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The modified Telephone Interview for Cognitive Status is more predictive of memory abilities than the Mini Mental State Examination

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Abstract

Although not as popular as the Mini Mental State Examination (MMSE), the modified Telephone Interview for Cognitive Status (mTICS) has some distinct advantages when screening cognitive functioning in older adults. The current study compared these two cognitive screening measures in their ability to predict performance on a memory composite (i.e., delayed recall of verbal and visual information) in a cohort of 121 community-dwelling older adults, both at baseline and after one year. Both the MMSE and mTICS significantly correlated with the memory composite at baseline (r's of 0.41 and 0.62, respectively) and one year (r's of 0.36 and 0.50, respectively). At baseline, stepwise linear regression indicated that the mTICS and gender best predicted the memory composite score (R^2=0.45, p<.001), and the MMSE and other demographic variables did not significantly improve the prediction. At one year, the results were very similar. Despite its lesser popularity, the mTICS may be a more attractive option when screening for cognitive abilities in this age range.

Keywords

memory; cognitive screening; geriatrics

Introduction

The Mini Mental State Examination (MMSE) [1] remains one of the most widely used cognitive screening instruments [2, 3], but it has been criticized for a number of shortcomings [4, 5], including being less sensitive to milder cognitive impairments in older adults. Even though the MMSE assesses general cognition, this screening measure has been extensively used in clinical trials for Alzheimer's disease, where memory is a primary deficit [6, 7]. Therefore, one reason for its decreased sensitivity in milder cases (e.g., mild Alzheimer's disease, amnestic Mild Cognitive Impairment) might be its minimal assessment of memory. For example, only 20% of the total points on the MMSE come from memory items (3 for immediate registration, 3 for recall after a brief delay).

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Conversely, other cognitive screening measures have a higher memory load. For example, the modified Telephone Interview for Cognitive Status (mTICS) [8, 9] devotes twice as much of its total score to memory (i.e., 20 of its 50 points to immediate and delayed recall of a list of 10 items) compared to the MMSE, which may make it more sensitive in identifying memory changes in patients. This measure was developed to identify dementia in community-dwelling cohorts of older adults. For example, Welsh et al. [8] used the mTICS to classify cognitively normal elders from those with mild cognitive impairments and dementia. Brandt et al. [10] used this screening instrument in a large study of Alzheimer's disease in aging twin veterans. The mTICS has other distinct advantages over the MMSE, including that it can be administered over the telephone. Like the MMSE, the mTICS has age- and education-corrected normative data [11], it is associated with more formal neuropsychological test results [12], and it can discriminate cognitively intact elders from those with amnestic Mild Cognitive Impairment [13].

Although multiple studies have reported modest to high correlations between scores on the mTICS and the MMSE in geriatric samples [14–19] and the mTICS has shown modest relationships to memory tests in neuropsychological batteries [17, 20] in older cohorts, to our knowledge, no studies have compared the MMSE and mTICS in their ability to predict current and future cognition on formal neuropsychological tests. If these screening measures accurately predict performance on more traditional cognitive measures, then their value in clinical practice and research settings increases. Therefore, the current study sought to compare these two cognitive screening measures in their ability to predict memory functioning on an in-person evaluation in a cohort of community-dwelling older adults, both at baseline and after one year. Based on our experience using these measures, it was hypothesized that the mTICS would better predict memory functioning compared to the MMSE.

Methods

Participants

One hundred twenty-one community-dwelling older adults (aged 65 and older) participated in this study, and these individuals have been previously described [12]. They were mostly female (77.7%) and mostly Caucasian (96.7%), with a mean age of 74.8 (6.6) years and mean education of 15.4 (2.8) years. These individuals also showed few symptoms of depression (30-item Geriatric Depression Scale: M=4.5, SD=3.8). Of these individuals, 81 also completed a one year follow up visit, and their demographics are similar to the larger group (e.g., 76.5% female, 97.5% Caucasian, mean age of 74.9 (6.8) years, mean education of 15.4 (2.9) years).

Procedures

Before the project began, the study protocol and all study procedures were approved by the University of Utah Institutional Review Board. Participants were recruited for this study by community newsletters and presentations at senior centers and independent living facilities. All participants provided written informed consent prior to participation in study procedures. Monetary compensation was also provided for participants' time.

Participants were screened for memory impairments over the telephone with the mTICS. Any individual scoring 19 or below was excluded, as this indicated frank dementia [21] and the study focused on persons with normal cognition or those experiencing mild cognitive impairment. Other exclusion criteria included history of major neurological disease (e.g., dementia, traumatic brain injury, stroke), psychiatric illness (e.g., Bipolar Disorder, Schizophrenia), or current depression (30-item Geriatric Depression Scale >15). Participants passing the mTICS screening were invited for an in-person baseline cognitive assessment.

The baseline cognitive assessment included: a brief medical history interview, MMSE, Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), Brief Visuospatial Memory Test – Revised (BVMT-R), and Hopkins Verbal Learning Test – Revised (HVLT-R). The one year follow up assessment included the above assessments with the exception of the MMSE. All measures were administered and scored according to their respective test manuals by trained research assistants.

Measures of interest. The MMSE [1] is a widely-used brief screening measure of cognition that taps several different areas of cognition, including orientation, attention, language, and memory. Scores range from 0 to 30, with higher scores indicating better cognition. A total of 6 points can be earned on memory items. The MMSE has demonstrated adequate reliability and validity, especially in the assessment of geriatric patients with notable cognitive deficits [5].

The mTICS [8, 9, 17] is also brief, and it can be administered in person or over the telephone. It is a 14-item measure with scores ranging from 0 to 50, with higher scores indicating better cognition. It also measures orientation, attention, language, and memory, with a total of 20 points devoted to memory. It also has research to support its reliability and validity in elderly samples [12, 13].

Data Analysis. First, two memory composite scores (baseline and one-year) were calculated for each participant by averaging the standard scores on the RBANS Delayed Memory Index, the HVLT-R Delayed Recall, and the BVMT-R Delayed Recall. Second, correlations were calculated between the two screening measures (mTICS and MMSE) and the two memory composite scores. Third, two sets of stepwise linear regression models were then calculated. In the first set, the baseline memory composite score was the criterion variable, and the mTICS, MMSE, age, education, and gender were the predictor variables. In a second set, the one year memory composite score was the criterion variable, with the same predictor variables. In each of these regression models, collinearity diagnostics did not appear to be problematic (e.g., tolerance 0.68 – 1.0, variance inflation factor 1.0 – 1.5).

Results

In the sample of 121 participants that completed baseline memory testing, the mean total MMSE score was 28.1 (1.8), with a range of 20 to 30, the mean total mTICS score was 36.5 (5.1), with a range of 20 to 48, and the mean baseline memory composite score was 97.7 (14.4), with a range of 52.7 to 123.3. Although the mTICS and baseline memory composite were normally distributed, the MMSE was not (Shapiro-Wilk $p<0.001$). As such, non-

parametric correlations (Spearman's rho) was used. MMSE and the baseline memory composite scores significantly correlated (r=0.38 p<0.001), and the mTICS was also significantly correlated with baseline memory composite scores (r=0.59 p<0.001). Fisher r to z transformations indicated that the mTICS was more highly correlated with the baseline composite than was the MMSE (z=−2.13, p=0.02).

Stepwise linear regression indicated that the mTICS significantly predicted the baseline memory composite score (F[1,119]=73.76, R^2=0.38, p<0.001). Gender significantly added to this equation (ΔR^2=0.07, p<0.001). The MMSE score did not significantly improve the prediction of the baseline memory composite scores (p=0.34). Age and education also did not significantly improve this equation (age: p=0.79, education: p=0.79).

In the sample of 81 participants that completed one year follow up memory testing, the mean total MMSE score was 28.2 (1.7), with a range of 22 to 30, the mean total mTICS score was 36.7 (5.4), with a range of 20 to 48, and the mean one year memory composite score was 99.1 (14.2), with a range of 62.7 to 125.3. There were no differences between those with follow-up data and those without follow-up data on any demographic (age, education, gender) or cognitive (MMSE, mTICS, baseline memory composite) variable. Spearman's correlation of the MMSE and one year memory composite score was significant (r=0.41 p=0.001), as was the correlation of the mTICS and one year memory composite (r=0.55 p<0.001). Fisher r to z transformation was not statistically significant (z=−1.14, p=0.12) indicating that these two correlations were comparable.

Stepwise linear regression again indicated that the mTICS significantly predicted the one year memory composite score (F[1,79]=29.49, R^2=0.27, p<0.001) with the addition of gender (ΔR^2=0.08, p=0.004). Again, neither MMSE, age, nor education significantly improved the prediction (p=0.21, p=0.29, p=0.52, respectively).

In secondary analyses, when each individual delayed memory score was considered separately, the results were very similar to those obtained using the memory composite score (i.e., mTICS predicted memory better than the MMSE). This was true for both baseline and one-year memory scores. The two screening measures were also compared to the baseline memory composite with receiver operating curves (ROC) analyses. In these, the baseline memory composite was dichotomized as ≤ 85 being "impaired" and >85 being "intact. When lower scores on the screening measures were indicative of greater memory impairment on the composite, the resulting areas under the curve (AUC) for the mTICS was 0.85 and the MMSE was 0.77, which were statistically comparable (z=−1.32, p=0.09).

Discussion

Although prior studies have found modest to high correlations between the mTICS and MMSE in geriatric samples [14–19], none have compared these two cognitive screening measures in their ability to predict current memory functioning in community-dwelling older adults. Consistent with our primary hypothesis, the mTICS was the best predictor of current memory functioning in this cohort. This is generally consistent with prior findings showing that the mTICS had modest correlations with memory tests in samples of older adults [17,

20]. Gender significantly added to the prediction of current memory functioning, but the MMSE and other demographic variables (e.g., age, education) did not. These results were very similar in a smaller subset of the sample who were re-evaluated for memory functioning after one year. Again, mTICS and gender best predicted this follow-up memory composite, whereas MMSE and other demographic variables did not significantly contribute to the model.

Despite the statistically significant prediction models, only 35 – 45% of the variance of current and one-year memory functioning was predicted by mTICS and gender. Clearly, additional variables need to be considered to improve these prediction models if they are to have more clinical relevance. Our sample was almost exclusively Caucasian, so greater diversity may improve the contribution of this variable, as racial and ethnic differences are common on neuropsychological tests [22]. Predominant occupation might be another variable worth examining in the future since it can also be predictive of late life cognitive abilities [23]. Other possible variables of interest include affect [24], personality [25], and physical functioning [26].

Our initial assumption was that the mTICS would more strongly predict a memory composite compared to the MMSE because the former measure devotes more of its total score to memory items (e.g., 40% vs. 20%, respectively). Although the current study was not specifically designed to address this assumption, the data seems to suggest that it is not just the memory items that make the mTICS sensitive. For example, as reported above, the total score on the mTICS correlated with the baseline memory composite at 0.62. However, memory-specific items within the mTICS showed slightly smaller correlations with the memory composite (e.g., immediate recall r=0.48, delayed recall r=0.52, immediate and delayed recall combined r=0.53). Clearly, the non-memory items of the mTICS also contribute to its sensitivity to memory functioning. It is also possible that the additional memory items on the mTICS may have a paradoxical effect. For example, patients may experience fatigue or stress in response to the longer list of items on the mTICS (compared to the MMSE), which could reduce its ability to accurately tap memory.

Despite the potential benefits of the mTICS identified in this study, there are some limitations of this work that should be noted. First, our sample was exclusively cognitively intact to mildly affected. Individuals with more significant cognitive impairments (mTICS<20) were excluded. It is unclear if these results would generalize to patients with dementia or other serious cognitive deficits. Second, our sample was also nearly all Caucasian, well-educated, willing to participate in longitudinal research, and with minimal depression, and generalizability to more diverse samples needs to be verified. Third, a formal hearing evaluation was not conducted on participants, and Pachana et al. [15] has shown that mTICS scores can be adversely affected by hearing loss. Fourth, the current results only examined a memory composite at baseline and one-year, when cognitive domains beyond memory may be of interest as well. Fifth, the differences between the mTICS and MMSE may not be huge, even though results favored the mTICS in this sample. For example, in our secondary analyses, ROC analyses showed that the AUC for the mTICS was higher than that for the MMSE, although both were adequate. Future comparisons between these two measures are needed. Finally, the mTICS was used as a screening

measure in this study, and it may have biased the sample. Using the MMSE or another screening measure may have led to a different composition of subjects. Similarly, linking the cognitive screening scores to widely-used clinical and biomarker variables (e.g., clinical diagnoses, amyloid beta or tau levels, structural or functional MRI) would be another future step.

Even with the above-noted limitations, the current results provide more information about the mTICS and how it relates to memory functioning in older adults. This may make it a more attractive option when screening for memory abilities in this age range. It is possible that this telephone-based cognitive screening instrument may supplant the MMSE for these types of milder cases. It is worth reiterating that these analyses focused on predicting memory abilities from screening measures designed to assess global cognition, as memory is one of the earliest and primary deficits seen in mild Alzheimer's disease and amnestic Mild Cognitive Impairment, two conditions on which clinical trials are currently focused.

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Table 1

Demographic and cognitive data on sample.

	Baseline sample	One-year sample
Age (years)	74.8 (6.6) 65 – 90	74.9 (6.7) 65 – 90
Education (years)	15.4 (2.8) 8 – 22	15.4 (2.9) 12 – 22
Gender (female)	77%	77%
mTICS	36.5 (5.1) 20 – 48	36.7 (5.4) 20 – 48
MMSE	28.1 (1.8) 20 – 30	28.2 (1.7) 22 – 30
Baseline memory composite	97.7 (14.5) 52.7 – 123.3	98.8 (14.6) 52.7 – 123.3
One-year memory composite	n/a	99.1 (14.2) 62.7 – 125.3

Note. Where applicable, means and standard deviations (in parentheses) are presented in the upper part of each cell, with ranges in the lower part of cells. mTICS = modified Telephone Interview for Cognitive Status. MMSE = Mini Mental State Examination.

Table 2

Regression table.

Variable	R^2	F(df), p	SEE	Constant	Equation
Baseline Memory					
mTICS	0.38	73.8(1,119), <0.001	11.4	34.2	+ (1.7*mTICS)
+ Gender	0.45	49.3(2,118), <0.001	10.8	46.8	+ (1.7*mTICS) – (9.3*Gender)
One-year Memory					
mTICS	0.26	29.5(1,79), <0.001	12.2	48.4	+ (1.4*mTICS)
+ Gender	0.33	20.8(2,78), <0.001	11.6	59.4	+ (1.4*mTICS) – (9.1*Gender)

Note. SEE = Standard Error of the Estimate of the regression model. mTICS = modified Telephone Interview for Cognitive Status. Gender (1 = female, 2 = male).