



The “Test Your Memory” test performs better than the MMSE in a population without known cognitive dysfunction

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ABSTRACT

Aim: To examine the relation of performance on the self-administered Test Your Memory test (TYM) and the Mini-Mental State Examination (MMSE) with a comprehensive neuropsychological assessment in a population sample including people with modest cognitive decrements.

Methods: Eighty-six participants (aged 56–77 years), without known cognitive dysfunction, performed a neuropsychological assessment including MMSE, and were asked to fill out the TYM. The relation between both the TYM and the MMSE and a neuropsychological assessment was examined by means of correlation analyses, area under the ROC curves for discriminating between a “normal” and “modest decrements” (≥ 1 SD below the sample mean) group, and Bland–Altman plots.

Results: Correlation with the full neuropsychological assessment was significantly stronger for the TYM than the MMSE ($r = 0.78$ versus $r = 0.55$; Steiger's $Z = 2.66$, $p < 0.01$). The TYM showed an area under the ROC-curve of 0.88 (95% CI 0.80 to 0.97) for differentiating between “normal” and “modest decrements” compared with 0.71 (0.53 to 0.90) for the MMSE. Bland–Altman plots showed limits of agreement for the TYM of -1.10 to 1.10 and for the MMSE of -1.39 to 1.38 .

Conclusions: The TYM showed good correlation with a neuropsychological assessment, performed better in discriminating between variations of cognition and showed more agreement with a neuropsychological assessment than the MMSE.

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1. Introduction

Brief cognitive tests are increasingly implemented in both clinical and research settings. They are not only used for early recognition of cognitive deficits and dementia [1], but also for measuring differences in cognitive functioning between groups, for assessment of treatment effects and for the detection of cognitive decline over time. For these purposes such an instrument should not only discriminate between dementia and normal cognitive functioning, but should also be able to measure more subtle variations in cognitive functioning.

The most widely used brief cognitive screening test is the Mini-Mental State Examination (MMSE) [2]. A recent addition to the available instruments is the Test Your Memory (TYM) test [3]. This test is self-administered by patients, takes about five minutes to complete, and intends to measure a broad range of cognitive domains [3]. In a memory

clinic setting, the TYM showed good diagnostic value compared with the MMSE [4,5]. Therefore, the TYM is a potentially interesting instrument to use, particularly in settings where little time is available for the assessment of cognitive functioning. One of those settings could be the practice of a general practitioner. The range of subtle cognitive decrements in a primary care population, however, is different from patients at the memory clinic, with more people performing in the range of “normal” cognitive functioning. The present study aimed to examine the relation of the performance on the TYM and the MMSE with a comprehensive neuropsychological assessment in a population sample including people with modest cognitive decrements.

2. Methods

2.1. Study population

Participants took part in a cluster-randomized trial in primary care in patients with screen-detected type 2 diabetes that compared the effectiveness of an intensive treatment versus standard care on cardiovascular outcome (the ADDITION-Netherlands study) [6,7]. Cognition was assessed in an add-on project of the main study in a subgroup of

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participants with type 2 diabetes [8], in people with an impaired fasting glucose and in people with a normal glucose level. Participants were aged between 50 and 70 years and participants had been screened for type 2 diabetes. Participants with normal glucose levels were relatives of participants with diabetes. Exclusion criteria were previously diagnosed dementia, a known psychiatric or neurological disorder that could influence cognitive functioning, a history of alcohol or substance abuse or the inability to complete a neuropsychological assessment. Participants with a previous non-invalidating stroke could participate. During the neuropsychological examination participants were asked to fill out the TYM after they had completed a full neuropsychological assessment that also included the MMSE. The present study included all participants who completed the TYM ($n = 86$). The ADDITION-study was approved by the medical ethics committee of the University Medical Center Utrecht, The Netherlands, and was completed in accordance with the Helsinki Declaration. Written informed consent was obtained from all participants.

2.2. Neuropsychological assessment

The neuropsychological assessment consisted of twelve verbal and nonverbal tasks addressing six cognitive domains. The division in cognitive domains was made a priori, according to standard neuropsychological practice and cognitive theory [9]. The domain 'abstract reasoning' was assessed by Raven Advanced Progressive Matrices. The domain "memory" was assessed by the subtest Digit Span of the Wechsler Adult Intelligence Scale –3rd edition (WAIS-III) [10], the Corsi Block-tapping Task [11], the Rey Auditory Verbal Learning Test [12], the Location Learning Test [13] and the delayed recall of the Rey-Osterrieth Complex Figure Test [14]. The domain "information-processing speed" was assessed by the Trail-making Test Part A [15], the Stroop Color-Word Test (part 1 and 2) [16] and the subtest Symbol Digit Substitution of the WAIS-III [10]. The domain "attention and executive function" was assessed by the Trail-making Test Part B (ratio score) [15], the Stroop Color-Word Test (part 3; ratio score) [16], the Brixton Spatial Anticipation Test [17], a letter fluency test using the letters "N" and "A" and category fluency (animal naming) [18]. The domain "visuoconstruction" was assessed by the copy trial of the Rey-Osterrieth Complex Figure Test. Finally, the domain "language comprehension" was assessed with the Token Test (short form) [19]. Subsequently the MMSE was administered. Educational level was recorded in seven categories [20] and subsequently translated into years of education [21]. The tests were administered in a fixed order at the patients' home by neuropsychologists and neuropsychologists in training. The entire battery took about 90 minutes to complete.

Raw test scores of the neuropsychological assessment were standardized into z -scores per test, based on the mean and the pooled standard deviation (SD) of the whole sample that was included in these analyses. The individual's z -score reflects the number of SDs a measurement deviates from the mean of this sample. The z -score of each domain was calculated by averaging all separate test z -scores comprising that domain. The cognitive domains in the neuropsychological assessment were determined a priori and theory-based, instead of with factor analysis. Previous studies by our group have shown that modest differences can be detected with these predefined domains [22,23]. We preferred this procedure above factor analysis on the data from the neuropsychological assessment. A composite score was also calculated by averaging the z -scores of the six domains, representing a "global cognition" score.

2.3. The Test Your Memory test

The TYM was developed to test a range of cognitive functions and consists of 10 subtasks [3]. It is a paper-and-pencil, self-administered

test and takes a person approximately five minutes to fill out. The tasks include orientation (10 points), ability to copy a sentence (2 points), semantic knowledge (3 points; assessed by the questions "who is the prime minister" and "in what year did the first world war start"), calculation (4 points), verbal fluency (4 points), similarities (4 points), naming (5 points), visuo-spatial abilities (2 tasks, total 7 points) and recall of a copied sentence (6 points). The ability to complete the test without help provides an 11th score (5 points). The maximum score is 50 points with lower scores indicating worse cognitive performance. The TYM was translated into Dutch after which a bilingual native English speaker back-translated the Dutch version into English, which resulted in a version almost identical to the original version.

2.4. Statistical analyses

Categorical variables are reported as numbers and percentages, continuous variables as means with SD and not normally distributed variables as median with interquartile range (IQR). Differences between groups in demographic variables and cognitive scores were analyzed with Chi-square tests for categorical variables, independent t -tests for normally distributed continuous variables and Mann-Whitney tests for not normally distributed continuous variables.

The relation between both the TYM and the MMSE and the neuropsychological assessment, which were administered consecutively, was examined in three steps. First, the correlations between both the TYM and the six domains of the neuropsychological assessment and between the MMSE and the six domains as well as the composite score of the neuropsychological assessment were examined using Spearman correlation coefficients, as the results from the TYM and the MMSE were not normally distributed. Differences between the correlations of the two brief cognitive tests with the neuropsychological assessment were statistically tested by means of the Steiger's Z -test [24]. In the primary analyses, no distinction was made between different categories of glucose regulation (diabetes, impaired fasting glucose, normal glucose level). However, because patients with type 2 diabetes were overrepresented in our sample and type 2 diabetes has been associated with modest cognitive decrements [25], a sensitivity analysis was performed adjusting the correlations for diabetes status.

Second, the sample was divided into two groups based on the scores of the neuropsychological assessment. Participants performing 1 SD or more below the mean of the whole sample on the composite z -score were defined as the group with "modest decrements"; those with a score above -1 SD were defined as "normal cognition". This dichotomization translates into a "below average" performance (lowest 16%) of the total sample for the "modest decrements" group. Based on the discrimination of these two groups, a receiver operating characteristics (ROC) curve was plotted to assess the discriminative power of the TYM and the MMSE respectively.

Bland and Altman illustrated that a high correlation between two measures does not necessarily imply that they give an equally high or low estimation of true values [26]. Therefore, in the third step agreement between performance on the TYM, respectively the MMSE, and the neuropsychological assessment was examined with Bland-Altman plots. The mean of the measurements (x -axis) was plotted against the difference between the two measurements (y -axis); both expressed as standardized z -scores with the accompanying corrected 95% limits of agreement [26]. These plots quantify the difference between performances on the TYM and the MMSE on the one hand and the neuropsychological assessment on the other. They create an interval in which 95% of the differences between the two instruments are expected to lie. A narrow 95% interval indicates greater agreement between the tests.

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