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New Developments in Cognitive Testing

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SYNOPSIS

Cognitive tests used in the long-term care insurance industry differ in cognitive domains tested, time required for testing, ease of test administration, sensitivity and specificity. Recently, new approaches to scoring or testing have improved test utility for screening for cognitive impairment. The cognitive test best suited for a particular situation is determined by the purpose of testing and the environment in which testing is conducted. In this article, we briefly review several tests of cognitive function currently used in the long-term care insurance industry, and describe two new approaches to cognitive testing. Though each of the cognitive tests addressed in this article has a role in assessing cognitive function, the AQT Test of Cognitive Speed provides several advantages to the long-term care industry, including ease of administration, high sensitivity and high specificity.

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Introduction to the Need and the Tests

Dementia is characterized by progressive cognitive impairment, leading to dependency and death.[1] The consequences are devastating for the individual and for the family, in terms of both personal loss and enormous financial cost.[2-5] While fewer than 5 percent of people have dementia at age 60, the incidence rises to about 50 percent in those in their 80s.[6-7]

More and more individuals want to be screened for dementia. Screening offers afflicted individuals an opportunity to be treated with medications with known effectiveness to improve cognition or delay cognitive decline. Thus, there is medical justification, as well, for early screening.

When the cost for care is covered by a long-term care insurance policy, the financial burden shifts, at least partially, to the long-term care insurance company that issued the policy. Long-term care insurance companies, hoping to avoid adverse selection, usually require some type of medical assessment prior to issuing a policy for long-term care insurance. Cognitive tests are commonly used as part of this assessment.

Numerous cognitive tests are available to assess cognitive function. They differ in cognitive domains tested, time required for testing and ease of test administration. Recently, new approaches to testing have been developed, and offer improved sensitivity and ease of testing. This article provides a review of key issues pertinent to screening for cognitive impairment in the long-term care insurance industry. We describe several current testing methodologies: the Mini Mental-State Examination (MMSE),[8] the Short Portable Mental Status Questionnaire (SPMSQ),[9] and the delayed word recall (DWR).[10] Then, we introduce two new testing methodologies—the Correspondence Analysis-Weighted Scores[11] and the AQT Test of Cognitive Speed.[12]

Why Is It Difficult to Detect Dementia?

Detecting cognitive disease at an early stage is challenging due to several related factors. First, cognitive performance in a normal population is characterized by wide variability; that is, some people have cognitive ability substantially above average, and some have cognitive ability substantially below average, albeit normal. This variability is due in part to the influence of hereditary and developmental factors, and also due to education, practice, medical disease, medication, age and a host of environmental factors.[13-18] This broad variability, both between individuals and within individuals, complicates detection of disease that impairs cognitive performance.[19-23]

Second, characteristics of dementia itself make identification difficult. Dementia occurs slowly. It causes few recognizable symptoms. In an early state, disease is unlikely to be suspected based on observation alone. Further, individuals with progressive disease may pass through multiple levels of intellectual function. If their pre-disease "normal" state is one of superior function, they may demonstrate intellectual performance that appears normal, even while they are losing cognitive skills.

Third, the most commonly used tests of cognitive content have suboptimal accuracy for detecting disease in early stages, or for differentiating disease from normal aging.[24] Newer tests offer hope of early detection, improved detection of disease or ease of administration.

Comparison of Cognitive Tests

The most commonly used tests of cognitive function have been based on observation or testing of cognitive content, such as memory and construction.[8, 25-27] Because aberration of content is both clearly recognizable and clearly abnormal, these observations or tests have been useful to detect established (moderate or late stage) dementia and differentiate it from the normal state.

The Mini-Mental State Examination (MMSE)[8] tests subject ability to perform serial subtraction, recall three words previously registered, name common objects, repeat a sentence, read text, write text and copy geometric figures. This exam is relatively easy to administer, but requires highly trained personnel. It has a relatively low sensitivity for detecting dementia.[24] MMSE is sometimes administered in partial form (excluding the writing, reading and construction portions) via telephone, but the validity of the telephone administration has not been published.

The Short Portable Mental Status Questionnaire (SPMSQ)[9] tests a subject's ability to perform serial 3 subtractions, and to recall their age, birth date, telephone number, street address, mother's maiden name, as well as the current U.S. president, past U.S. president and day of the week. SPMSQ can be administered by telephone. Educated English-speaking adults with normal cognition usually perform the MMSE or SPMSQ tests without difficulty. However, both the MMSE and SPMSQ have low sensitivity and specificity, and are affected by the subject's education level.[8,26,28] And, disturbingly, the SPMSQ appears to be affected by race. This effect occurs even when educational levels are considered. This means that if the test were used as designed, one would need to have different criteria by race for deciding when a subject is impaired. To have different criteria might be deemed socially unacceptable; to not have different criteria would be scientifically invalid.[9]

Delayed word recall is commonly used in the long-term care insurance industry, either alone or as part of a battery of tests. For this test, the subject is shown 10 cards each containing one word. As the cards are being shown one at a time, the subject is asked to read the word, use the word in a sentence, and memorize it. After a delay, the individual is asked to recall the 10 words. Only 1 of 55 normal individuals recalls all 10 words.[10] The mean score is six words; some normal subjects recall as few as three out of 10 words. If scored alone, DWR should probably not be used for decision-making because of known low repeatability. Used together with other data as part of a prediction equation, it is acceptable, if the DWR factor improves the predictive value of the equation.

Some organizations administer the DWR over the telephone—a modification that makes administration convenient. However, this method of testing obviously tests different cognitive circuits, and may achieve different results. Further, this method of testing has not been fully validated in the literature. Delayed word recall has been incorporated into a test battery known as the Minnesota Cognitive Acuity Screen (MCAS).[29]

New Approaches to Cognitive Testing

Correspondence Analysis-Weighted Scores: In hopes of improving the utility of delayed word recall, some investigators[11] have proposed a weighted scoring system for delayed word recall, based on the fact that recall difficulty is influenced by the word itself (some words are harder to remember), and by its position in the list (words in the middle are harder to remember). When this weighted score was used in a regression equation, together with other demographic and medical information, the test sensitivity to detect cognitive impairment improved compared to sensitivity when the correct word count alone was used in the equation.

Because correspondence analysis depends on word recall, it should be expected to have the same limitations and restrictions as DWR. Further, the test procedure requires considerable time and repetitive testing. Whether the advantages extend to administration over the telephone has not yet been determined.

The AQT Test of Cognitive Speed: An alternative approach to assess cognitive function is to measure processing speed. Tests of processing *speed* use time, rather than content, as the outcome measure, and include both reaction time and response time for various tasks.[12,13, 30-33] These methods are sensitive to even small changes in processing speed and have been used to examine the effects on cognition of epilepsy, executive function disorders, frontal lobe involvement, temporal-parietal lobe dysfunction, medication effect and other neurological conditions.[14,16-17] Tasks based on rapid automatic naming of familiar competing stimuli are specialized measures of processing speed that allow evaluation of cognitive functions that underlie recognition, memory, reading and language production. The AQT can be performed easily and inexpensively in a matter of minutes, and training to administer the test can be accomplished with just a few minutes

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Figure 1: AQT Stimuli for Naming Color, Form and Color-Form

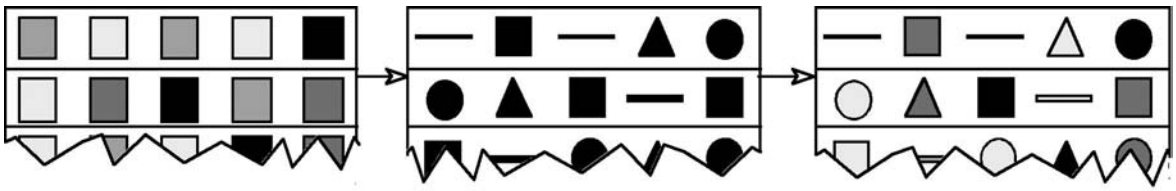
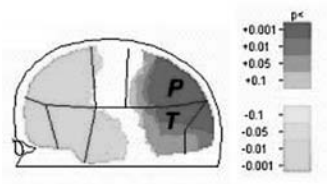


Figure 2: During color-form naming tests, the normal brain shows greatly increased cognitive activity in the temporal (T) and parietal (P) regions.



of self-training.[34] AQT may be administered by telephone.[35]

People complete the AQT by naming, as rapidly as possible, the color of 40 colored squares on the first test page (Fig. 1A). Then, as quickly as possible, they name the form (shape) of 40 black forms on a second test page (Fig. 1B). Finally, as quickly as possible, they name both the color and form combination of a series of 40 items on a third test page (Fig. 1C), e.g. "blue line, red square, blue line, yellow triangle". The combination-naming task is substantially more challenging than naming either color or shape alone.[31] Individuals with impaired cognition require more time than non-afflicted individuals to complete the naming.[36-37]

The AQT in Figure 1 above detects cognitive impairment because it is designed to detect impairment in the brain regions involved with dementia. Braak and Braak,[38] in exquisitely detailed pathological studies, have shown that the earliest pathological signs of Alzheimer's Disease begin in the parahippocampus and hippocampus, which are temporal lobe structures, and then spread to the parietal lobe. The AQT is designed specifically to test temporal and parietal lobe functions. If the temporal and parietal regions are damaged, as in dementia, there is reduced activity and reduced blood flow during color-form naming,[39] and an associated increase in color-form naming time.[36]

AQT sensitivity (detection of people who have the disease) in Figure 2 above is 97 percent.[36] Specificity (recognition of normality in people without disease) is 97 percent.[36] The positive predictive value (likelihood that a person with a positive test actually has the disease) is thus 99.9 percent. This result is impressive, considering the apparent simplicity of the test and its administration. Further, AQT utility to diagnose dementia is not affected by age, gender or cultural-linguistic background.[12] Results are similar across languages—including English, Spanish, French Canadian, Swedish and Danish.[37] While results have a low positive correlation with age (increasing about 0.1 seconds per year), this age-effect will not interfere with test utility because people with dementia have scores substantially above the normal range.[33]

Choice of a Cognitive Screening Test

The choice of test will be influenced by the purpose of testing and the population tested. Medical providers at a cognitive clinic, where the incidence of dementia is high, will want a test with high sensitivity (ability to detect disease when it is present). Specificity will have secondary importance because false positives will be less common in this population. Medical providers have available an array of alternative tests to substantiate or eliminate a diagnosis. The cost of

evaluation and patient inconvenience usually are not primary considerations.

Hopefully, underwriters for a long-term care insurance company will be exposed to a population with a low incidence of cognitive impairment. The optimal test for widespread screening will be characterized by rapidity, ease of administration by non-medical personnel, ease of training, low cost and high utility as measured by both sensitivity and specificity. It may be administered via telephone, so as to minimize subject inconvenience and cost of administration.

Table 1 below compares cognitive tests on the basis of these criteria for a screening test of cognitive impairment. The tests that provide the best performance for each characteristic are shaded.

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Table 1: Characteristics of a Screening Test

Characteristic	MMSE[a]	SPMSQ[b]	DWR[c]	CA[d]	AQT[e]
Rapidity (minutes for testing)	10 mins.	10 mins.	15 mins.	15 mins.	3-5 mins.
Non-medical Personnel	No	No	No	No	Yes
Simple Training	No	Yes	No	No	Yes
Estimated Cost	Moderate	Moderate	High	High	Low
Free from influence of age, education, culture	No	No	No	No	Yes
Specificity[f]	.94	.92	.96	.96	.99
Sensitivity[f]	.88	.87	1.00	.91	.99
Candidate for administration via telephone	Partial	Yes	Yes	Partial	Yes
Utility as Screen	Low	Low	Low	Moderate	High

a) Mini Mental-State Examination
b) Short Portable Mental Status Questionnaire
c) Delayed Word Recall
d) Correspondence Analysis-Weighted Scores
e) Alzheimer's Quick Test
f) Highest value reported in literature

To summarize, those interested in screening for disease or establishing a baseline for later comparison, will demand a test that is simple, inexpensive and reliable. MMSE and SPMSQ are not optimal for these purposes because of low sensitivity (lowering the predictive value of a negative test) and specificity (lowering the predictive value of a positive test). Delayed word recall can be administered via the telephone. Correspondence analysis-weighting scores improve the predictive value of the regression equation. AQT does not require medical training, can be administered in person or over the telephone, and has high sensitivity and specificity. ❋

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