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Functional cognitive assessment scale (FUCAS): a new scale to assess executive cognitive function in daily life activities in patients with dementia and mild cognitive impairment

Fotini Kounti[1], Magda Tsolaki[2]* and Grigoris Kiosseoglou[1]

[1]*School of Psychology, Aristotle University of Thessaloniki, Thessaloniki, Greece*
[2]*School of Medicine, Aristotle University of Thessaloniki, Thessaloniki, Greece*

Background Several tests have been developed to examine performance of demented patients in daily life activities. However, most of them are based either on the subjective evaluation of performance by the patient him/herself, or on the reports of relatives. Functional Cognitive Assessment Scale (*FUCAS*) is a new reliable ($\alpha > 0.89 - 0.92$) cognitive-behavioral scale that assesses executive function in daily life activities directly in patients with dementia.
Aims This study aimed at testing *FUCAS*' internal consistency of items, criterion-related validity, interrater reliability, discriminative ability, and effect of age, sex, and education on FUCAS scores.
Results Criterion-related validity was supported by significant correlations between FUCAS, CAMCOG, MMSE, and FRSSD. The interrater reliability of FUCAS' total score for two raters was r 0.997 and we found no significant effect of age, sex, or education on FUCAS' total performance. Discriminant analysis has identified that FUCAS was able to sufficiently discriminate the patients with MCI from those with moderate-severe dementia.
Conclusion FUCAS is a useful and reliable diagnostic tool for MCI. Cognitive-behavioral assessment such as that provided by FUCAS can provide objective information that can serve to enhance the quality of clinical decision-making.

KEY WORDS — assessment; executive function; daily life activities; behavioral test of everyday functioning

INTRODUCTION

There is a growing consensus that damage to the frontal lobes predominantly affects higher integrated processes such as planning, decision-making, or central executive processes devoted to the control and regulation of cognition (Amieva *et al*., 2003). From a variety of sources, there is now abundant evidence that the prefrontal cortex undergoes deterioration as a function of normal aging. Dysfunction of frontal systems was related to many of the age-related cognitive deficits such as working memory deficits or decline in executive functions (Daigneault and Braun, 1993; West, 1996; Phillips, 1999). Indeed, deficits in planning, decision-making, organization, self-control, and awareness of problems are very likely to affect daily life functioning of elderly people. For instance, executive functioning was shown to be an important determinant of how elderly people manage with instrumental activities of daily living such as managing money or taking medication (Grigsby *et al*., 1998; Carlson *et al*., 1999). The study of Goverover (2004) examined the relationship between executive function and everyday functional competence in individuals with brain injuries. Executive function was assessed using measures of categorization and deductive reasoning ability, both of which were shown by multiple regression analysis to predict performance of Instrumental Activities of Daily Living.

Declines in functional ability [typically measured by activities of daily living (ADL)] have been consistently related to cognition (Kelly-Hayes *et al*.,

* Correspondence to: M. Tsolaki, Medical School, Aristotle University of Thessaloniki, Thessaloniki, Greece. Tel.: 30-2310-234239. E-mail: tsolakim@med.auth.gr

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1992; Gill *et al*., 1995; Moritz *et al*., 1995; Béland and Zunzunegui, 1999; Hebert *et al*., 1999), particularly as part of the dementia syndrome (Freels *et al*., 1992; Zanetti *et al*., 1993). Indeed, functional decline is an important hallmark of Alzheimer's disease (AD) and other neurogenerative diseases (World Health Organization, 1992 and American Psychiatric Association, 1987, DSM-III-R), and is one of the most manifest features in the clinical course of dementia. However, it has been also found that cognitively impaired subjects who do not reach a dementia diagnosis still have higher disability than subjects with intact cognition (Gill *et al*., 1995). Using data from the Kungsholmen Project (Agüero-Torres *et al.*, 1998), Agüero-Torres *et al*. (2001) found that dementia and cognitive impairment are the strongest contributors to both the development of functional dependence and decline in function in the elderly, after controlling for sociodemographic factors and other chronic diseases.

To tap the patient's ability to engage in activities of daily living, measures such as the Blessed Dementia Rating Scale (Blessed *et al*., 1968), OARS: Instrumental Activities of Daily Living Scale (1988), Functional Assessment Tool (Reisberg *et al.*, 1985), and Functional Rating Scale of Symptoms of Dementia (Hutton, 1990) have been developed. These scales rely either on self-reports of the patient or, more often—particularly in instances of increasing disability—on the reports of family members. While valuable, these approaches have the drawback of reporter's bias (Lowenstein, 1989). The few instruments that have been developed to directly assess functional behaviors of the elderly, such as the PPG Instrumental Activities of Daily Living Scale (Lawton, 1972) or the Performance Activities of Daily Living Scale (Kurianky and Gurland, 1976) may be insensitive to subtle changes in specific skills, which occur in the incipient phases of AD and other dementias (Lowenstein, 1989).

The Functional Cognitive Assessment Scale (FUCAS) is a new cognitive-behavioral scale, designed to assess parameters of executive function affecting the execution of daily life activities, in patients with dementia and Mild Cognitive Impairment (MCI). The construction of FUCAS is based on the assumption that performance of daily life activities is essentially a problem-solving situation, involving awareness of the problem, planning of the solution, and execution of the planned solution (Levin *et al*., 1991).

Aims

The study aimed to examine the internal consistency of the items, the criterion-related validity, the interrater reliability, and the discriminative ability of FUCAS. Moreover, we wanted to assess the possible effect of age, sex, and education on FUCAS scores.

METHOD

Participants

Participants were outpatients from the memory clinic of the Papanikolaou Hospital in Thessaloniki. One hundred ninety-one men and 256 women, 55–88 years old, with 4–19 years of education and matched socioeconomic background participated in the validation study of FUCAS. Performance in MMSE ranged from 10 to 30. Participants had undergone neurological, neuroimaging, and neuropsychological assessment. They did not present sensory motor impairment and they were not suffering from depression. Two hundred sixty-six participants met NINCDS-ADRDA (McKhann et al., 1984) and DSM IV (1994) criteria for dementia and 182, the criteria of Petersen *et al.* (2001) for MCI. The participants were stratified in three groups, patients with very mild dementia ($N = 135$), moderate and severe dementia ($N = 131$), and MCI ($N = 181$), and the groups were matched in age, sex, and education (Table 1). The patients with very mild dementia had a family history of dementia from a first-degree relative. Their performance in MMSE was equal to 24. They had lost points from the recall of the three words and the questions of time orientation. However, they were using compensating cognitive strategies and neuroimaging had shown a normal CT but temporo-parietal impairment in SPECT. We used the Clinical Dementia Rating scale in order to discriminate between the stages of dementia and MCI. Thus, MCI patients' performance was CDR = 0.5. They presented subjective and objective memory impairment but they

Table 1. Demographic characteristics of the participants in the validation study

Characteristics	MCI	Very mild dementia	Moderate-severe dementia
CDR	0.5	0.5	1
Men	76	64	51
Women	105	71	80
Education	4–19 years	4–19 years	4–19 years
Age	55–88 years	55–88 years	55–88 years
MMSE *M* (SD)	24.40 (4.02)	25.45 (3.70)	18.44 (4.24)
FRSSD *M* (SD)	3.04 (1.53)	7.95 (2.00)	12.83 (4.66)

MMSE, mini mental state examination, FRSSD, functional rating scale of symptoms of dementia, CDR, clinical dementia rating.

were functionally independent (FRSSD = 5). Patients with very mild dementia had CDR = 0.5, memory impairment, impaired executive function, and mildly impaired daily functioning (FRSSD = 6). Patients with moderate or severe dementia had CDR = 1–1.5, moderate or severe memory impairment, moderate deficits in several cognitive abilities, and moderate-severe impairment in daily functioning (FRSSD = 10). Patients with MCI were not taking any medication that could affect cognitive function, while patients with dementia were taking inhibitors of cholinesterase. Men and women participated voluntarily in the study.

Procedure

The neuropsychological assessment included Camcog (CAMDEX, Fountoulakis *et al*., 2000) and Mini Mental State Examination (CAMDEX, Fountoulakis *et al*., 2000) as cognitive tests, Functional Rating Scale of Symptoms of Dementia (Hutton, 1990) as a test of daily functioning, and FUCAS. MMSE, Camcog, and FRSSD were included in the neuropsychological evaluation in order to be used for the examination of the criterion-related validity of FUCAS. The tests were administered by trained psychologists; the examiners did not know the diagnosis of the patient that they were assessing. The order of tests' administration was kept stable across the three groups. Thirty patients, 10 with MCI, 10 with very mild dementia, and 10 with moderate-severe dementia were assessed simultaneously by two different psychologists, in order to examine the interrater reliability of FUCAS. The examination session lasted about 2 h with an interval of 15 min.

Measures

The *Mini Mental State Examination* (MMSE) is a common, fast, reliable psychometric tool, for the assessment of cognitive performance. It examines orientation in time and place, memory, attention, naming, comprehension, execution of oral and written instructions, and written language. The total score is up to 30 points. According to its standardization in Greek population, points 23–24 were found to be the cut-off point for the differentiation between healthy persons and patients with probable dementia. Previous research has shown that performance on MMSE is influenced by education, race, and socio-economic level (Fountoulakis *et al*., 2000).

The *Cambridge Cognitive Function Examination* (CAMCOG) is part of the psychiatric battery CAMDEX, designed to diagnose and assess dementia. CAMCOG assesses cognitive functions such as: orientation (in time and place), verbal comprehension and expression, long-term and short-term memory, concentration, perception, praxis, abstract thinking, and calculation ability. The best possible score is 107. According to its standardization in Greek population, 79/80 points were found to be the cut-off point for the differentiation between healthy persons and patients with probable dementia. The CAMCOG examination is not influenced by sex or race, but is influenced by age and education (Tsolaki *et al*., 2000).

The *Functional Rating Scale for Symptoms of Dementia* (FRSSD) assesses the functioning of the patient in 14 everyday life activities: food, clothing, incontinence, speech, sleeping, face recognition, personal hygiene, and memory for names, episodic memory, vigilance, global confusion, orientation (place), emotion, and social behavior. The rating scale ranges from 0 to 3 points, that is, from no impairment (0) to severe impairment (3). The FRSSD is administered to the caregiver rather than the patient him/herself. Therefore, the report may be influenced by the emotional and physical impact caused by the disease on the caregiver. A score of 5 is proposed as the cut-off point for the differentiation between healthy persons and patients with possible dementia.

Functional Cognitive Assessment (FUCAS) is a 13-item scale that asks patients to execute 6 different activities of daily life. The activities include telephone communication, shopping, orientation in place, taking of medication, personal hygiene, and clothing. The examiner evaluates through constant direct observation seven parameters of executive function during the execution of each daily activity by the patient. The parameters assessed are awareness of the problem, working memory, planning of the solution, distribution of time between the steps of the activity, sequence of steps, accuracy of steps, and goal maintenance. A score of 1 indicates no problem with the executive parameter that we examine in a certain activity, 2 indicates a mild-to-moderate problem, and 3 indicates a severe problem. FUCAS is designed to provide also a sub score of performance for each executive parameter which reflects the total patient's performance in the six activities. Thus, a score of 6 indicates no problem with the executive parameter assessed totally in all the six activities, 7–12 indicates a mild-to-moderate problem, and 13–18 indicates a severe problem. It is also possible to extract a sub score of total executive function in every activity assessed. A score of 7 indicates no problem with total executive function in a certain daily activity, 8–14

indicates a mild-to-moderate problem, and 15–21 indicates a severe problem. At last, we can have a total score of FUCAS representing the sum of the executive parameters' sub scores, ranging from 42 to 126 points. In the validation study of FUCAS, we used the seven sub scores, one for each executive parameter, the six sub scores for the total executive function in each daily activity assessed, and the total score of FUCAS.

RESULTS

The primary objective of this study was to document the psychometric properties of FUCAS. Chronbach's alpha analysis ($N = 75$) revealed acceptably high internal reliability for all items and sub scores, ranging from 0.89 to 0.92 (Table 2).

The criterion-related validity was examined by comparing FUCAS' scores with CAMCOG, MMSE, and FRSSD total scores. Pearson's analysis has shown significant correlations between the total score of Camcog and the sub scores of Fucas (Table 3), representing the seven parameters of executive function namely, Awareness of the problem (r −0.669), Working Memory (r −0.603), Planning of the solution (r −0.677), Distribution of time between the steps of the activity (r −0.317), Sequence of steps (r −0.635), Accuracy of steps (r −0.592), and Goal maintenance (r −0.617). Significant correlations were also found (Table 3) between the total score of MMSE and Awareness of the problem (r −0.704), Working Memory (r −0.577), Planning of the solution (r −0.668), Distribution of time between the steps of the activity (r −0.289), Sequence of steps (r −0.610), Accuracy of steps (r −0.561), and Goal maintenance (r −0.597).

Moreover, we examined the correlation between the total score of FRSSD and the six sub scores of FUCAS representing the total executive function in each functional domain. Pearson's analysis has shown significant correlation (Table 3) between FRSSD total score and taking of medication (r 0.508), telephone communication (r 0.545), shopping (r 0.459), orientation in place (r 0.505), personal hygiene (r 0.127), and clothing (r 0.425). The total score of FUCAS was also significantly correlated with the total score of Camcog (r −0.784), MMSE (r −0.781), and FRSSD (r 0.623).

According to Pearson's correlation, the interrater reliability of FUCAS' total score for two raters was 0.997. The FUCAS' mean total scores for Raters 1 and 2, were 54.90 (SD = 13.58) and 54.53 (SD = 13.53), respectively. Table 4 shows the correlations between

Table 2. Internal consistency reliabilities (coefficient alphas) of FUCAS' sub scores

Sub score	Cronbach's alpha if item deleted
Problem's awareness	0.90
Working memory	0.89
Planning of the solution	0.89
Time distribution	0.91
Sequence of steps	0.89
Accuracy of steps	0.89
Goal maintenance	0.89
Taking of medication	0.89
Telephone communication	0.89
Shopping	0.89
Personal hygiene	0.92
Orientation in place	0.89
Clothing	0.90

Table 3. Pearson's correlation between the sub scores and total score of FUCAS and the total scores of CAMCOG, MMSE, and FRSSD

Sub score	CAMCOG r	FRSSD r	MMSE r
Problem's awareness	−0.669[a]		−0.704[a]
Working memory	−0.603[a]		−0.577[a]
Planning of the solution	−0.677[a]		−0.668[a]
Time distribution	−0.317[a]		−0.289[a]
Sequence of steps	0.635[a]		−0.610[a]
Accuracy of steps	−0.592[a]		−0.561[a]
Goal maintenance	−0.617[a]		−0.597[a]
Taking of medication		0.508[a]	
Telephone communication		0.545[a]	
Shopping		0.459[a]	
Personal hygiene		0.127[a]	
Orientation in place		0.505[a]	
Clothing		0.425[a]	
FUCAS total	−0.784[a]	0.622[a]	−0.781[a]

[a]Correlation is significant at the 0.01 level (two-tailed).

Table 4. Pearson's correlations between the two ratings of FUCAS sub scores

SUB SCORE	r	M (SD) RATER 1	M (SD) RATER 2
Problem's awareness	0.983[a]	11.36 (5.06)	11.00 (4.84)
Working memory	0.992[a]	6.80 (1.47)	6.83 (1.48)
Planning of the solution	1.000[a]	7.10 (1.86)	7.10 (1.86)
Time distribution	1.000[a]	7.03 (1.90)	7.03 (1.86)
Sequence of steps	1.000[a]	6.86 (1.69)	6.89 (1.69)
Accuracy of steps	1.000[a]	7.06 (1.94)	7.06 (1.94)
Goal maintenance	0.995[a]	6.93 (1.87)	6.96 (1.88)
Taking of medication	1.000[a]	8.40 (2.01)	8.40 (2.01)
Telephone communication	0.991[a]	9.00 (2.74)	9.00 (2.65)
Shopping	0.987[a]	10.40 (3.75)	10.33 (3.50)
Personal hygiene	0.997[a]	8.20 (2.20)	8.16 (2.18)
Orientation in place	0.992[a]	10.33 (3.63)	10.16 (3.56)
Clothing	0.997[a]	8.53 (2.45)	8.50 (2.44)
FUCAS total	0.997[a]	54.90 (13.58)	54.53 (13.53)

[a]Correlation is significant at the 0.01 level (two-tailed).

the two ratings for every sub score, and their mean total scores for Raters 1 and 2, in the whole sample.

We performed one-way analysis of variance (ANOVA) in order to examine possible effects of age, sex, and education on the total performance of FUCAS. ANOVA was performed separately in each one of the three groups (MCI $n = 181$, very mild dementia $n = 135$, and moderate-severe dementia $n = 131$). We found no significant effect of age ($p = 0.05$), sex ($p = 0.05$), or education ($p = 0.05$) on the FUCAS total score.

DISCRIMINANT ANALYSIS

We performed discriminant analysis using as grouping variable two diagnostic groups and as dependent variables the sub scores of FUCAS. Analysis has shown that Working memory, Awareness of the problem, and Telephone communication were able to classify patients with MCI and patients with Moderate-Severe dementia (Table 5), with statistical significance (canonical correlation = 0.618, Wilks' Lambda = 0.618, x^2 (3) = 148.272, $p = 0.000$). Working memory, Awareness of the problem, and Telephone communication have correctly classified 80, 10% of original cases, and they have recognized correctly 92, 8% of MCI patients and 62, 6% of the patients with Moderate-Severe dementia.

Working memory and Goal maintenance were able to classify patients with MCI and patients with Mild dementia (Table 6), with statistical significance (canonical correlation = 0.274, Wilks' Lambda = 0.925, x^2 (2) = 24.478, $p = 0.000$). Working memory and Goal maintenance have correctly classified 65, 20% of original cases, and they have recognized correctly 86, 20% of MCI patients, and 37% of the patients with Mild dementia.

Table 6. Classification results[a] for the discrimination of MCI patients and those with mild dementia (MD)

Group	Sub scores	M (SD)	Predicted group membership		Total
			MCI	MD*	
MCI	Working memory	6.70 (1.02)	156	25	181
	Goal maintenance	6.72 (1.11)			
MD*	Working memory	7.26 (1.21)	85	50	135
	Goal maintenance	7.38 (1.45)			
% MCI			86.2	13.8	100.0
MD*			63.0	37.0	100.0

[a]Original grouped cases (65.2%) correctly classified.
*MD = mild dementia.

Finally, Planning of the solution, Distribution of time between the steps of the activity and Working Memory were able to classify patients with Mild dementia and patients with Moderate-Severe dementia (Table 7), with statistical significance (canonical

Table 7. Classification results[a] for the discrimination of patients with mild (MD) and moderate-severe dementia (MSD)

Group	Sub scores	M (SD)	Predicted group membership		Total
			MD*	MSD*	
MD*	Planning of the solution	6.85 (1.42)	117	18	135
	Time distribution	6.64 (1.19)			
	Working memory	7.26 (1.21)			
MSD*	Planning of the solution	8.93 (2.59)	55	76	131
	Time distribution	8.73 (2.81)			
	Working memory	9.17 (2.61)			
% MD*			86.7	13.3	100.0
MSD*			42.0	58.0	100.0

[a]Original grouped cases (72.6%) correctly classified.
*MD = mild dementia; MSD = moderate-severe dementia.

Table 5. Classification results[a] for the discrimination of MCI patients and those with moderate-severe dementia (MSD)

Group	Sub scores	M (SD)	Predicted group membership		Total
			MCI	MSD*	
MCI	Working memory	6.70 (1.02)	168	13	181
	Telephone communication	8.14 (2.18)			
	Awareness of the problem	7.06 (2.82)			
MSD*	Working memory	9.17 (2.61)	49	82	131
	Telephone communication	12.88 (4.43)			
	Awareness of the problem	10.03 (4.35)			
% MCI			92.8	7.2	100.0
MSD*			37.4	62.6	100.0

[a]Original grouped cases (80.1%) correctly classified.
*MSD = moderate-severe dementia.

correlation = 0.510, Wilks' Lambda = 0.740, x^2 (4) = 078.943, $p = 0.000$). Planning of the solution, Distribution of time between the steps of the activity, and Working Memory have correctly classified 72, 60% of original cases, and they have recognized correctly 86, 70% of Mild dementia patients, and 58% of the patients with Moderate-Severe dementia.

DISCUSSION

FUCAS has shown a high internal and interrater reliability. Further more, we found a strong correlation between the executive parameters of FUCAS and the total score of CAMCOG and MMSE. However, we noticed a low correlation between the ability of Time distribution and the total scores of the two tests. We suggest that this seems reasonable since CAMCOG and MMSE do not include items assessing this executive ability. Pearson's analysis has shown also significant correlation between FRSSD total score and FUCAS' items representing the total executive function in each functional domain. Personal Hygiene was the only item that has shown a relatively low correlation with FRSSD total score. Personal Hygiene includes face and hand washing, which is a very well learned skill. We think that the low correlation can be accepted since this skill is not included between the items of FRSSD. The strong correlations between FRSSD, CAMCOG, MMSE, and FUCAS suggest that the new measure is able to provide us with a reliable cognitive profile of the patient through the examination of executive function, in simple daily-life activities.

Moreover, discriminant analysis has identified that FUCAS was able to sufficiently discriminate the patients with MCI from those with moderate-severe dementia. Working memory, Awareness of the problem were the critical parameters of executive function for this classification, because they are severely impaired during the moderate-severe stage of dementia. Impaired or spared ability for Telephone communication was also able to discriminate MCI patients. However, FUCAS was not able to discriminate sufficiently MCI patients from those with mild dementia. This finding could be explained by the existence of possible co-linearity between the sub scores that does not permit the sufficient classification of the patients with dementia. There were very subtle quantitative differences of performance between MCI patients and those with mild dementia. Thus, FUCAS as a qualitative test could not discriminate well enough the two groups. Planning of the solution, Distribution of time between the steps of the activity, and Working Memory were able to classify the patients with mild and moderate-severe dementia. These executive parameters represent abilities that are seriously impaired in moderate and severe dementia and are relatively spared during the mild stage of the disease. We could say that FUCAS is a useful diagnostic tool for MCI. It can help us also discriminate between the mild and moderate-severe stages of dementia but it is not able to help us discriminate between MCI and mild dementia.

FUCAS is not affected by age, sex, or education and consequently, we can use it also for the very old persons and for those with low education. Moreover, the administration of FUCAS is short lasting and it is accepted with pleasure by the examinee, in the contrary of the widely used cognitive or functional tests.

As a conclusion, we suggest that FUCAS is a useful and reliable diagnostic tool for MCI, since it assesses parameters of the executive function, presumed to be mainly responsible for the impairment. We suggest that directly observed cognitively as well as behaviorally based assessment such as that provided by FUCAS can provide objective information that can serve to enhance the quality of clinical decision making. Further, from both a clinical and research perspective, data obtained through this kind of assessment are less likely to be prone to those biases inherent to subjective ratings and, as such, provide a superior method for assessment conducted longitudinally.

REFERENCES

Agüero-Torres H, Fratiglioni L, Zhenchao G, Viitanen M, Winblad B. 1998. Dementia is the major cause of functional dependence in the elderly: 3-year follow-up data from a population-based study. *Am J Public Health* **88**: 1452–1456.

Agüero-Torres H, von Strauss E, Viitanen M, Winblad B, Fratiglioni L. 2001. Institutionalization in the elderly: the role of chronic diseases and dementia. Three-year follow-up data from a population-based study. *J Clin Epidemiol* **54**: 795–801.

American Psychiatric Association. 1987. *Diagnostic and Statistical Manual of Mental Disorders*, 3rd ed., revised (DSM-III-R), Division of Public Affairs. American Psychiatric Association: Washington, DC; 103–107.

Amieva H, Phillips L, Della Sala S. 2003. Behavioral dysexecutive symptoms in normal aging. *Brain Cogn* **53**(2): 129–132.

Béland F, Zunzunegui MV. 1999. Predictors of functional status in older people living at home. *Age Ageing* **28**: 153–159.

Blessed G, Tomlinson BE, Roth M. 1968. Association between quantitative measures of dementing and senile change in the cerebral gray matter of elderly subjects. *Br J Psychiatry* **114**: 797–811.

Carlson MC, Fried LP, Xue QL, Bandeen-Roche K, Zeger SL, Brandt J. 1999. Association between executive attention and

physical functional performance in community-dwelling older women. *J Gerontol: Psychol Sci* **54B**(5): S262–S270.

Daigneault S, Braun CMJ. 1993. Working Memory and the self-ordered pointing task: further evidence of early prefrontal decline in normal aging. *J Clin Exp Neuropsychol* **15**: 881–895.

DSM IV. 1994. *International Classification of Diseases*. World Health Organization; 58–62.

Fountoulakis K, Tsolaki M, Chantzi E, Kazis A. 2000. Mini Mental State Examination (MMSE). A validation study in demented patients from the elderly Greek population. *Am J Alzheimer Dis* **15**: 342–347.

Freels S, Cohen D, Eisdorfer C, *et al*. 1992. Functional status and clinical findings in patients with Alzheimer's disease. *J Gerontol* **47**: M177–M182.

Gill TM, Richardson ED, Tinetti ME. 1995. Evaluating the risk of dependence in activities of daily living among community-living older adults with mild to moderate cognitive impairment. *J Gerontol* **50**: 235–241.

Goverover Y. 2004. Categorization, deductive reasoning, and self-awareness: association with everyday competence in persons with acute brain injury. *J Clin Exp Neuropsychol* **26**(6): 737–749.

Grigsby J, Kaye K, Baxter J, Shetterly SM, Hamman RF. 1998. Executive cognitive abilities and functional status among community-dwelling older persons in the San Luis Valley Health and Aging Study. *J Am Geriatr Soc* **46**: 590–596.

Hebert R, Brayne C, Spiegelhalter D. 1999. Factors associated with functional decline and improvement in a very elderly community-dwelling population. *Am J Epidemiol* **150**: 501–510.

Hutton JT. 1990. Alzheimer's Disease in Conn's Current Therapy: 778–781.

Instrumental Activities of Daily Living (IADL) Scale. 1988. Self-rated version. Incorporated in the Philadelphia Geriatric Center. Multilevel Assessment Instrument (MAI). *Psychopharmacol Bull* **24**: 789–791.

Kelly-Hayes M, Jette AM, Wolf PA, D' Agostino RB, Odell PM. 1992. Functional limitations and disability among elders in the Framingham study. *Am J Public Health* **82**: 841–845.

Kurianky JB, Gurland B. 1976. Performance test of activities of daily living. *Int J Aging Hum Dev* **7**: 343–352.

Lawton MP. 1972. Assessing the competence of older people. In *Research, Planning, and Action for the Elderly*, Kent D, Kastenbaum R, Sherwood S (eds). Behavioral Publications: New York.

Levin HS, Goldstein FC, Williams DH, Eisenberg HM. 1991. The contribution of frontal lobe lesions to the neurobehavioral outcome of closed head injury. In *Frontal Lobe Function and Disfunction*, Levin HS, Eisenberg HM, Benton AL (eds). Oxford University Press: New York; 318–338.

Lowenstein AD. 1989. A new scale for the assessment of functional status in AD and related disorders. *J Gerontol: Psychol Sci* **44**(4): 114–121.

McKhann G, Drachman D, Folstein M, Katzman R, Price D, Stadlan EM. 1984. Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's disease. *Neurology* **34**: 939–944.

Moritz DJ, Kasl SV, Berkman LF. 1995. Cognitive functioning and the incidence of limitations in activities of daily living in an elderly community sample. *Am J Epidemiol* **141**: 41–49.

Petersen RC, Stevens JC, Ganguli M, Tangalos EG, Cummings JL, DeKosky ST. 2001. Practice parameter: early detection of dementia: mild cognitive impairment (an evidence-based review). Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology* **56**: 1133–1142.

Phillips LH. 1999. Age and individual differences in letter fluency. *Dev Neuropsychol* **15**: 249–267.

Reisberg B, Ferris SH, Franssen E. 1985. An ordinal functional assessment tool for Alzheimer's type dementia. *Hosp Community Psychiatry* **36**: 593–595.

Tsolaki M, Fountoulakis C, Chantzi E, Kazis A. 2000. The Cambridge Cogntive examination for the elderly. A validation study in demented patients from the elderly Greek population. *Am J Alzheimer Dis* **15**: 269–278.

West RL. 1996. An application of prefrontal cortex function theory to cognitive aging. *Psychol Bull* **120**: 272–292.

World Health Organization. 1992. *International statistical classification of diseases and related health problems, 10th revision (ICD-10). Chapter V, categories F00-F99. Mental, behavioural and developmental disorders: clinical description and diagnostic guidelines*. World Health Organization: Geneva.

Zanetti O, Bianchetti A, Frisoni B. 1993. Determinants of disability in Alzheimer's disease. *Int J Geriatr Psychiatry* **8**: 581–586.

