part due to the differences in pronunciation between Cantonese and English, and in the "Sentence initiation" part, participants were asked to make up any complete sentence instead of one using the words "man" and "car." The last adaptation was modifying questions in the "Orientation" part of the Memory subscale to suit the societal background of Hong Kong.

Normative data of 83 healthy older adults and 40 adults with Alzheimer's disease (AD) was provided by Chan et al. (2003). The study showed that CDRS demonstrated satisfactory reliability (Cronbach's $\alpha = .89$ for total sample) and construct validity (correlation with a Chinese version of MMSE ranged from .62 to .86 for individual subscales). The study recommended an optimal cutoff score of 112 for the total CDRS score in differentiating between AD and normal adults, which attained sensitivity and specificity rates of 80.0% and 91.6%, respectively. A study that compared DRS performance of age- and education-matched Hong Kong and U.S. older adults showed that Hong Kong participants obtained a lower mean DRS score ($M = 135.06$) than U.S. participants ($M = 138.76$). The two groups also differed in the pattern of DRS subscale performance, suggesting that individual subscale items may be susceptible to cultural differences (Chan, Choi, & Salmon, 2001).

The Hong Kong List Learning Test (HKLLT; Chan & Kwok, 1999). This is a Chinese verbal learning test developed in Hong Kong that consists of two 16-word lists in which all words are two-character nouns. The words in the first list come from four categories and are organized randomly (random condition); however, the second list consists of words from another four categories that are semantically clustered (blocked condition). The level of typicality, frequency, and difficulty of words in the two lists was matched. The test consists of three immediate recall trials, two delayed recall trials (10 and 30 min), and one recognition task. Normative data have been obtained from 338 native Chinese speakers (age range = 7–95).

The HKLLT has been tested on individuals with schizophrenia (Chan et al., 2000) and nasopharyngeal carcinoma (NPC; Cheung, Chan, Law, Chan, & Tse, 2000). Chan et al. (2000) found a similar pattern of memory deficits in individuals with acute and chronic schizophrenia, with both groups demonstrating an encoding deficit but relatively intact retention ability. This finding is consistent with previous studies conducted in Western countries (e.g., Brebion, Amador, Smith, & Gorman, 1997; Paulsen et al., 1995). Cheung et al. found that NPC patients who developed temporal lobe necrosis (TLN) after radiotherapy had a memory profile similar to patients with medial temporal lobe damage. Compared to normal controls and NPC patients without TLN, they demonstrated rapid rate of forgetting, impaired free recall, and impaired recognition abilities. The results were consistent across several other verbal and visual memory tests.

This test was also found to differentiate between normal adults and those with AD, and between adults with mild and moderate AD (Au, Chan, & Chiu, 2003). The best predictor of normal versus

impaired group membership was the rate of forgetting in the first 10 min for the random condition, and the total retention for the blocked condition. Regarding the differentiation between adults with mild and moderate AD, semantic clustering was identified as the best predictor. There was one study that investigated the effect of ruptured aneurysm of the anterior communicating artery (ACoA) on cognitive functions (Chan, Ho, & Poon, 2002). Given that the vascular territories of the perforating branches of ACoA include the mesial temporal lobe, memory might become impaired following rupture of the artery. The study found that HKLLT was able to detect memory deficits of ACoA aneurysm patients, who demonstrated significantly worse total learning and higher rate of forgetting than normal controls.

Unidimensional Scale for Dementia (Kashima et al., 2001). This scale was developed in Japan with the aim of constructing a simple and useful measure of dementia progression in the domain of memory function. The original test comprised 27 subscales that measure various cognitive functions including orientation, recall, and recognition of verbal and visual stimuli, calculation, and construction. The test was administered to 262 adults with dementia and 92 normal older adults. Using factor analysis, 12 subscales were selected with 4 subscales representing each of the three factors identified: recent memory (Factor 1; e.g., date of hospitalization and delayed recall of five words), immediate response (Factor 2; e.g., digit span and sentence repetition), and remote memory (Factor 3; e.g., place of birth and number of children).

Concurrent validity of the scale was demonstrated by satisfactory correlation between the total score and the *Diagnostic and statistical manual of mental disorders* (3rd ed., rev.; DSM-III-R; American Psychiatric Association, 1987) grading of mild, moderate, and severe dementia ($r = -.84$). The distribution of Factor 1, Factor 2, and Factor 3 scores and results of the scalogram analysis suggested an existence of a continuum of dementia severity. The results showed that simultaneous decline of Factor 1 and Factor 2 occurs in the first stage (total score = 9–12), decline in Factor 1 slightly precedes that in Factor 2 in the next stage (total score = 5–8), and Factor 3 declines successively in the last stage (total score = 0–4). Based on these results, the authors suggested that this unidimensional scale was an adequate measure for the latent continuum of the cognitive function of dementia.

Korean-California Verbal Learning Test (K-CVLT; J. K. Kim & Kang, 1999). The Korean version of the CVLT (Delis, Kramer, Kaplan, & Ober, 1987) follows the basic principles of the original test, but with the use of more elaborated instructions and newly selected stimulus items. Similar to the CVLT, the K-CVLT consists of two word lists in the format of shopping lists ("Monday" and "Tuesday" lists). Each list comprises 16 words chosen from four semantic categories. Two categories were common across the lists. The words on the two lists were matched in terms of exemplar frequency and typicality.

The test was administered to 357 healthy adults (age range = 20–79). Split-half reliabilities of Trials 1 + 3 versus Trials 2 + 4, and Trials 2 + 4 versus Trials 3 + 5 were .89 and .91, respectively. Validity of the K-CVLT was supported by its factor structure in which six factors representing meaningful processes underlying verbal memory were obtained. The factors were General Verbal Learning (e.g., total recall of List A and delayed free recalls), Response Discrimination (e.g., intrusions and false positives), Proactive Interference Effect (List B versus List A Trial 1 recall),

Serial Position Effect (e.g., percent primacy and recency recall), Retroactive Interference Effect (short delay versus Trial 5 recall), and Learning Rate (Learning slope). It was found that the CVLT norms were generally inflated compared to that of K-CVLT. The authors suggested that such a result might be due to the involvement of a sample in the CVLT that had higher mean educational level (13.83 years) than that of the national population.

The Korean version of the Consortium to Establish a Registry for Alzheimer's Disease Assessment Packet (CERAD-K; J. H. Lee et al., 2002). This test was adapted from the clinical and neuropsychological assessment batteries of the CERAD (Morris et al., 1989). The fourth English version of the CERAD packet (Protocol 4a for probable AD and Protocol 4b for vascular dementia, Parkinson's dementia, and other less common types of dementia) was used as an original text for translation. Most items of the CERAD-K used those of the original battery except for the MMSE, modified Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983), and the verbal memory tests. For the MMSE, reading and writing items were replaced by items concerned with judgment, due to the significant number of illiterate people in Korea. The modified BNT was adapted by using 15 items chosen from the K-BNT (H. Kim & Na, 1999). For the Word List Memory and Word List Recognition, Korean words that had high mental imagery similar to the English ones were used in the CERAD-K.

Test-retest reliability of the CERAD-K was examined by administering the battery twice to 20 people 1 month apart. Reliabilities ranged from .54 to .98 for tests of the neuropsychological battery, which were similar to those of the original tests. Validity of the CERAD-K was investigated by administering it to 186 healthy, and 106 demented, older adults, including 78 adults with AD. The results showed that the mean scores of the Short Blessed Test, Blessed Dementia Scale, and all tests in the neuropsychological part of the demented or AD group were significantly poorer than those of the control group. Construct validity of the neuropsychological part of CERAD-K was supported by factor analysis, which indicated that it is composed of three factors: Memory, Language, and Constructional Ability. These findings are consistent with the intention and design of the original CERAD neuropsychological battery (Morris et al., 1989).

Discussion

In this article, we have discussed the development of neuropsychological assessment instruments and their application in research in a number of Asian countries over the past 20 years. We have also recommended a set of clinically validated assessment instruments based on some statistical criteria in order to facilitate the selection of tests for clinical assessment.

From our review, we noted a growing trend of research in the area of neuropsychological assessment, with about 40% of the reviewed studies related to test development or adaptation. This high percentage reflects the increasing recognition of the importance of neuropsychological assessment in Asia, and the growing awareness of the importance of using instruments and normative data that are suitable for local populations. Test evaluation was based on a set of criteria that included a demonstration of test validity, but not reliability. The investigation of test reliability typically lags behind that of test validity, especially for a newly

developed science, such as neuropsychology in Asia. Nonetheless, it is important to point out the need for careful attention to reliability issues in the future development of neuropsychological assessment instruments.

The results of test evaluations showed that only 8 of the 36 instruments reviewed fulfilled our criteria as clinically validated assessment tools. Our review shows that a number of adapted tests met all criteria except that of cross-cultural comparison. The need to evaluate cross-cultural validity of adapted tests arises from research findings demonstrating that social and cultural factors affect some aspects of test performance. For example, there is evidence that cultural difference beyond simple demographic factors, such as age and educational level, affects the performance of older adults on the DRS (Chan, Choi, & Salmon, 2001). When a group of older Hong Kong Chinese and U.S. adults of similar age and educational level were assessed with the Chinese or the original version of the DRS, it was found that the Chinese participants performed more poorly on a verbal fluency task that required them to generate items found in a supermarket. The authors suggested that the slower retrieval by the Chinese participants was due to their limited familiarity with supermarkets, which are not the primary shopping venues of older adults in Hong Kong. This illustrates that even identical test items constructed from accurate translations may not necessarily be tapping the same kind of function with comparable levels of difficulty. Therefore, it is necessary not only to adapt Western neuropsychological tests for use in Asian populations, but also to develop a locally validated normative database.

The results of our review show that the majority of tests (30 of 36 tests included in the selection) were adapted from Western tests, and only 5 were locally developed. Whereas adaptation of existing tests may appear to be easier than the development of instruments from scratch, there are advantages of constructing original neuropsychological tests. One advantage is that there is more freedom in the development of new tests. Without limitations on test items, format, or administration procedures of the original instrument, new instruments can be developed to best suit the specific profile, needs, cultural, and linguistic characteristics of local populations. Thus, more sensitive and ecologically valid tests can be developed. Another advantage is that, although it is important to verify the translations involved in test adaptation and to demonstrate cross-cultural validity, such efforts are not needed for locally developed tests.

There is another important reason that argues for the necessity of developing new assessment tools. Recent advances in neuroimaging techniques have accelerated the development of our understanding of the brain-behavior relationship. With the incorporation of the latest findings and theories in brain science, new tests with better sensitivity and validity could be developed for the assessment of Asian populations, whose cognitive processes may differ, in some aspects, from those of their Western counterparts. Indeed, some recent studies have suggested that the neurocognitive networks that mediate the use of English and Chinese are different, at least on some levels of processing (Chan, Yeung, et al., 2002). The study suggested that the processing of Chinese language involves more bilateral brain areas compared to English, which is more lateralized to the left hemisphere. With future scientific and technological advances in brain science, more discoveries regarding culture- or language-specific neurocognitive processing may

be found. Thus, some assessment tools that were constructed based on neurocognitive models developed for Western cultures might not be suitable for people of other cultures.

With new findings in cognitive neuroscience, our understanding of how the brain functions is increasing, along with our understanding of how early experience of language affects some of the ways the brain processes information. Driven by these scientific advances, we believe that the future direction of neuropsychological assessment in Asia lies in the development of indigenous tools for tapping cognitive functions that may be, in some ways, unique to a particular cultural or linguistic community, and also in the generation of new knowledge regarding human cognitive processes. Currently, several groups of scientists in Asia are working toward this goal by developing ecologically valid neuropsychological assessment tools: researchers from the Neuropsychology Laboratory of The Chinese University of Hong Kong, who are active in neuropsychological test development and are currently developing a Chinese naming test and a test of executive dysfunction; scientists from the Institute of Psychology in Beijing and the Beijing Medical Centre, who have developed a scale for assessing aphasia; and the neuropsychological team in Hushan Hospital in Shanghai, that is developing assessment tools for individuals with neurological disorders.

It should be noted that our literature review has some limitations for the following reasons. First, studies that reported on cognitive and neuropsychological assessment instruments in Asian countries might not be published in journals commonly included in PsycINFO, and we have not been able to get further information through direct communication with psychologists in some Asian regions. Second, psychologists (especially practitioners) who use cognitive and neuropsychological assessment instruments in Asian countries might not be engaged in research, and even if they are, they may not publish their research findings. Third, the key words used in the search might have missed some articles that did not use the same key words. Finally, as previously mentioned, some studies were not available for review, such as those published in the authors' native language. Despite these limitations, we believe that this article provides a general picture of the status of the adaptations and development of neuropsychological assessment in Asia.

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