

Neuropsychological screening performance and the association with activities of daily living and instrumental activities of daily living in dementia: baseline and 18- to 24-month follow-up

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Objective: The use of neuropsychological assessment beyond diagnosis is related partly to the extent to which it can indicate everyday function. This study investigates whether the associations between neuropsychological functioning, activities of daily living (ADL) and instrumental activities of daily living (IADL) change over an 18- to 24-month follow-up, exploring whether these change with dementia progression.

Method: Thirty-four patients with probable Alzheimer's disease were assessed at baseline and again after between 18 and 24 months. Neuropsychological function was assessed using the revised Cambridge Cognitive Examination, which includes in it the Mini mental state examination and an executive functions scale. ADL and IADL were also measured, together with background neuropsychiatric features by using the Neuropsychiatric Inventory.

Results: Pearson correlations between the measures of daily functioning and cognitive abilities and neuropsychiatric symptoms showed that initially neuropsychological test results tended to correlate with IADL rather than ADL measures. Neuropsychiatric symptoms were not correlated whether IADL or ADL. At follow-up, none of the neuropsychological function measures correlated with IADL or ADL, but neuropsychiatric symptoms were correlated with IADL.

Conclusions: At baseline, neuropsychological function is associated with IADL but not ADL. At follow-up, the association between neuropsychological function and IADL diminishes, and associations between neuropsychiatric disturbances and IADL emerge. Copyright © 2011 John Wiley & Sons, Ltd.

Key words: Alzheimer's disease; dementia; CAMCOG-R; MMSE; executive functions; ADL; IADL; NPI

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Introduction

Dementia by definition involves concurrent deterioration of neuropsychological and functional abilities. As part of the clinical management of a patient with dementia, it is necessary to ascertain their level of function, either by a formal clinical neuropsychological assessment or by exploring their functional abilities in everyday life. Indeed, a question has been the extent to which neuropsychological functioning is

indicative of everyday functioning (Tomaszewski *et al.*, 2008).

In considering this issue, it is necessary to distinguish between activities of daily living (ADL) and instrumental activities of daily living (IADL). The former involves activities of self-care, such as eating, washing and dressing, and are usually defined as physical self-maintenance tasks (Lawton and Brody, 1969). IADL are associated with more complex tasks and require a greater variety of cognitive abilities,

usually involving higher order cognitive processes. For example, everyday activities, such as using the telephone, money and medications, are usually defined as complex, real-world adaptive human behaviour that requires independence, organisational ability, judgment and sequencing (Brennan *et al.*, 1997; Royall *et al.*, 2000). Both concepts are commonly used in the context of community dwelling older adults who are able to perform some of the tasks needed for continued independent living (George and Fillenbaum, 1985) but may be differentially applied to people with dementia at different stages. For example, Juva *et al.* (1997) found that IADL were better able to determine early dementia, with many individuals with mild dementia still able to carry out basic ADL activities. Furthermore, IADL scales have been shown to be effective in screening for dementia (Castilla-Rilo *et al.*, 2007), especially when assessing less educated people performing poorly on cognitive testing (Fillenbaum *et al.*, 1999). Studies have shown that cognitive impairment is associated with both ADL and IADL but more strongly with the latter (Chen *et al.*, 1995; Aguero-Torres *et al.*, 1998; Mattis, 1998; Paul *et al.*, 2002; Dodge *et al.*, 2003). Such research has explored specific types of neuropsychological tests or functions and has explored this issue in relation to different severities of dementia. For example, Barberger-Gateau *et al.*, (1999) found that there is a strong association between performance on neuropsychological tests and measures of IADL; deterioration in IADL also predicted risk for developing dementia, with early cognitive impairment reflected in decline in IADL linked to the 'preclinical' stage.

Global measures of cognitive functioning, such as the Mini mental state examination (MMSE), have been shown to be associated with functional status (Moritz *et al.*, 1995; Greiner *et al.*, 1996; Gill *et al.*, 1997), and this has also been demonstrated with more comprehensive test batteries (e.g. Kaye *et al.*, 1990). However, many studies have shown how specific cognitive abilities may be related to particular functions. For example, Baum *et al.* (1996) found that the performance of older adults with Alzheimer's disease (AD) on neuropsychological assessment was substantially correlated with functional abilities. In particular, the initiation/perseveration subscale of the Dementia Rating Scale (verbal fluency task, imitating motor programmes and copying a repeated pattern) was an important predictor for cooking, community functioning, money management, safety, self-care and taking medications. Other studies of executive function have shown that these are generally associated with a decrease in functional ability including IADL

and an increase in care and supervision (Nadler *et al.*, 1993; Cahn-Weiner *et al.*, 2000; Grigsby *et al.*, 2000; Royall *et al.*, 2000). Cahn-Weiner *et al.* (2000) found that measures traditionally held to be sensitive to executive functioning (such as Fluency Test, Wisconsin Card Sorting Test, Stroop and Trail Making Test) accounted for the greatest amount of variance in IADL. Plehn *et al.* (2004) found that measures sensitive to executive functioning were indicators of IADL functioning, whereas memory retention was more sensitive to changes in social functioning. Additional functions have been implicated, for example, Goldstein *et al.* (1992) reported that memory tests are robust predictors of instrumental functional skills within a heterogeneous group of older adults. However, a more recent study by Lim *et al.* (2007) suggests that executive functions (category fluency) play a more important role than episodic memory in predicting ADL. Tomaszewski *et al.* (2008) confirm that both memory and executive functioning may have a significant impact on daily functioning.

The present study explores whether the relationship between neuropsychological function and ADL or IADL changes as dementia progresses, in this case, assessing function after between 18 months and 2 years using a commonly used neuropsychological screening tool, namely the Cambridge Cognitive Examination (CAMCOG-R), to measure a range of neuropsychological functions. This instrument includes the MMSE and an Executive Functioning Scale (EFS), pertinent to the current issue. How well these procedures are related to ADL or IADL was explored cross-sectionally at each time point to determine longitudinally whether the associations hold up over time. Additional measurements of neuropsychiatric features were made using the Neuropsychiatry Inventory (NPI), the rationale being that neuropsychiatric symptoms specifically associated with dementia might provide an alternative cause for decline in everyday function, in addition to neuropsychological impairment.

Method

Participants

The study included 34 (5 men, 29 women) community dwelling participants with a mild to moderate stage of AD who were referred to a Memory Clinic (term used in the UK for a predominately dementia assessment clinic) as patients and followed up between 18 and 24 months. Severity here is determined by the MMSE (Folstein *et al.*, 1975) result in which a score of 21 or

above is mild and a score of 10–20 is moderate. Their age at baseline ranged between 55 and 90 years (mean 76.4 years). Diagnosis of probable AD was based on DSM-IV and the National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association (McKhann *et al.*, 1984) criteria. They were all being treated using either donepezil or rivastigmine. Exclusion criteria comprised English as not the first language. The approach to diagnosis was multidisciplinary, including a consultant geriatrician, an associated specialist in psychiatry and clinical neuropsychologists. The participants were diagnosed as follows: 19 had AD and 15 had AD with a vascular component. There was a mixture of ethnicity/country of origin, with 26 White British, 6 White Irish, 1 Guyana and 1 Black Caribbean. Educational level was 10 years for the 32 participants and 13 years for the two participants.

Neuropsychological assessments

Neuropsychological assessment was conducted using the CAMCOG-R, part of the Cambridge Examination for Mental Disorders of the Elderly—Revised (Roth *et al.*, 1999). The CAMCOG-R is a short neuropsychological battery designed specifically for dementia assessment covering a range of neuropsychological functions commonly used in neuropsychological assessments to investigate dissociable functions (Roth *et al.*, 1999). This includes items that can be used to create ten indices, namely abstract thinking, attention and calculation, language comprehension, language expression, learning, recent memory, remote memory, orientation, perception and praxis. When the CAMCOG was revised to form the CAMCOG-R, it was expanded to include an EFS. This consists of measures relating to ideational fluency, visual reasoning, word list generation and similarities (Heinik, 2007). Embedded in the CAMCOG-R are all the items from the MMSE (Folstein *et al.*, 1975) (items testing orientation, immediate recall, attention and calculation, delayed recall and language), such that an MMSE score can also be obtained. There is a total aggregate score for the CAMCOG-R, of 105 points. The MMSE is out of 30 points, and the EFS is out of 28 points.

Measures of functional abilities

These were obtained using questionnaire instruments filled in by an informal carer, such as a family member.

The ADL scale (Katz et al., 1963):

This is a carer-rated instrument consisting of six daily-living abilities including basic tasks of personal care in everyday life, including bathing, continence, transfers, feeding, dressing and transferring. For this study, the questionnaire responses were made on to a Likert scale ranging from 0 (completely dependent) to 2 (independent).

The IADL scale (Lawton and Brody, 1969):

This measures the activities related to independent living. It is a carer-rated instrument consisting of seven daily-living abilities includes items related to using the telephone, preparing meals, taking medicine, travelling, shopping for groceries or personal items, performing light or heavy housework and managing money. In a similar way to the ADL, every activity is rated on a scale that includes three choices: person is independent, person requires assistance and person is completely dependent on others. For this study, the questionnaire responses were made using a Likert scale ranging from 0 (completely dependent) to 2 (independent).

Neuropsychiatric symptoms

The NPI was used to measure psychopathology in the participants; this measure was developed also specifically for use with dementia (Cummings, 1997). It rates the severity and the frequency of 12 neuropsychiatric disturbances that are common in dementia: delusions, hallucinations, agitation, dysphoria, anxiety, apathy, irritability, euphoria, disinhibition, aberrant motor behaviour, night-time behaviour disturbances, and appetite and eating abnormalities together with the related carers' distress. As with the measures of functional abilities, the same informal carer was interviewed by the assessor who filled in the scale. Every symptom is rated on a Likert scale that includes the choices absent, mild, moderate or severe (scored 0–3 on the scale).

Analysis

Statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS, Version 15 for Windows; SPSS Inc., Chicago, IL, USA). Pearson correlations between the measures of daily functioning and cognitive abilities and neuropsychiatric symptoms were used. To allow for the use of multiple analyses when correlating between measures, a more conservative $p < 0.005$ was used to define the statistical significance based on a Bonferroni division by 10, the number of CAMCOG-R indices. Stepwise regression

analysis was used to explore the main statistical predictors of IADL.

Results

Neuropsychological function

Statistical analysis showed that cognitive functioning had significantly declined between initial and follow-up assessment (Table 1). Paired sample *t*-tests showed that CAMCOG-R ($p < 0.0001$), MMSE ($p < 0.05$) and EFS ($p < 0.05$) scores changed significantly. The 10 CAMCOG-R indices were analysed in the same fashion. Here, there was a significant deterioration in language comprehension ($p < 0.01$), language expression ($p < 0.01$), abstract thinking ($p < 0.05$), new learning ($p < 0.05$), orientation ($p < 0.001$) and praxis ($p < 0.001$). The other indices were not so sensitive to change with no significant difference for attention/calculation ($p = 0.79$), recent memory ($p = 0.023$), remote memory ($p = 0.08$) and perception ($p = 0.11$).

The functional abilities and neuropsychiatric symptoms remained more stable across time between the initial and follow-up assessments. Paired sample *t*-tests showed that ADL scores did not change ($p = 0.978$)

and neither did IADL scores ($p = 0.109$) or neuropsychiatric symptoms ($p = 0.955$).

Associations with ADL or IADL

Pearson correlations showed that there were no significant correlations with the ADL measure either at the initial assessment or on follow-up.

For IADL at the initial assessment, the neuropsychological test results tended to correlate (see Table 2); there were robust correlations for the total CAMCOG-R, the MMSE and EFS. For the other CAMCOG-R indices, there were also correlations with abstract thinking, attention, and calculation and orientation. To investigate these associations, a further stepwise regression analyses were computed with IADL as the dependent variable. This analysis explores the association with the main variables the CAMCOG-R total score (which incorporates the MMSE), EFS and the NPI. For this analysis, the EFS score was subtracted from the CAMCOG-R total score to ensure that the two measures were independent. The results showed that only the EFS score remained in the model ($\beta = 0.65$), the model explaining 43% of the variance ($F(1,33) = 24.0$, $p < 0.0001$). At the follow-up assessment, none of the neuropsychological function

Table 1 The mean scores for neuropsychological assessment (CAMCOG-R), the activity of daily living scales (ADL and IADL) and the neuropsychiatric scale (NPI)

	Performance at initial assessment	Follow-up at 18–24 months
Neuropsychology		
CAMCOG-R	60.4/105 (13.2)	53.9/105 (17.1)
MMSE	19.6/30 (5.3)	18.1/30 (5.3)
Executive Functioning Scale	12.0/28 (3.9)	10.5/28 (4.9)
Indices		
Abstract thinking	58.9 (24.7)	49.8 (32.4)
Attention/calculation	59.1 (31.3)	58.2 (29.5)
Comprehension	88.7 (12.8)	81.2 (19.5)
Expression	72.4 (11.3)	65.1 (18.7)
New learning	32.8 (20.5)	27.1 (19.3)
Recent memory	49.3 (34.5)	42.9 (35.0)
Remote memory	55.4 (20.0)	47.2 (27.5)
Orientation	69.5 (24.1)	49.7 (28.3)
Perception	74.0 (20.1)	67.8 (23.6)
Praxis	72.8 (18.4)	64.9 (19.6)
Activities of daily living		
ADL	10.61/12 (2.12)	10.88/12 (1.67)
IADL	8.55/14 (3.92)	7.65/14 (3.28)
NPI	6.80/36 (5.55)	6.78/36 (6.17)

Raw scores and maximum scores are given for Cambridge Cognitive Examination (CAMCOG-R) total scores, Mini mental state examination (MMSE), the Executive Functioning Scale, activities of daily living (ADL), instrumental activities of daily living (IADL) and Neuropsychiatric Inventory (NPI). The CAMCOG-R individual subscale score (indices) are percentage correct scores to assist the comparison. The higher the score on ADL and IADL, the more independent the person; the higher the score on the NPI scale, the higher/more severe the number of reported symptoms. The values given in brackets denote standard deviations.

Table 2 Pearson (two-tailed) correlations between neuropsychological functioning and ADL and IADL at baseline, with the correlations with neuropsychiatric symptoms (NPI) shown as a comparison

	ADL	IADL
Neuropsychology		
CAMCOG-R	0.26 (0.257)	0.76 (0.000)*
MMSE	0.11 (0.641)	0.73 (0.000)*
Executive Functioning Scale	0.38 (0.092)	0.73 (0.000)*
Indices		
Abstract thinking	0.12 (0.591)	0.67 (0.001)*
Attention/calculation	0.06 (0.803)	0.73 (0.000)*
Comprehension	-0.03 (0.88)	0.41 (0.049)
Expression	0.15 (0.518)	0.33 (0.127)
New learning	0.25 (0.283)	0.41 (0.050)
Recent memory	-0.12 (0.610)	0.44 (0.035)
Remote memory	0.25 (0.277)	0.32 (0.136)
Orientation	0.03 (0.881)	0.61 (0.002)*
Perception	0.39 (0.081)	0.35 (0.100)
Praxis	0.46 (0.036)	0.45 (0.033)
NPI	-0.57 (0.044)	-0.23 (0.412)

CAMCOG-R, Cambridge Cognitive Examination; MMSE, Mini mental state examination; NPI, Neuropsychiatric Inventory. Significance levels are given in brackets.

*Statistical significance at $p < 0.005$.

measures correlated with IADL or ADL (see Table 3). This time, neuropsychiatric symptoms were correlated with IADL. A further stepwise regression analysis with the CAMCOG-R total score, EFS and NPI showed that only the NPI stayed in the model ($\beta = -0.49$), explaining 24% of the variance ($F(1,32) = 10.7$, $p < 0.01$).

Discussion

In summary, in the baseline assessment, there was a robust association between neuropsychological functioning as indicated by the main CAMCOG-R aggregate measures and the ability to carry out IADL, whereas no such strong association was present with the ADL.

Table 3 Pearson (two-tailed) correlations between neuropsychological functioning and ADL and IADL at follow-up, with the correlations with neuropsychiatric symptoms (NPI) shown as a comparison

	ADL	IADL
Neuropsychology		
CAMCOG-R	0.38 (0.037)	0.27 (0.139)
MMSE	0.27 (0.142)	0.27 (0.140)
Executive Functioning Scale	0.37 (0.042)	0.17 (0.356)
Indices		
Abstract thinking	0.28 (0.129)	0.13 (0.477)
Attention/calculation	0.12 (0.524)	0.14 (0.466)
Comprehension	0.34 (0.060)	0.29 (0.117)
Expression	0.31 (0.094)	0.22 (0.236)
New learning	0.29 (0.109)	0.40 (0.027)
Recent memory	0.31 (0.091)	0.38 (0.033)
Remote memory	0.15 (0.434)	0.26 (0.163)
Orientation	0.16 (0.387)	0.29 (0.112)
Perception	0.38 (0.037)	0.26 (0.164)
Praxis	0.14 (0.448)	0.18 (0.339)
NPI	-0.44 (0.026)	-0.55 (0.004)*

CAMCOG-R, Cambridge Cognitive Examination; MMSE, Mini mental state examination; NPI, Neuropsychiatric Inventory. Significance levels are given in brackets.

*Statistical significance at $p < 0.005$.

This confirms findings from the previous studies that IADL are more strongly related to cognitive abilities than ADL; the latter can usually be carried out independently in mild dementia. At the follow-up assessment, 18–24 months later, the results indicated that the neuropsychological test performance was no longer related to IADL or ADL. Overall, this suggests that neuropsychological test performance is not related to ADL but is associated with IADL, at least early on in dementia. As the dementia progresses, the association is weakened.

Such results have implications for clinicians because neuropsychological assessment, as well as aiding diagnosis, is used to estimate functioning in everyday life, as an adjunct to direct observation or informant accounts. This study supports the use of a global measure of functioning, such as the CAMCOG-R, which contains various neuropsychological indices as well as the EFS. The results at initial assessment of this study show a significant association between the overall CAMCOG-R score, its MMSE, EFS and IADL; and the abstract thinking, attention/calculation and orientation indices and IADL. This confirms the results of the previous studies, for example, Bell-McGinty *et al.* (2002) found a modest, but significant association between executive test results and everyday independence, but concluded that other factors have yet to be identified. Other studies (Nadler *et al.*, 1993; Grigsby *et al.*, 1998; Baird *et al.*, 2001) have found that global cognitive abilities are important in the evaluation of functional status.

It appears that an overall measure of cognitive functioning, such as the CAMCOG-R can significantly aid clinical practise, indicating IADL ability early on in dementia. There is some evidence that executive functioning is more sensitive in this regard. Specifically, when the CAMCOG-R total minus EFS scores, the EFS and the NPI were included in a stepwise regression analysis, only EFS remained in the model. This is also consistent with the study by Royall *et al.* (2000) who found that when compared with memory, language and visuospatial skills, executive functions were the best predictors in IADL in healthy older adults. On the other hand, the current study does not support the view that perceptual abilities are significantly associated with IADL (Glosser *et al.*, 2002) or memory (Goldstein *et al.*, 1992). In terms of implication for clinical practise, the CAMCOG-R appears to have validity early on in assessing functional independence.

Conversely, although neuropsychiatric measure was not associated with either ADL or IADL in the initial assessment, it was with IADL on follow-up. The

measure of neuropsychiatric problems was developed specifically for dementia and covers the range of difficulties commonly found (Cummings, 1997). These in turn might be expected to interfere with ADL, supported to some extent on the follow-up assessment where there was an association with IADL. However, in this study, the neuropsychiatric symptoms did not increase from baseline to the follow-up assessment, and correspondingly, there was no deterioration in IADL, despite the fact that the dementia-associated cognitive impairment became more severe. Overall, this suggests that as dementia progresses, independence in complex everyday activities, combined with information on neuropsychiatric status, are equally important to measure as cognitive function. In terms of clinical implication, these findings support the use of a specific assessment of neuropsychiatric symptoms, for example, through a questionnaire such as the NPI.

Only a paucity of studies has investigated that cognitive abilities are associated with independent functioning in ADL and IADL. The current study focused on the validity of neuropsychological testing in dementia but shedding further light on which abilities are implicated with a decline in functioning could be useful in understanding which cognitive domains are the most important for the assessment of everyday functioning in dementia. Although most participants were women, studies indicate that dementias such as AD are more common in women than men (e.g. Copeland *et al.*, 1999). Furthermore, women live longer, and their prevalence is higher as they get older (Mooney, 2002). Some non-cognitive variables such as mood were not collected in this study but are likely to play an important role in everyday functioning. The use of informant-based rating of everyday functioning has been shown to be useful in differentiating individuals with dementia from healthy older adults (Isella *et al.*, 2006), but it can also be subjected to reporter bias.

It should be noted that the IADL scale used in the current study (Lawton and Brody, 1969) was not sufficiently sensitive to detect changes in the current sample after an 18- to 24-month follow-up. This scale was selected because, although it was designed to measure IADL as a generic scale for community dwelling older adults, it is the most widely applied for people with dementia (Sikkes *et al.*, 2009) and is one of the few well-validated scales designed to measure exclusively IADL. Other scales, although not so validated extensively, are potentially more sensitive to change, for example, the Disability Assessment for Dementia scale developed by Gelinas *et al.* (1999) has

been shown to show deterioration in people with dementia within 12 months (Feldman *et al.*, 2001). Future studies with large samples exploring the prediction of IADL based on neuropsychological screening instruments are still needed using such scale, and also incorporating longitudinal data collection.

Conclusions

This prospective study demonstrated a robust association between neuropsychological function and ability to carry out IADL, but no such association was present with the ADL in the earlier stages of dementia. This supports the findings from the previous studies, which found that the ADL scale often presents with a ceiling effect, the ease of the tasks measured not necessarily making them susceptible to the measured neuropsychological dysfunction. Particular subscales of the CAMCOG-R, indices of abstract thinking, attention/calculation and orientation, showed association with IADL independence at baseline, and these aspects may all contribute to the integrity of more sophisticated everyday abilities. However, executive function assessment appears to be the most predictive statistically of instrumental functional abilities early on. At the follow-up assessment, 18–24 months later, the results instead indicated that the neuropsychological test performance was no longer related to IADL or ADL. Overall, this suggests that as dementia progresses, neuropsychological tests no longer is associated with functional abilities; it appears that different cognitive abilities may be more important in everyday life at different stages of the disease progression.

The results of this study support the use of a neuropsychological assessment specifically tailored for people with dementia, such as the CAMCOG-R, to be used when investigating the effects of early dementia in relation to everyday function at least in the initial stages. This study points towards the usefulness of the CAMCOG-R beyond the MMSE in this respect, for example, including brief tests executive functioning, although it is acknowledged that these also exist in similar batteries such as the Montreal Cognitive Assessment. In this context, we advocate the use of executive tests rather than just self-report measure of executive function, not only to avoid biases but also to recognise that tests cannot fully substitute a skilled clinician given their imperfect ecological validity.

Conflict of interest

The authors declare no conflict of interest.

Key points

- The study showed that CAMCOG-R measured neuropsychological function is associated with IADL but not ADL in people with mild and moderate dementia.
- On follow-up after about 2 years, this association disappeared, but neuropsychiatric symptoms became associated with IADL.

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