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The clinical utility, reliability and validity of the Rivermead Behavioural Memory Test – Third Edition (RBMT–3) in Hong Kong older adults with or without cognitive impairments

Kenneth N. K. FONG[1], Karen K. L. LEE[1], Zoe P. Y. TSANG[1], Jovi Y. H. WAN[1], Y. Y. ZHANG[1], Andy F. C. LAU[2]

[1]Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong SAR

[2]Occupational Therapy Department, Tuen Mun Hospital, Hospital Authority, Hong Kong SAR

Corresponding: Dr. Kenneth N. K. FONG, Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Kowloon, Hong Kong. Email: rsnkfong@polyu.edu.hk

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Abstract

This study examined the use of the Hong Kong version of the Rivermead Behavioral Memory Test - Third Edition (RBMT-3) for older adults, and by presenting the optimal cut-off scores for patients with cognitive impairments, and for a group of peers who have functional everyday cognition. 100 older adults residing in community dwellings were recruited from 3 non-government organizations and completed the RBMT-3: 29 patients with mild to moderate dementia, 34 persons at risk for MCI, and 37 matched older adults with everyday functional cognition for a healthy control group (NC). The test has excellent inter-rater (ICC [2, 1] = 0.997), intra-rater (ICC [3, 1] = 0), and parallel version (ICC [3, 1] = 0.990) reliabilities, as well as satisfactory internal consistency (Cronbach's alpha: 0.643 - 0.832). The scores of the MCI group were significantly lower than those of NC group in 4 subtests. The optimal cut-off scaled scores of ≤ 41.5, ≤ 102.5, and ≤ 131.5 are suggested for the RBMT-3 to discriminate between patients with mild and moderate dementia, mild dementia and MCI, and MCI and NC, with sensitivities 73%, 100% and 94.1% respectively. This version is useful to differentiate those with or without risk of cognitive impairments.

(Words: 200)

Keywords: mild cognitive impairment, dementia, everyday memory, older adults, cut-off score

Introduction

Care for people with dementia has become more common in Hong Kong as a result of long life expectancy and aging population as do other countries. The proportion of people aged 60 or older reached 14.9% in 2001, increased to a high of 19.1% in 2011 (Census and Statistics Department, 2012a; 2012b), and is projected to be 36.4% in 2041. Currently among the community-dwelling elderly, the prevalence rate of dementia estimates to be 7.2% of which 84.6% are suffering from mild grade dementia and 9.8% of moderate grade, and the prevalence rate was also found to double for every 5 years advanced in age (Department of Health, 2006).

Another concern for the elderly in Hong Kong is mild cognitive impairment (MCI) that refers to a syndrome characterized by memory performance below the age norm, while intellectual functioning and activities of daily living are unimpaired (Petersen et al., 1999). Lam et al. (2008) suggested that the overall prevalence rate of MCI is 8.5% among local elderly aged 70 or above. As well, a substantial proportion of patients with MCI, 12–15% per year, will gradually worsen and convert to dementia, compared to 1–2% of the general population; moreover, 40–65% of patients with MCI will eventually progress to Alzheimer's disease (AD) in their lifetime (Petersen et al., 1999). Because of this imminent danger of dementia to a growing elderly population, it is necessary to detect persons with MCI at an early stage, optimize their cognitive functioning, and contribute to the slowing of cognitive decline in order to curb the onset of disability in AD (Belleville, 2008). In addition, there has been an increasing number of studies reporting that cognitive training may have beneficial effects on objective cognitive measures in MCI, however, a threat to internal validity may be suspected in most of the studies not having administered parallel forms of testing available in the cognitive measures (Jean, Bergeron, Thivierge, & Simard, 2010).

The Rivermead Behavioral Memory Test (RBMT) was originally developed in 1985 for assessing memory difficulties in people with brain injuries (Wilson, Cockburn, & Baddeley, 1985; Wilson, Cockburn, Baddeley, & Hiorns, 1989) but RBMT is now validated and widely used to examine everyday memory function across different cultures and across diagnostic groups of older adults including healthy persons and groups with MCI, mild AD, vascular dementia, and intellectual disability (Adachi et al., 2013; Fraser, Glass & Leathem, 1999; Glass, 1998; Hon, Hupper, Holland, & Watson, 1998; Johansson, 2012). The original RBMT has 4 parallel versions, so the RBMT is suitable for assessing change in memory function over time without influencing the practice effects of the test (Wilson, Cockburn, & Baddeley, 1985; Wilson et al., 1989). In fact, stratified normative data for the RBMT are available from a compendium of literature on 680 patients with brain injury (van Balen, Westzaan, & Mulder, 1996), and recently, extensive studies have been conducted on patients with psychiatric illnesses (Al-Uzri et al., 2006; Guaiana, Tyson, & Mortimer, 2004; Levkovitz, et al., 2003; Tyson, Laws, Roberts, & Mortimer, 2005). The RBMT has been investigated as an early detection instrument for patients with MCI (McDougall, Becker, & Arheart, 2006), in Japan (Kazui et al., 2005), and patients with dementia and MCI in Brazil (Yassuda et al., 2010). The relationship of the RBMT with the Wechsler Memory Scale (WMS) was tested on a population with AD, and the tested population performed poorer in semantic memory tasks including verbal and visual recognition, visual reconstruction and spatial tasks, and orientations (Efklides et al., 2002).

Given that the third edition of the RBMT, RBMT–3 is a new and more recent edition, a Hong Kong version was developed in 2013 by the team of authors, and its content validities were examined. Apart from the translation of instructions to Chinese with reference to the local context in Hong Kong, the Hong Kong version of RBMT-3 sought to include more pictures of

people of the Chinese population, pictures of South East Asians, and pictures of people from the West to ensure the version of the test accounted for the ethnic diversity of Hong Kong society. In order to investigate its psychometric characteristics, the objectives of this study were: (1) to investigate the clinical utility of the RBMT-3 in everyday memory assessment and determine the RBMT-3 optimal local cut-off scores for older adults at risk for MCI, patients with mild to moderate dementia, and older adults with everyday functional cognition in Hong Kong; and (2) to examine the inter-rater reliability, intra-rater reliability, and parallel forms reliability of the RBMT-3 as well as its internal consistency throughout this population.

Methods

Participants

A total of 100 participants aged 60 or above residing in community dwellings were recruited for the study through convenience sampling from 3 non-government organizations in Hong Kong (Table 1). There were 66 female participants and 34 male participants with a mean age of 70.39 (S.D. 7.75). Their mean number of years of education was 7.46 (S.D. 4.37) with 8% being illiterate. Participants were assigned to three groups: (a) the dementia group consisting of patients (N=29) who were diagnosed by psychiatrists or geriatricians using the DSM-IV-TR (2000) as having dementia with mild to moderate grade; (b) the MCI group consisting of older adults (N= 34) at risks for MCI screened according to Petersen et al. (1999)'s five criteria for MCI; and (c) the normal control (NC) group (N=37) of older adults with everyday functional cognition. Petersen et al.'s (1999) criteria for MCI includes (a) subjective memory complaint; (b) normal general cognitive function; (c) objective memory impairment; (d) preserved activities of daily living, and (e) not demented. However, vulnerability to MCI may be difficult to identify

because some people might have fewer complaints about memory loss or that the family members might think that this is normal for the age of the individual. Therefore, this study adopted on the classification of the five criteria of MCI using a practical approach in a sample of older adults. Participants were identified as having risks for MCI when scored with both a ≧3 in the Subjective Memory Complaints Questionnaire (SCMQ) (Lam, Lui, Tam, & Chiu, 2005) and with either a ≧27 after adjusted for education (Doody et al., 2009) in the Mini-mental state examination (MMSE) (Chiu, Lee, Chung, & Kwong, 1994; Chiu et al., 1998) or a ≧24 in the Montreal Cognitive Assessment (MoCA) (Chu, Ng, Law, Lee & Kwan, 2014; Wong et al., 2009), i.e. scored 1.5 SDs below the mean on at least one cognitive domain (Allaire, Gamaldo, Ayotte, Sims, & Whitfield, 2009; Thal et al., 2005). They were identified as having risks for MCI at stage 2 in the Global Deterioration Scale (GDS) (Reisberg, Ferris, de Leon, & Crook, 1982) or stage 0.5 of the Clinical Dementia Scale (CDR) (Hughes, Berg, Danziger, Coben, & Martin, 1982; Morris, 1997). Since there was no single cutoff score served all purposes to make a differentiation between people having risks for MCI and healthy controls, the reason of using cutoff scores of 24 in the MoCA and 27 in the MMSE was with reference to the mean scores of healthy controls in this study as well as the suggestion of the original MoCA study which recommended a cutoff of 25 or below in MoCA and 26 or below in MMSE for the detection of MCI and Alzheimer's disease (Nasreddine et al., 2005). The NC group was confirmed with everyday functional cognition by the same screening assessments. Other criteria for both groups were that they had no auditory impairment or visual impairment (including color blindness) and that they had the ability to follow and understand instructions. Individuals with severe mental disorder such as psychosis or depression were excluded**.**

Instruments

The first version of the RBMT was developed to bridge the gap between laboratory tests and observational measures of everyday memory (Wilson, Cockburn, & Baddeley, 1985; Wilson et al., 1989). The Cantonese version of the RBMT (RBMT-CV) was developed in 1998 (Ng et al., 1998) by a group of occupational therapists in the Hong Kong Hospital Authority. They developed the RBMT-CV for patients who acquired brain injury and validated the RBMT-CV for assessing memory in a group of stroke patients (Man & Li, 2001). The test remains in extensive use both in the public hospitals of Hong Kong (Wong et al., 2009) and in other clinical settings that care for patients with memory impairments (Fung, Poon, Fong, & Tse, 2011).

Although the RBMT was useful in the assessment of everyday memory, the Rivermead Behavioral Memory Test-Third Edition (RBMT-3) has been developed with the goal of updating clinical applicability and the utility of the tool, so a number of changes were made to the test to meet this goal (Wilson et al., 2008). For instance, some items in the RBMT were thought to be too easy for certain groups of patients, so adjustments have been made in terms of difficulty: (a) the photos of the Face Recognition subtest were changed to colorful photos, which now include a wide ethnic diversity of the United Kingdom population; (b) the stories were updated with a standardized difficulty between the 2 parallel versions; (c) and a new task—the Novel Task was added to assess the person in the process of learning a new skill (Wilson et al., 2008). For purposes of statistical measure, revisions have been made to its normative data in people with a brain injury. Also, the RBMT-3 now has 2 parallel versions with 14 subtests each, and the raw scores of RBMT-3 can now be converted to scaled scores for each subtest, which allows users to know the standing of an individual performance in comparison to his or her peers (Wilson et al., 2008). In this study, the conversion table of original RBMT-3 is used for calculating the scaled scores.

Apart from RBMT-3, the following 5 instruments were used to differentiate cognitive and daily functioning of the participants: (1) the Cantonese version of Mini-mental State Examination (MMSE) (Chiu et al., 1994; Chiu et al., 1998), (2) the Montreal Cognitive Assessment (MoCA) Hong Kong version (Chu, Ng, Law, Lee & Kwan, 2014; Wong et al., 2009), (3) the Global Deterioration Scale (GDS) (Reisberg et al., 1982), (4) the Clinical Dementia Rating (CDR) (Stage 0.5) (Hughes et al., 1982; Morris, 1997), and (5) the Subjective Memory Complaints Questionnaire (SMCQ) (Lam et al., 2005).

The Cantonese version of Mini Mental State Examination (MMSE) was developed by Chiu, Lee, Chung and Kwong (1994), using a sample of 190 patients (mean age = 75.1 years) in Hong Kong, the instrument was validated with a high internal consistency of 0.86 indicated by Cronbach's alpha. The test-retest reliability was 0.78. The inter-rater reliability was excellent, with an intra-class correlation coefficient of 0.99.

The MoCA is a cognitive screening instrument developed to detect MCI (Julayanont et al., 2013). It is a simple 10 minute paper-and-pencil test that assesses multiple cognitive domains including memory, language, executive functions, visuospatial skills, calculation, abstraction, attention, concentration, and orientation. Wong et al. (2009) found that the reliability, internal consistency, and clinical utility of MoCA Hong Kong version were good.

The Global Deterioration Scale provides caregivers an overview of the stages of cognitive function for those suffering from a primary degenerative dementia. The GDS is comprised of 7 stages, each defined by a set of clinical characteristics such as memory, learning, communication, sleep, physical impairment, mental impairment, and social impairment. The concurrent validity was established by comparing scores of the GDS to scores from the MMSE and showed high correlation between the two tools (Reisberg et al., 1982). The inter-rater

reliability for the GDS was found to be high, ranging from 0.87 to 0.97 in various studies (Herndon, 2006).

The CDR was developed for evaluating the severity of the stages in dementia. As evidenced by Chan, Choi, Chiu, & Lam (2003), it has good reliability with internal consistency ranging from 0.7 to 0.9 and significant correlation with the MMSE.

The SMCQ was found to be a brief, reliable, and valid questionnaire for evaluating subjective memory complaints (Youn et al., 2009). Cronbach's alpha coefficient and intra-class correlation coefficients of the SMCQ were 0.864 and 0.828 ($p < 0.001$) respectively. The SMCQ score discriminated well between non-demented elderly without dementia and those with dementia ($p < 0.01$). The area under the curve value of the SMCQ was 0.84, indicating that it had a high diagnostic ability.

Procedures

The study was conducted under the terms of the Declaration of Helsinki. Written and informed consent was obtained for all participants, and for those who were not able to make their own consent mentally (e.g. those with dementia), research procedures were explained to their next of kin or family in order to obtain their support. Approvals from the original author and copyright owner of the RBMT-3 were obtained for the translation, cultural and linguistic validation in Hong Kong, and ethical approval was sought from the Humans Research Ethics Committee of the Hong Kong Polytechnic University before study implementation.

The Hong Kong version of the RBMT-3 used the visual stimuli of the original test for pictures but colored portraits in face recognition have been changed so that Chinese, South-Asian, and European people were included to represent the ethnicity in Hong Kong. Subjects were closely matched in facial features with that of the original RBMT-3 to ensure that they have

remained highly similar to the original ones. Photos were adjusted with similar angle, brightness, and contrast according to the requirements of the portraits in the original RBMT-3 by professional photographers. Verbal stimuli, such as names and stories, were adapted to Hong Kong culture, but remained similar in terms of structure and task difficulty. The verbal instructions and assessment form were directly translated from the original test. The translation procedures were first carried out by a group of 5 occupational therapy students in their final year of study, followed by synthesis, back translation, expert committee review and pilot testing, so that both adaptation to the identified target population's culture and to the original connotative meaning were kept (Beaton, Bombardier, Guillemin, & Ferraz, 2000).

Figure 1 shows the flow chart of the procedures for measuring reliabilities. In this study, 4 trained occupational therapy students were responsible for administrating the procedures according to Version 1 and Version 2 of the manual RBMT-3. All participants were initially assessed by a rater using the RBMT-3 Version 1. To establish the inter-rater reliability, 20 randomly selected participants (5 in dementia group and 15 in healthy control group) were each simultaneously rated during the first assessment by another rater also using RBMT-3 Version 1. Regarding intra-rater reliability, after 4 to 7 days of the first assessment a random subset of 12 participants (3 from the dementia group and 9 from the NC group) were rated by their same initial rater using again RBMT-3 Version 1. To establish parallel version reliability, 4 to 7 days after the first assessment a subset of 13 participants (5 in dementia group and 8 from NC group) were assessed again by their same initial rater who in this second assessment rated each participant using RBMT-3 Version 2.

Statistical Analysis

Differences between participants with and without MCI or dementia on the demographic and cognitive measures were compared using one-way ANOVA, Krusal Wallis test and Chi-square test, where appropriate. Tests of normality in each group were done with Kolmogorov-Smirnov tests to make sure parametric tests should be used. Between-group differences on the RBMT-3 sum of scaled scores and subtest scaled scores were assessed using one-way ANOVA with Tukey's test for post hoc analysis. The inter-rater reliabilities were computed by using an intra-class correlation coefficient (ICC), (Model 2, 1), and the intra-rater and parallel version reliabilities were computed using ICC (Model 3, 1). The internal consistency of each subscale of RBMT-3 was examined using Cronbach's alpha, and the concurrent validity between the RBMT total scaled score and total scores of MMSE or MoCA was examined by Pearson's correlation. With reference to a previous study of using RBMT as an early detection instrument for dementia and MCI (Yassuda et al., 2010), the Receiver-Operating Characteristic (ROC) analysis was used to determine the optimal cut-off points of the RBMT-3 for older adults with dementia or at risks for MCI, comparing with those in the NC group. All statistics were performed by using SPSS version 20. All statistical testing was 2-sided, and the level of significance was set at $p \leq .05$.

Results

Baseline characteristics of participants

Table 1 shows the participants' demographic characteristics such as gender, age, and educational level, and scores of measurements (except RBMT-3) for the three groups. For gender distribution, there is no statistically significant difference among the three groups ($\chi^2 = 1.302$, $p = 0.522$) except in the mean ages of patients with dementia (77.34; SD 7.128), which showed significant difference with that of MCI (68.09; SD 6.077; $t = 5.565$; $p < 0.001$) and healthy control groups (mean age = 67.05; SD 6.023; $t = 6.355$; $p < 0.001$). The mean years of education

for the dementia groups were 3.31 (SD 3.219), which was significantly lower than that of MCI and normal controls, which were 8.50 (SD 4.201; $t = 5.428$; $p < 0.001$) and 9.76 (SD 2.823; $t = 8.656$; $p < 0.001$) respectively.

Performances of RBMT-3 among groups

The mean and SD of the RBMT-3 scaled scores of the three groups are presented in Table 2. Analysis of covariance (ANCOVA) has been used to study the effect of age and years of education on the RBMT-3 total scaled score. The analysis has found that the age ($F = 0.228$, $p = 0.634$) and years of education ($F = 3.601$, $p = 0.061$) were not significant covariates of the RBMT-3 total scaled score. The one-way ANOVA test revealed an overall group effect on the RBMT-3 total scaled scores among the 3 groups [$F (2, n = 100) = 232.537$, $p < 0.001$] (see Table 2). The post hoc Tukey's test revealed that the dementia group scored significantly lower than the MCI ($p < 0.001$) and the NC group ($p < 0.001$), but the difference between MCI and NC groups did not reach any the level of significance ($p = 0.067$).

In addition, there were significant differences in all the subtests among the three groups (see Table 2). The post hoc Tukey's test revealed that dementia subjects scored significantly lower than the NC and MCI groups in all the subtests (see Table 2). However, the scores of the MCI group were significantly lower than those of NC group in the following subtests: Delayed Recall of Belongings, Face Recognition, Story, and Route. In the subtest of Delayed Recall of Picture Recognition, although the difference reached a level of significance, the MCI group scored higher than the NC group.

Inter-rater Reliabilities and Internal Consistency

For the RBMT-3, the ICC (Model 2, 1) is 0.997 for inter-rater reliability, and the ICC (Model 3, 1) is 0.924 for intra-rater reliability, and the ICC (Model (3, 1) is 0.990 for the parallel version reliability.

The internal consistencies for 3 groups are presented in Table 3. The Cronbach's alpha coefficient of MCI ($\alpha = 0.734$), dementia ($\alpha = 0.832$) and NC ($\alpha = 0.643$) groups were satisfactory, and this showed that the 14 items in the test measured the same construct. In both MCI and dementia groups, deletion of any items in the scale resulted in a negligible change in Cronbach's alpha, except in the NC group when the item of Orientation and Date were deleted. In this case, the Cronbach's alpha increased.

Concurrent Validities

Table 4 shows the correlation between RBMT-3 and either the MMSE or MoCA total scores among the 3 groups, while controlling for age and education factors. For the MCI group, the RBMT-3 was found to be correlated moderately and positively with the MoCA ($r = 0.359$, $p = 0.043$) but not significantly associated with the MMSE ($r = 0.322$, $p = 0.072$). For the dementia group, concurrent validities showed significant relationship with both the MMSE ($r = 0.724$, $p < 0.001$) and MoCA ($r = 0.636$, $p = 0.006$). However, the results were insignificant for the NC group scored with the MMSE ($r = 0.198$, $p = 0.255$) but were of fair significant association with the MoCA ($r = 0.343$, $p = 0.044$).

Cut-off Scores

The ROC analysis was used to determine corresponding sensitivity and specificity for scaled scores of RBMT-3. An ideal scale should have both high sensitivity and high specificity to ensure a low false positive rate and a low false negative rate. Table 5 shows that an optimal scaled score of 131.50, which yields a sensitivity of 73% and a specificity of 50%, can be used to

correctly differentiate the subjects with MCI from the NC group. This cut-off score has a false positive rate of 50% and a false negative rate of 27%. Table 5 shows that 102.50 yielded a sensitivity of 100% and a specificity of 100%, which is an excellent cut-off scaled score for the RBMT-3 that correctly differentiates those with mild dementia from those at risks for MCI. Table 5 shows that 41.50, which yields a sensitivity of 94.1% and a specificity of 50%, is an optimal cut-off score for the RBMT-3 to correctly differentiate subjects with mild from moderate dementia.

The percentile ranks corresponding to scaled scores in the sample were calculated according to the definitional formula by Ley (1972), that is: Percentile Rank = (b+0.5a/N)100, where b = number of persons in a sample obtaining a lower score than the given score, a = the number obtaining the given score, and N is the total number of people in the sample. The equivalent percentile ranks for the 3 optimal cut-off scaled scores were: 57% for older adults at risks for MCI, 30% for those with mild dementia, and 10% for those with moderate dementia.

Discussion

The major finding was that there was a global deterioration of all memory aspects in patients' dementia when compared to that in the MCI and NC groups. Excluding dementia, we also found that participants with or without risks for MCI closely resembled each other in overall everyday memory functioning. Further analysis of the subtests indicated that the MCI group scored significantly lower than the NC group, which showed that MCI subjects would have difficulties in various situations of everyday life requiring delayed recall memory. This result was consistent with the finding of Kazui et al. (2005) that MCI patients showed impairment of everyday memory tasks which requiring delayed recall. The results of the subtests, which were

classified as retrospective memory tests in the RBMT-3, indicated that older adults at risk for MCI have difficulties in three categories of delayed recalling: (1) faces of some unfamiliar persons, (2) a new route, and (3) a short story. As for prospective memory, they have difficulty in remembering to ask for belongings when compared to NC subjects. Thus, our results suggest that older adults at risks for MCI will function normally in everyday functioning when compared to older adults with everyday functional cognition; as well, amnesia would mainly affect delay recall memory in visual, verbal, or spatial information either retrospectively or prospectively.

However, we cannot determine the reason why the score of MCI group was significantly higher than those of the NC group in the subtest of Delayed Recall of Picture Recognition, except that perhaps the 2 groups closely resembled each other in our subject recruitment or that during the measurement, there might be a confounding effect of other demographic variables.

We found that the Hong Kong version of RBMT-3 had excellent inter-rater, intra-rater, and parallel version reliabilities. The high values of Cronbach's alpha in three groups indicated that the 14 items the RBMT-3 measures are of the same construct. The alpha coefficient was the highest in the dementia group, followed by the MCI and NC groups respectively. This result suggests that the memory impairment in dementia is global, because the participants' performances were similar in every item of the RBMT-3. Whereas in the NC group, the memory performance was quite diverse. In normal controls, the alpha increased when the item of Orientation and Date was deleted, which suggests that orientation itself is not consistent with other items measuring memory and does not fit in the everyday memory construct.

The concurrent validity found was higher with dementia group, followed by the MCI and NC groups. As by the DSM-IV-TR (2000) definition, dementia refers to the development of multiple cognitive deficits that include memory impairment, and cognitive disturbances. It is

understandable that patients with dementia performed poorly in most cognitive domains in these tests, so better correlation would be expected. On the other hand, ceiling effect is experienced in MMSE for educated individuals (Hoops et al., 2009), coupled with the higher educational level observed in the MCI and NC groups, a lower correlation of MMSE and RBMT-3 is expected.

Our results showed that although both age and years of education of patients with dementia were significantly lower than that of the other two groups, they did not account for the overall performance of the RBMT-3.

The three cut-off scaled scores in RBMT-3 for the three groups found in this study may be used as a reference for clinical judgment in Hong Kong. We found the difference between total scaled scores and optimal cut-off scores: 131.50 (sensitivity = 73%, specificity = 50%) to differentiate the MCI group from normal control, 102.5 (sensitivity = 100%, specificity = 100%) to correctly differentiate the MCI group from the mild dementia group, and 29 to differentiate between the mild and moderate group. The percentile ranks for the MCI, mild, and moderate dementia in this sample is 57, 30, and 10. Thus the RBMT-3 is concluded to be a little too difficult for the older adults with cognitive impairment, especially those with dementia. The older adults performed particularly poor in the Novel Task which assesses the ability of a person to learn a new skill. A specificity of 50% to differentiate between MCI and NC in a clinical context is indeed, disappointing. This might probably due to the reason that MCI population is heterogeneous and not everyone with MCI will progress to dementia (Belleville, 2008), and that cognitive decline is not the endpoint of MCI, there might exist some difficulties in daily functioning that circumscribe the functional abilities of these patients which we have not considered in the screening according to the Petersen's criteria (Jean et al., 2010). Patients with MCI might have mild impairment in instrumental activities of daily living such as keeping

memory lists (Nasreddine et al., 2005). Another reason for the low specificity might be that the MoCA cutoff score of 24 for older adults with risks for MCI in this study was a bit higher compared to a recent study in Hong Kong which suggested a cutoff of 22 for detection of amnestic MCI for Southern Chinese older adults (Chu et al., 2014), however, we found that the overall cognitive performances of our populations were in general better due to a prevalence of higher education, and that there was no consensus on a single cutoff score of the MoCA for MCI as different cutoff scores were reported in Japan (25/26), South Korea (22/23), and Taiwan (23/24) in several Asian studies (Fujiwara et al., 2010; Lee et al., 2008; Tsai et al., 2012).

Limitations

This study had several limitations. First, selection bias likely influenced the results. The sample did not closely match the general older adult population in Hong Kong which was not representative of key demographic variables (age, educational level, gender, etc.). This study did not include a large population sample in generalizing the population norms for the standardization of RBMT-3 in Hong Kong. We suggest using a standardized sample from the whole population in later research for this purpose. Unfortunately, the present small sample size did not allow stratification of the dementia group into different stages of dementia. It could be questioned whether sensitivity of 72% and specificity of 50% is adequate to differentiate between MCI and NC in a clinical context, it is recommended that a larger sample size will clarify whether this cut off is in fact correct. Older adults with risks for MCI were not included in the investigation of external reliabilities because of different timing in data collection. It is recommended a well-mixed group with equal ratio should be adopted for the external reliability testing.

Conclusion

The Hong Kong version of RBMT-3 is proved to be an assessment tool for everyday memory with excellent external reliabilities and satisfactory internal consistency in older adults with cognitive impairments. Identification of people with MCI may assist in planning of service provision in future, both in relation to rehabilitation programmes and continuing care. The present findings need to be interpreted with cautions as clinicians need to take into account the cultural differences between Hong Kong and other countries. Owing to the difficulty level of the test, the RBMT-3 might not be sensitive to identify everyday memory problems in people with severe cognitive impairments.

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Figure 1 Flow chart of the procedures for measuring reliabilities

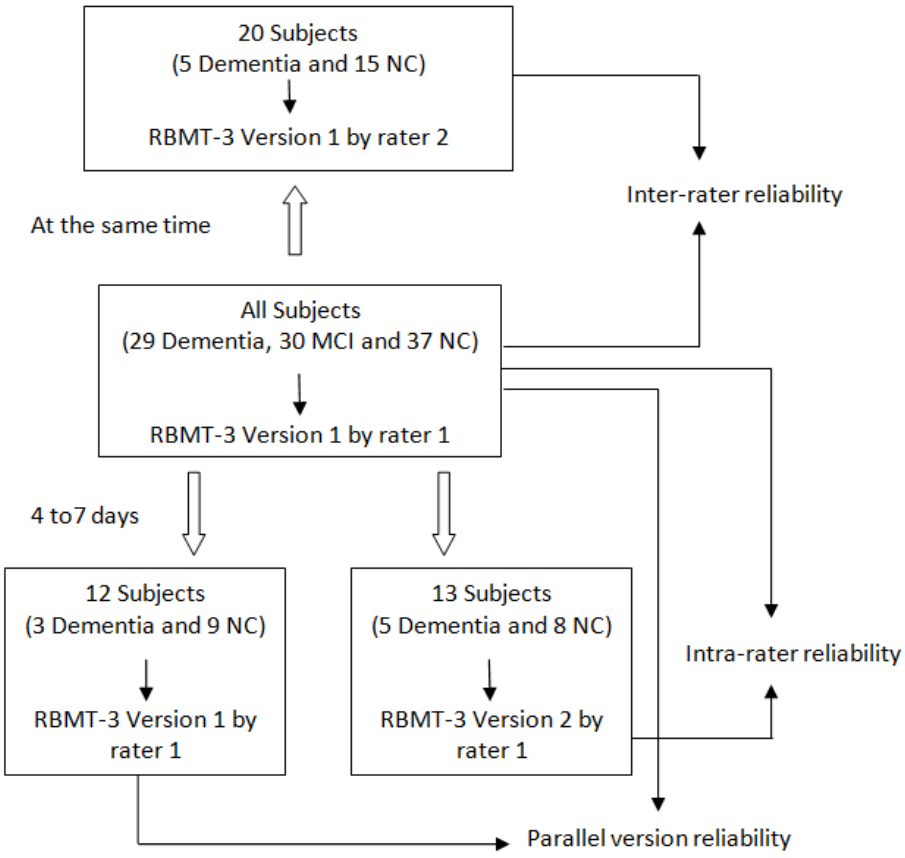

Table 1 Demographic characteristics of participants and the comparison of older adults at risks for mild cognitive impairment, patients with dementia and healthy controls

	ALL (N = 100)	MCI (N = 34)	Dementia (N = 29)	NC (N = 37)	p
Gender, N					
Male	34	9 (26.5%)	11 (37.9%)	14 (37.8%)	0.522 [c]
Female	66	25 (73.5%)	18 (62.1%)	23 (62.2%)	
Age, mean years (SD)	70.39 (7.747)	68.09 (6.077)	77.34 (7.128)	67.05 (6.023)	0.000** [a] (F = 24.508)
Age range, N					0.000** [b]
55-64	24 (24%)	11 (32.4%)	0	3 (35.1%)	
65-74	44 (44%)	15 (44.1%)	8 (27.6%)	21 (56.8%)	
75-89	32 (32%)	8 (23.5%)	21 (72.4%)	3 (8.1%)	
Education, mean years (SD)	7.46 (4.370)	8.50 (4.201)	3.31 (3.219)	9.76 (2.823)	0.000** [a] (F = 30.590)
Educational level, N					0.000** [b]
illiterate	8 (8%)	0	8 (27.6%)	0	
literate, but no formal education	2 (2%)	0	2 (8.8%)	0	
primary	35 (35%)	12 (35.3%)	16 (55.2%)	7 (18.9%)	
secondary	49 (49%)	18 (52.9%)	3 (10.3%)	28 (75.7%)	
tertiary	6 (6%)	4 (11.8%)	0	2 (5.4%)	
SMCQ (SD)	2.72 (1.248)	3.09 (1.264)	2.86 (1.407)	2.27 (0.962)	0.016* [a]
GDS, N					0.000** [b]
1	26 (26%)	3 (8.8%)	0	23 (62.2%)	
2	31 (31%)	17 (50%)	0	14 (37.8%)	
3	13 (13%)	12 (35.3%)	1 (3.4%)	0	
4	17 (17%)	1 (2.9%)	16 (55.2%)	0	
5	12 (12%)	1 (2.9%)	11 (37.9%)	0	
6	1 (1%)	0	1 (3.4%)	0	
7	0	0	0	0	
CDR, N					0.000** [b]
0	48 (48%)	13 (38.2%)	0	35 (94.6%)	
0.5	8 (8%)	2 (5.9%)	5 (17.2%)	1 (2.7%)	
1	44 (44%)	19 (55.9%)	24 (82.8%)	0	
2	0	0	0	0	
CMMSE total score, mean (SD)	24.35 (6.864)	27.44 (1.779)	15.00 (5.695)	28.84 (1.143)	
MoCA total score, mean (SD)	20.98 (7.945)	23.79 (3.245)	9.93 (4.543)	27.05 (2.041)	

NA = not applicable; *p≤0.05; **p<0.001; [a] One-way ANOVA for equality of means; [b] Krusal Wallis test for comparisons of means; [c] Chi-square test for comparison of categorical data; GDS = Global Deterioration Scale; CDR = Clinical Dementia Rating; SMCQ = Subjective Memory Complaints Questionnaire; MMSE = Mini-mental State Questionnaire; MoCA = Montreal Cognitive Assessment; MCI = At risk for mild cognitive impairment; NC = Healthy controls

Table 2 RBMT-3 total scaled scores and subtest scaled scores among 3 groups

	MCI (N = 34)	Dementia (N = 29)	NC (N = 37)	p [a] (among groups)	p [b] (MCI vs NC)	p [b] (MCI vs dementia)	p [b] (NC vs dementia)
RBMT-3(HK) Total Scaled Score (SD)	130.35 (16.028)	58.07 (18.896)	139.05 (14.089)	0.000**	0.067	0.000**	0.000**
Subtests scale scores							
First and Second Names - Delayed Recall (SD)	8.76 (2.511)	5.10 (1.081)	9.22 (2.485)	0.000**	0.661	0.000**	0.000**
Belongings - Delayed Recall (SD)	8.91 (2.417)	4.79 (3.052)	10.41 (1.607)	0.000**	0.025*	0.000**	0.000**
Appointments - Delayed Recall	10.09 (2.527)	5.79 (0.978)	9.59 (2.114)	0.000**	0.563	0.000**	0.000**
Picture Recognition - Delayed Recall (SD)	9.82 (1.930)	2.34 (1.969)	8.41 (2.544)	0.000**	0.020*	0.000**	0.000**
Story - Immediate Recall (SD)	9.47 (2.926)	3.45 (2.339)	10.19 (2.817)	0.000**	0.511	0.000**	0.000**
Story - Delayed Recall (SD)	8.50 (2.926)	4.24 (1.272)	9.84 (2.421)	0.000**	0.049*	0.000**	0.000**
Face Recognition Delayed Recall (SD)	8.94 (2.674)	4.83 (2.508)	11.08 (3.040)	0.000**	0.004*	0.000**	0.000**
Route - Immediate Recall (SD)	9.15 (1.987)	3.86 (3.533)	10.41 (2.587)	0.000**	0.132	0.000**	0.000**
Route - Delayed Recall (SD)	8.06 (2.498)	3.83 (2.791)	10.27 (2.535)	0.000**	0.002*	0.000**	0.000**
Messages - Immediate Recall (SD)	9.32 (2.421)	4.69 (3.072)	10.49 (1.346)	0.000**	0.093	0.000**	0.000**
Messages - Delayed Recall (SD)	10.21 (2.157)	4.31 (2.977)	10.62 (1.139)	0.000**	0.695	0.000**	0.000**
Orientation and Date (SD)	9.47 (2.273)	1.21 (0.559)	9.54 (2.785)	0.000**	0.990	0.000**	0.000**
Novel Task - Immediate Recall (SD)	9.35 (2.116)	4.28 (2.604)	9.73 (2.745)	0.000**	0.802	0.000**	0.000**
Novel Task - Delayed Recall (SD)	10.29 (2.223)	4.41 (2.196)	9.27 (2.376)	0.000**	0.145	0.000**	0.000**

*p≤0.05; **p<0.001; [a] One-way ANOVA for comparisons between means among 3 groups; [b]Post hoc Tukey's test for comparison of means between 2 groups; MCI = At risk for mild cognitive impairment; NC = Healthy controls

Table 3 Results of internal consistency of RBMT-3 in 3 groups

	MCI (N = 34)	Dementia (N = 29)	NC (N = 37)
Cronbach's α	0.734	0.832	0.643
Cronbach's alpha if item deleted			
First and Second Names - Delayed Recall	0.722	0.825	0.638
Belongings - Delayed Recall	0.750	0.807	0.610
Appointments - Delayed Recall	0.703	0.840	0.654
Picture Recognition - Delayed Recall	0.718	0.819	0.634
Story - Immediate Recall	0.707	0.840	0.587
Story - Delayed Recall	0.716	0.837	0.576
Face Recognition - Delayed Recall	0.710	0.828	0.547
Route - Immediate Recall	0.732	0.795	0.659
Route - Delayed Recall	0.717	0.797	0.645
Messages - Immediate Recall	0.710	0.808	0.626
Messages - Delayed Recall	0.719	0.806	0.627
Orientation and Date	0.697	0.831	0.700
Novel Task - Immediate Recall	0.721	0.820	0.610
Novel Task -Delayed Recall	0.738	0.822	0.610

MCI = At risk for mild cognitive impairment; NC = Healthy controls

Table 4 Correlation between RBMT-3 total scaled score, MMSE and MoCA among 3 groups, controlling for age and education factors

	MCI (N = 34)		Dementia (N = 29)		NC (N = 37)	
	RBMT vs MMSE	RBMT vs MoCA	RBMT vs MMSE	RBMT vs MoCA	RBMT vs MMSE	RBMT vs MoCA
Partial correlation coefficient	0.322	0.359	0.724	0.636	0.198	0.343
p (2-tailed)	0.072	0.043*	0.000**	0.000**	0.255	0.044*

*p≤0.05; **p<0.001; MCI = At risk for mild cognitive impairment; NC = Healthy controls; MMSE = Mini-mental State Questionnaire; MoCA = Montreal Cognitive Assessment

Table 5 RBMT-3 cut-off scores

Cut-off score	Sensitivity (%)	Specificity (%)
MCI vs NC		
124.5	83.8	41.2
127.0	81.1	41.2
128.5	75.7	41.2
129.5	73	41.2
130.5	73	47.1
131.5	**73**	**50**
132.5	70.3	52.9
133.5	64.9	52.9
134.5	56.8	52.9
135.5	51.4	58.8
MCI vs mild dementia		
70.5	100	64.7
73.5	100	76.5
75.5	100	82.4
85.5	100	88.2
97.5	100	94.1
102.5	**100**	**100**
106.0	97.1	100
107.5	91.2	100
109.0	88.2	100
111.0	85.3	100
113.0	82.4	100
Mild vs moderate dementia		
32.0	100	0
34.5	100	8.3
37.0	100	16.7
39.5	100	41.7
41.5	**94.1**	**50**
42.5	82.4	50
43.5	82.4	58.3
44.5	82.4	66.7
49.0	76.5	66.7
53.5	70.6	75

MCI = At risk for mild cognitive impairment; NC = Healthy controls