

Multidimensional Assessment of Awareness in Early-Stage Dementia: A Cluster Analytic Approach

Linda Clare^a Christopher J. Whitaker^a Sharon M. Nelis^a Anthony Martyr^a
Ivana S. Markova^b Ilona Roth^c Robert T. Woods^a Robin G. Morris^d

^aBangor University, Bangor, ^bUniversity of Hull, Hull, ^cOpen University, Milton Keynes, and
^dKings College London Institute of Psychiatry, London, UK

Key Words

anosognosia · insight · meta-cognition · Alzheimer's disease · vascular dementia

Abstract

Background/Aims: Research on awareness in dementia has yielded variable and inconsistent associations between awareness and other factors. This study examined awareness using a multidimensional approach and applied cluster analytic techniques to identify associations between the level of awareness and other variables. **Methods:** Participants were 101 individuals with early-stage dementia (PwD) and their carers. Explicit awareness was assessed at 3 levels: performance monitoring in relation to memory, evaluative judgement in relation to memory, everyday activities and socio-emotional functioning, and metacognitive reflection in relation to the experience and impact of the condition. Implicit awareness was assessed with an emotional Stroop task. **Results:** Different measures of explicit awareness scores were related only to a limited extent. Cluster analysis yielded 3 groups with differing degrees of explicit awareness. These groups showed no differences in implicit awareness. Lower explicit awareness was associated with greater age, lower MMSE scores, poorer recall and naming scores, lower anxiety and greater carer stress. **Conclusion:** Multidi-

dimensional assessment offers a more robust approach to classifying PwD according to level of awareness and hence to examining correlates and predictors of awareness.

Copyright © 2011 S. Karger AG, Basel

Introduction

The many empirical studies exploring aspects of awareness in people with dementia are characterised by variability and inconsistency of results concerning the nature of awareness in dementia and its interrelationships with other factors [1]. Neuropsychological investigations have focused on memory, executive function and language, but have not yielded consistent associations [2]. The literature presents conflicting findings on the relationship between mood and awareness, and with regard to associations between awareness and disease severity or personal characteristics such as age and gender [3]. Several studies have demonstrated that carers who experience more burden rate their relatives' functioning more poorly [4], but again an association is not consistently found [5]. Similarly, some studies have reported an association with self-reported quality of life for the person with dementia (PwD) [6], but others have found no such association [7]. The cause of this variability and inconsis-

tency may in part reflect variations in the conceptualisation of awareness, differences in the object of awareness selected, and differences in the type of assessment measure used.

The range of terminology used to describe states of reduced awareness, including 'lack of insight', 'anosognosia' and 'denial' [1], is indicative of different underlying assumptions. Since these terms are often used interchangeably and without explicit clarification of the theoretical connotations, this creates a potentially confusing picture. The lack of conceptual clarity evident in this field has hindered the development of comprehensive explanatory models [8], and many studies fail to outline a clear conceptual framework or to provide a precise operational definition of awareness. Attempts at explanation have typically focused on specific elements such as cognitive processes [9] or defensive denial [10]; however, there is a need to develop a comprehensive framework to account for a range of influences on the expression of awareness, both biological and psychosocial or contextual [11]. Hitherto, the most frequently studied objects of awareness in dementia are memory and activities of daily living (ADLs) [12], either discretely or in combination [13, 14]. Some attention has also been given to social functioning [5]. Findings suggest that the extent of awareness differs in relation to different objects [15] and that awareness phenomena may be domain specific.

The main methods of assessing awareness are general ratings of awareness based on interviews conducted by a clinician or researcher [16], calculation of discrepancies between patient and informant ratings on parallel questionnaires [17], and calculation of discrepancies between patient estimates of performance and actual task performance [18]. All have significant limitations [12, 19, 20]. In view of this, some studies have compared findings from two different types of measure, typically participant-informant discrepancies and participant-test discrepancies [21–24]. Others have combined one or both of these with clinician ratings of awareness and in some cases qualitative interview data [25–29]. Awareness scores appear to differ according to the assessment method used, and awareness scores obtained from different methods are typically not highly correlated [14, 30].

As a result of these conceptual and methodological difficulties, current empirical evidence provides only a limited basis for determining how the degree of awareness shown by a PwD may be evaluated in a meaningful and potentially useful way. This situation would be improved by use of relevant theoretical models, provision of clear operational definitions and precise selection of ob-

jects. For the purposes of the present study, awareness will be broadly defined as 'a reasonable or realistic perception or appraisal of a given aspect of one's situation, functioning or performance, or of the resulting implications' [31]. Awareness will be examined in the context of a theoretical framework which specifies that in early-stage dementia this broad definition encompasses cognitive-affective operations at 3 main levels: performance monitoring in relation to selected tasks, evaluative judgement about aspects of functioning such as memory or everyday activities, and meta-cognitive reflection, for example in relation to the impact and implications of the condition. For research purposes, it is necessary to identify precisely the specific clinical phenomena that will be elicited empirically [1]. In this study, awareness at each level will be assessed in relation to a clearly identified object or objects.

A multiplicity of levels and objects calls in turn for an appropriate range of measurement approaches. In addition to the standard discrepancy and rating methods, based on directly eliciting explicit responses, there is scope for further methodological development. For example, the use of more indirect methods of accessing participants' subjective experience of, and knowledge about, the condition might be experienced as less threatening than direct questioning, and hence elicit evidence of greater awareness. Similarly, where awareness is not expressed explicitly, signs of awareness may still be present at an implicit level [9, 32]. This might be evident at the level of behavioural adaptation, or at the conceptual level, with tacit knowledge about the condition expressed through reference. Therefore, if there is evidence that condition-salient information affects cognitive processing and consequently impacts on behavioural responses in the absence of explicit expressions of awareness, this might indicate that awareness is retained at an implicit level. Here a dissociation between implicit and explicit awareness scores might be anticipated. This study incorporated novel assessment methods to measure these aspects of awareness alongside more established techniques.

Given that individual scores are likely to differ across different levels and objects of awareness and when assessed using multiple measurement approaches, the question then arises as to whether it is possible to identify any meaningful groupings among participants on the basis of a range of measures tapping different awareness phenomena [33]. This study will attempt to answer this question using a cluster analytic approach. The following specific research questions will be addressed:

Table 1. Overview of awareness assessments in relation to the conceptual framework used in the study

Level of awareness	Object(s) of awareness	Measurement approach	Measure(s) used
<i>Explicit awareness</i>			
Performance monitoring	Memory performance	Discrepancy between self-rating (postdiction) of task performance and objective task performance	Memory performance discrepancy
Evaluative judgement	Memory functioning; functioning in ADLs; social and emotional functioning	Discrepancy between self-rating and informant rating made by caregiver on parallel questionnaires evaluating functioning in the relevant domain	Memory functioning discrepancy; functional activity discrepancy; social functioning discrepancy
Metacognitive reflection	Personal salience and experience of the condition, nature of the condition, coping with the condition, and implications of developing and living with dementia for self and others	<i>Direct measure:</i> awareness rating made on the basis of detailed interview with participant and collateral information from detailed interview with carer <i>Indirect measure:</i> responses to questions about vignettes describing fictional characters with early-stage and established dementia and normal ageing, relating to the nature of the problem and the kinds of actions that would be advisable in the circumstances	Interview global rating; vignette problem identification and problem response scores, summed to give vignette total score
<i>Implicit awareness</i>			
Implicit	Personal salience of the condition	Emotional Stroop task assessing attentional bias to condition-related words	Stroop index score

- (1) How do results from different assessment methods applied at different levels of awareness to different objects of awareness relate to each other?
- (2) Is there a dissociation between the scores achieved on explicit and implicit measures of awareness?
- (3) Is it possible to group participants according to degree of awareness by means of cluster analysis when using a range of explicit awareness measures targeting different levels and objects of awareness?
- (4) If so, does the resulting grouping differentiate participants on other characteristics sometimes found to be related to awareness: memory, language and executive function, mood, quality of life and degree of carer stress?

Method

Design

The Memory Impairment and Dementia Awareness Study is a longitudinal study of awareness in early-stage dementia. This paper presents cross-sectional data from the first stage of the study. Ethical approval was granted by the relevant University and NHS Ethics Committees, and informed consent was given by all participants.

Participants

Participants were recruited from Memory Clinics in North Wales, UK. Inclusion criteria were an ICD-10 diagnosis of Alzheimer's disease (AD), vascular dementia or mixed AD and vascular dementia, a score of 18 or above on the Mini-Mental State Examination (MMSE) [34], ability to communicate verbally in English, and availability of a carer who was willing to contribute. Exclusion criteria were concurrent major depression, psychosis or other neurological disorder, and history of neurological disorder, stroke or brain injury.

Measures of Awareness

An overview of the methods used to assess awareness at different levels and in relation to each object is provided in table 1.

Performance Monitoring

Awareness at this level was assessed in relation to memory by comparing participants' self-ratings of performance on a memory test made after completing each subtask with objective scores on the memory test, using the following measures:

- Rivermead Behavioural Memory Test (RBMT) [35], an ecologically valid test of everyday memory functioning;
- Memory Awareness Rating Scale (MARS), Memory Performance Scale (MPS) [26]. The MARS comprises the MPS and an isomorphic Memory Functioning Scale, and has good internal consistency, test-retest reliability and criterion validity in a sample of people with dementia [26]. The 13-item MPS is designed to be administered alongside the RBMT and elicits participants' judgements about the efficiency of their performance

on each subtest. Each item is presented immediately after the associated RBMT subtest has been completed. Higher scores indicate better perceived performance. Scores are prorated to form a scale equivalent to the scoring parameters for the RBMT. To prevent scaling effects distorting measurement when calculating discrepancies between the objective test scores and the participant self-ratings of performance, a memory performance ratio (MPR) was derived [36] by dividing the MPS self-rating by the RBMT score. In order not to exclude participants who scored 0 on either measure, a constant of 0.5 was added to each set of scores prior to calculating the ratios. Because of the skewed distributions associated with ratio scores, log transformations of the MPR score were used in analyses involving the MPR [20]. MPR scores close to 1 indicate close agreement between the test score and the self-rating. Scores above 1 indicate that the self-rating was greater than the test score, while scores below 1 indicate that the self-rating was lower than the test score. The self-ratings of performance showed good internal consistency in our study ($\alpha = 0.85$).

Evaluative Judgement

Awareness at this level was assessed in relation to 3 objects, namely everyday memory, ADLs and socio-emotional functioning, by means of parallel self- and informant ratings, using the following measures:

- MARS Memory Functioning Scale [26]. The 13-item Memory Functioning Scale self-rating version elicits general judgements about everyday memory functioning. Carers provide parallel ratings of memory functioning. Higher scores indicate better perceived functioning. Self- and carer ratings showed good internal consistency in our study ($\alpha = 0.87$ and 0.92 , respectively).
- Functional Activities Questionnaire [37]. This measure assesses the degree of independence with which the person can carry out 10 ADLs; for the present study, 1 item regarding telephone use was added. Participants made judgements about their everyday functioning, and carers provided parallel ratings. Lower scores indicate better perceived functioning. The Functional Activities Questionnaire has acceptable internal consistency and validity with older people [37]. Self- and carer ratings showed good internal consistency in our study ($\alpha = 0.80$ and 0.88 , respectively).
- Socio-Emotional Questionnaire [38]. This 30-item scale elicits evaluative judgements about social and emotional functioning. Participants rated their own functioning and carers provided parallel informant ratings. Lower scores indicate better perceived functioning. The Socio-Emotional Questionnaire has demonstrated reliability and validity with brain-injured patients [38]. Self- and carer ratings showed good internal consistency in our study ($\alpha = 0.75$ and 0.83 , respectively).

To prevent scaling effects distorting measurement when calculating discrepancy scores based on the difference between self- and informant ratings, the differences between the two ratings were divided by their means [36]. This yielded memory functioning discrepancy (MFD), functional activity discrepancy (FAD) and social functioning discrepancy (SFD) scores. Discrepancy scores close to 0 indicate good agreement between PwD and informant. Positive scores indicate that self-rating is higher than informant rating, and vice versa.

Metacognitive Reflection

Awareness of the condition, its implications and its impact were assessed with a direct measure involving ratings based on a detailed interview and an indirect measure derived from responses to vignettes.

- For the direct measure, a semistructured interview was conducted with the participant, covering current functioning and recognition of changes in memory, engagement in ADLs and social activities, coping, feelings about the situation and its impact, and perceptions of the future. A parallel interview was conducted with the carer. Interviews lasted between 10 and 60 min and were later transcribed in full. Interview global ratings (IGRs) were based on both the participant and the informant interview. Awareness was classified using a 5-point awareness rating scale, as follows: 1 = no evidence of awareness; 2 = limited evidence of awareness; 3 = some evidence of awareness; 4 = moderate evidence of awareness; 5 = extensive evidence of awareness [32]. Ratings were made by 7 expert raters, all psychiatrists or psychologists. Interrater reliability was established with a subset of interviews. Raters achieved 88.9% agreement ($n = 18$; 16 agreements, 2 differences of 1 scale point; Cohen's $\kappa = 0.85$).
- The indirect measure of awareness at this level involved obtaining responses to 3 vignettes depicting fictional characters reflecting healthy old age, early-stage dementia and established dementia. In each case, the participants were asked to identify the nature of the problem (if any) and to say what advice they would offer to the person depicted and to the person's relative or friend. Scores were calculated separately for vignette problem identification (maximum score 6) and vignette problem response (maximum score 12) and summed to give a total score (VTS, maximum 18), with higher scores indicating greater indirect awareness.

Implicit Awareness

Attentional bias to condition-related words was evaluated with an emotional Stroop task [32]. Participants were asked to name the colour in which either salient (condition-related) words, neutral words or strings of Xs (baseline) were printed, and response time was measured. Five salient and 5 neutral words were used, each repeated 10 times. A slowing of response times in the condition-related words compared to the neutral word condition suggests the operation of emotional interference at an automatic pre-attentive processing level, which is interpreted as an indicator of retained implicit awareness of the condition. An emotional Stroop index score was calculated from response times using the formula $(\text{salient} - \text{baseline}) / (\text{neutral} - \text{baseline})$ [32]. This score provides an index of the extent of slowing in the salient condition relative to the neutral condition, correcting for level of baseline performance in each case [39]. A positive score indicates greater slowing in the salient relative to the neutral condition, while a negative score indicates faster response times in the salient relative to the neutral condition.

Other Measures

All PwD also completed a short neuropsychological test battery covering memory (Wechsler Memory Scale word list subtest immediate recall score) [40], language (Graded Naming Test) [41] and executive function (Delis-Kaplan Executive Function System, letter and category fluency) [42], together with questionnaire

measures of mood (Hospital Anxiety and Depression Scale) [43] and quality of life (Quality of Life – Alzheimer’s Disease Scale) [44]. Carers rated the number and severity of behavioural symptoms in the PwD, and their own resulting distress (Neuropsychiatric Inventory – Questionnaire) [45], and completed a questionnaire measure of carer stress (Relatives’ Stress Scale) [46].

Procedure

Participants and their carers were seen, usually in their own homes, by two researchers, and the assessment typically took 2–3 visits to complete.

Data Analysis

Correlational analysis was used to explore the extent of association among the awareness measures. Cluster analysis, based on average between-group linkage using squared euclidean distance in Predictive Analytics Software version 18, was performed on measures standardised to z-scores in order to examine whether distinct groupings of participants could be identified based on their awareness profiles across the various measures. Stepwise discriminant analysis was used to determine which of the 6 awareness scores were needed to discriminate between the resulting clusters. Mean scores for the clusters on awareness measures and other variables were compared using one-way analysis of variance (ANOVA) with post hoc least significant difference tests.

Results

The participants were 101 individuals with early-stage AD, vascular or mixed AD and vascular dementia. In each case a carer also contributed. Sample characteristics are summarised in table 2. Between-group analysis indicated a significant difference in age across diagnostic groups [$F(2, 98) = 3.13, p = 0.048$], with the AD group being slightly younger, but post hoc tests revealed no individual group differences. There were no other significant differences. Scores on the awareness measures are summarised in table 3 and demonstrate the degree of variability within the sample. For measures of performance monitoring and evaluative judgement, while individual scores ranged from underestimation in relation to objective test score or carer rating through to overestimation, mean scores indicated that overestimation was more common on all measures. For the 3 evaluative judgement measures, overestimation was greatest in relation to everyday activities and least for socio-emotional functioning, with memory falling in between. The measures of metacognitive reflection produced a good range of scores. For the emotional Stroop task, 3 outliers with extreme scores were removed. The positive mean score demonstrates the presence of the expected effect at group level; 67 (88.2%) of the participants had slower response times in the salient word condition. One-way ANOVA indicat-

Table 2. Participant characteristics expressed as means \pm SD and range or frequency counts

		PwD (n = 101)	Carers (n = 101)
Age, years	Mean \pm SD	78.74 \pm 7.71	68.39 \pm 14
	Range	51 – 91	33 – 89
Gender	Female	54	64
	Male	47	37
Years of education	Mean \pm SD	11.68 \pm 2.67	
	Range	8 – 19	
Diagnosis	AD	51	
	VaD	30	
	Mixed AD/VaD	20	
MMSE score	Mean \pm SD	24.17 \pm 2.81	
	Range	18 – 30	
AChEI medication	Yes	57	
	No	44	
Relationship to PwD	Spouse/partner		66
	Adult child		26
	Niece/nephew		3
	Sibling		3
	Friend		3
	Coresident with PwD		74

VaD = Vascular dementia; AChEI = acetylcholinesterase inhibitor.

Table 3. Scores on the awareness measures

	n	Mean	SD	Range
Performance monitoring				
MPR	95	5.01	11.25	0.71–75
Evaluative judgement				
MFD	99	0.58	0.61	–1.13 to 2
FAD	96	0.91	0.8	–2 to 2
SFD	97	0.11	0.26	–0.54 to 0.95
Metacognitive reflection				
IGR	96	3.10	1.11	1–5
VTS	91	8.78	3.05	1–16
Implicit				
Stroop index score	76	1.43	1.95	–3.43 to 10.48

ed no significant differences between diagnostic groups in scores on the awareness measures. Therefore, in line with similar studies [47], the data were collapsed across diagnostic groups for further analysis.

Correlational analysis (table 4) indicated that the MPR measure was associated with measures of evaluative

Table 4. Bivariate correlations among the awareness measures

	MPR	MFD	FAD	SFD	IGR	VTS	SIS
MPR	1						
MFD	0.424**	1					
FAD	0.114	0.525**	1				
SFD	0.382**	0.402**	0.296**	1			
IGR	-0.208*	-0.439**	-0.255*	-0.134	1		
VTS	-0.310**	-0.196	-0.083	-0.218*	0.346**	1	
SIS	0.399**	0.343**	0.094	0.100	-0.052	-0.047	1

SIS = Stroop index score.

* $p < 0.05$, ** $p < 0.01$. Cases excluded pairwise in the event of missing data; number ranged from 74 to 97.

judgement in relation to everyday memory (MFD) and social functioning (SFD), but not ADLs (FAD), and with interview (IGR) and vignette (VTS) measures of metacognitive reflection. At the level of evaluative judgement, awareness scores for memory (MFD), ADLs (FAD) and social functioning (SFD) were moderately associated. Evaluative judgements in relation to memory (MFD) and ADLs (FAD), but not social functioning (SFD), were also modestly associated with the direct interview measure (IGR) of metacognitive reflection, while scores for social functioning (SFD) were modestly associated with the vignette measure (VTS) of metacognitive reflection. At the level of metacognitive reflection, the vignette measure (VTS) was modestly associated with the direct interview measure (IGR). The direct interview measure (IGR) was associated with memory performance monitoring and evaluative judgements about memory (MFD) and ADLs (FAD), while the indirect vignette measure (VTS) was associated with MPR and evaluative judgements about social functioning (SFD). The implicit measure (Stroop index score) was associated with memory functioning (MFD) and memory performance (MPR) only.

Cluster analysis included all explicit measures of awareness; the implicit Stroop measure was not included in view of the hypothesised dissociation between implicit and explicit measures. The analysis was based on 87 participants, having excluded 14 cases with missing data on 1 or more measures. Examination of the cluster analysis dendrogram (fig. 1) indicated a 3-cluster solution with 2 additional cases that did not cluster with the remainder. These cases, a 79-year-old man with an MMSE score of 26 and a 60-year-old man with an MMSE score of 18, showed high within-subject variability across levels and objects of awareness, and were excluded from further analysis.

The 3 resulting clusters were defined relative to each other as reflecting lower, moderate and higher awareness scores (table 5). Mean scores distinguished the 3 clusters on all explicit awareness measures, with the higher awareness group showing smaller ratio and discrepancy scores and higher interview and vignette scores. A stepwise discriminant analysis confirmed that all 6 scores were needed to discriminate between the clusters ($p < 0.001$ for each score). One-way ANOVA indicated that there were between-group differences on all explicit awareness measures. Post hoc tests indicated significant differences between all 3 groups for all measures except SFD, where there was a significant difference between the low awareness group and the other 2 groups. The implicit Stroop measure, added in table 5 for comparison purposes, showed no significant between-group differences; this is in line with the hypothesised dissociation between implicit and explicit awareness measures.

Mean scores for the 3 clusters on other variables are shown in table 6. The groups were well balanced with regard to gender, but differed significantly in age; the lower awareness group was the oldest on average, and the higher awareness group the youngest. There were significant differences in anxiety scores, with the low awareness group reporting significantly less anxiety than the moderate group, but no significant differences in scores for depression or quality of life. The groups differed significantly on MMSE, with the lower awareness group scoring more poorly than the other 2 groups. On neuropsychological testing, the pattern was mixed, with significant differences for recall, where the lower and moderate awareness groups scored more poorly than the high awareness group, and naming, where the lower awareness group scored more poorly than the moderate and high awareness groups. There were no differences in scores on

verbal letter and category fluency. Carer ratings of symptoms, severity and resulting distress did not differ among the groups, but carer stress was significantly greater in the lower awareness group than in the other 2 groups.

Discussion

This study, based on a theoretical framework that distinguishes awareness phenomena at different levels and of different types, has presented a multidimensional approach to the assessment of awareness in early-stage dementia, including both established and innovative methods. It has been the first to use cluster analytic methods to group participants according to the level of awareness shown across a number of measures and to examine whether the resulting groupings differentiate participants with regard to variables sometimes found to be associated with awareness.

The first aim was to examine the extent to which awareness scores derived from different assessment methods, applied at different levels of awareness in relation to different objects of awareness, are associated with each other. Within each level, where more than 1 measure was used, and where more than 1 object was considered, the measures were modestly associated; this is consistent with previous evidence that awareness scores obtained by different methods are not highly correlated [14, 30]. This in turn supports the conclusion that for any individual the extent of awareness may differ in relation to different objects [15]. Comparing across levels of awareness, again the measures show modest associations in some, but not all, cases. For example, at the metacognitive level, the interview ratings and vignette score were both modestly associated with the measure of MPR, but interview ratings were associated with evaluative judgements of memory and functional ability, while vignette scores were associated with evaluative judgements of social functioning.

Further consideration of the specificity of awareness phenomena involved the examination of a possible dissociation between scores on explicit and implicit measures of awareness. It has been observed that where awareness is not expressed explicitly, signs of awareness may still be present at an implicit level [9]; this suggests that there should be a dissociation between implicit and explicit awareness scores. The Memory Impairment and Dementia Awareness Study has been the first to attempt to examine implicit manifestations of awareness using an emotional Stroop task [32]. The Stroop index score did

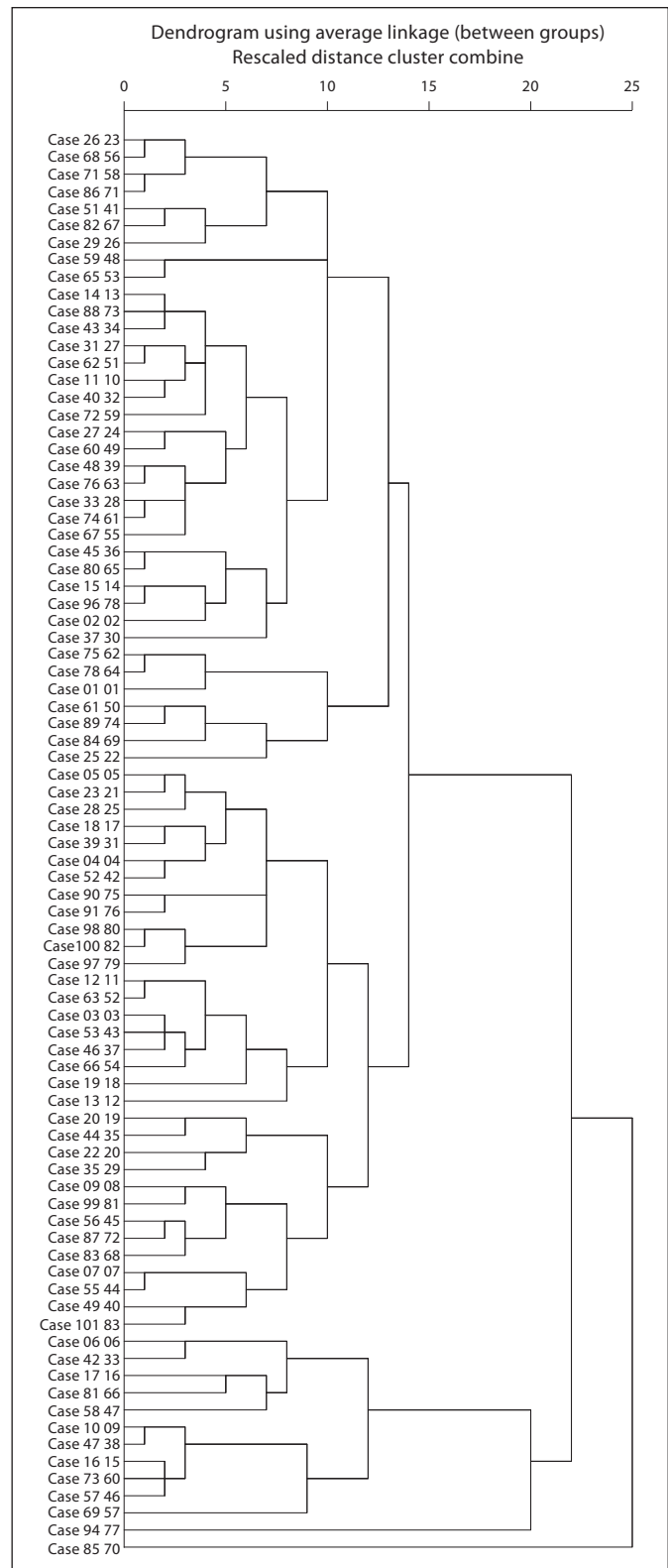


Fig. 1. Cluster analysis dendrogram. Cluster 1: cases 5–101 (n = 33); cluster 2: cases 26–25 (n = 37); cluster 3: cases 6–69 (n = 11). Cases 85 and 94 were excluded from further analysis as outliers.

Table 5. Mean scores (SD and range) on the awareness measures for the three clusters, and statistical comparison of scores

	C1: lower awareness (n = 33)	C2: medium awareness (n = 37)	C3: higher awareness (n = 11)	One-way ANOVA
MPR	3.64 (2.14; 0.71–10.5)	2.14 (0.98; 0.8–4.67)	1.19 (0.43; 0.72–2)	F(2, 78) = 18.12, p < 0.001 [C1 < C2 < C3]
MFD	1.11 (0.44; 0.14–2)	0.37 (0.33; –0.38 to 0.82)	–0.07 (0.36; –0.52 to 0.75)	F(2, 78) = 53.12, p < 0.001 [C1 < C2 < C3]
FAD	1.4 (0.49; 0.22–2)	0.84 (0.7; –0.71 to 2)	0.16 (0.9; –1.4 to 2)	F(2, 78) = 16.32, p < 0.001 [C1 < C2 < C3]
SFD	0.2 (0.21; –0.25 to 0.71)	0.02 (0.23; –0.54 to 0.43)	–0.09 (0.16; –0.26 to 0.22)	F(2, 78) = 10.44, p < 0.001 [C1 < C2 = C3]
IGR	2.36 (0.82; 1–4)	3.16 (0.9; 2–5)	4.64 (0.67; 3–5)	F(2, 78) = 30.86, p < 0.001 [C1 < C2 < C3]
VTS	7.82 (2.88; 1–12)	9.22 (2.52; 2–15)	11.82 (2.93; 8–16)	F(2, 78) = 9.11, p < 0.001 [C1 < C2 < C3]
SIS	1.82 (n = 28; 2.33; –3.43 to 8.77)	0.96 (n = 27; 1.11; –2.07 to 3.3)	1.26 (n = 9; 0.75; 0.37–2.41)	F(2, 61) = 1.91, p = 0.16 (n.s.)

C1–C3 = Clusters 1–3; SIS = Stroop index score; Stroop scores have been added here for completeness, although they were not included in the cluster analysis; these are taken from the 64 participants included in the cluster analysis who also completed the Stroop test. SD and ranges are given in parentheses, post hoc least significant differences in square brackets.

not differ between the 3 clusters, and participants with lower awareness on the explicit measures showed the Stroop effect to the same degree as those with greater explicit awareness. The task demonstrates the operation of information-processing biases in response to emotionally salient condition-related words, which are not evident in response to neutral words, in the majority of participants. As not all participants showed the effect, this cannot readily be attributed to extraneous factors such as priming by other tasks during the assessment. The emotional Stroop task is generally understood to tap implicit, pre-attentive responses in a range of conditions, and the present findings may therefore provide a first demonstration of implicit awareness in people with dementia. However, while the findings support the view that implicit processes can be elicited, the nature and origins of any implicit knowledge or representations underlying the observed effect, and the possible factors affecting emotional salience of the stimuli, remain to be clarified.

Overall, the findings suggest that awareness phenomena should be regarded as specific to a given level, object and method of measurement. Individual measures address a specific aspect of awareness at a given level in relation to a specific object, and even then, it is possible that applying a different measurement method might elicit different results. This has important implications for attempts to draw general conclusions by making comparisons across studies. Any findings on awareness should specify clearly the level of awareness involved, the object of awareness that was of interest and the measurement method used, as this will clarify where direct compari-

sons are, or are not, appropriate. Single measures cannot be considered to provide a reliable classification in relation to a presumed general construct of awareness.

In seeking to address these issues, a multidimensional approach to the assessment of awareness, of the kind outlined here, offers a potential means of classifying participants according to level of awareness across a number of levels and objects, and hence a more robust means of exploring correlates and predictors of awareness. The present study has demonstrated that it is possible to group participants according to degree of awareness when using a range of explicit awareness measures targeting different levels and objects of awareness, and that the resulting grouping is able to differentiate participants on other characteristics likely to be related to the degree of awareness. The use of cluster analysis has previously been advocated in this context, with the suggestion that it can uncover subtle distinctions between levels of awareness which other methods cannot [33]. However, that study used only 1 measure, involving participant and informant ratings and a discrepancy score. In this study, using a combination of awareness measures, encompassing the levels of performance monitoring, evaluative judgement and metacognitive reflection, and addressing a range of objects including memory, ADLs, social functioning, and the nature and implications of the condition, it was possible to identify clusters of participants reflecting lower, medium and higher levels of awareness, with significant between-group differences in scores on all explicit awareness measures. The 3 groups identified in the cluster analysis differed significantly on age, anxiety, MMSE score, perfor-

Table 6. Mean scores for the 3 clusters on other variables, and statistical comparisons

	Cluster 1: lower awareness (n = 33)	Cluster 2: moderate awareness (n = 37)	Cluster 3: higher awareness (n = 11)	One-way ANOVA
<i>PwD variables</i>				
Gender (female/male)	21/19	18/19	5/6	n.a.
Age	82.67 (3.89; 73–90)	77.97 (7.44; 59–91)	69 (10.87; 51–82)	F(2, 78) = 16.76, p < 0.001 [C1 > C2 > C3]
MMSE	23.06 (1.84; 19–26)	25.03 (2.52; 18–29)	26 (3.49; 18–29)	F(2, 78) = 8.65, p < 0.001 [C1 < C2 = C3]
HADS anxiety	4.18 (3.16; 0–13)	6.51 (3.69; 0–14)	6.09 (5.22; 0–16)	F(2, 78) = 3.58, p < 0.05 [C1 < C2]
HADS depression	3.24 (2.68; 0–11)	4.73 (3.2; 0–12)	4.73 (4.8; 0–17)	F(2, 78) = 2.03, p = 0.138 (n.s.)
QoL-AD quality of life	38.39 (4.3; 28–46)	36.62 (5.43; 21–48)	37.18 (6.52; 27–48)	F(2, 78) = 1.04, p = 0.358 (n.s.)
WMS list recall	13.39 (4.48; 5–20)	15.25 (6.11; 3–30)	21 (7.38; 10–35)	F(2, 74) = 6.75, p < 0.01 [C1 = C2 < C3]
GNT naming	10.79 (5.91; 0–25)	14.42 (6.25; 2–24)	16.90 (6.08; 9–25)	F(2, 76) = 5.15, p < 0.01 [C1 < C2 = C3]
Letter fluency	30.7 (13.81; 5–56)	30.05 (14.06; 8–62)	19.73 (7.91; 7–35)	F(2, 78) = 3.05, p = 0.053 (n.s.)
Category fluency	18.79 (8; 3–36)	21.14 (8.75; 2–40)	23.55 (8.8; 5–38)	F(2, 77) = 1.49, p = 0.231 (n.s.)
<i>Carer ratings of PwD</i>				
NPI-Q symptoms	4.73 (2.47; 0–10)	4.46 (2.47; 0–10)	3.09 (2.07; 0–6)	F(2, 78) = 1.92, p = 0.153 (n.s.)
NPI-Q severity	8.79 (5.75; 0–20)	8.08 (5.96; 0–25)	4.18 (3.19; 0–10)	F(2, 78) = 2.86, p = 0.063 (n.s.)
<i>Carer self-ratings</i>				
NPI-Q distress	9.67 (8.13; 0–29)	9.14 (7.35; 0–32)	5.36 (4.82; 0–17)	F(2, 78) = 1.44, p = 0.242 (n.s.)
RSS stress	22.7 (10.52; 6–48)	16.61 (9.56; 2–42)	16.09 (7.78; 4–31)	F(2, 77) = 3.93, p < 0.05 [C1 > C2]

n.a. = Not applicable; HADS = Hospital Anxiety and Depression Scale; QoL-AD = Quality of Life in Alzheimer's Disease questionnaire; WMS = Wechsler Memory Scale; GNT = Graded Naming Test; NPI-Q = Neuropsychiatric Inventory Questionnaire; RSS = Relatives' Stress Scale. SD and ranges are given in parentheses, post hoc least significant differences in square brackets.

mance on tests of recall and naming, and levels of carer stress. This suggests that a comprehensive, multilevel evaluation of awareness has the potential to identify subgroups of early-stage PwD who can be regarded as differing in level of awareness across a range of levels and objects, and this in turn may help to clarify the nature of any associations between level of awareness and other factors.

The literature presents conflicting findings on the association between awareness and demographic and disease-related factors [3, 48]. In the present study, the 3 awareness groups differed with regard to age and mean MMSE score, although there was overlap between the groups. Those with high awareness were more likely to have milder impairment and to be younger, and vice versa. There was no indication of gender differences in awareness. In previous studies, neuropsychological investigations have focused on memory, executive function and language, but have not yielded consistent associations [2]. The present analysis differentiated the groups on recall and naming, but not with regard to the verbal and category fluency tasks that are often considered as tests of executive functions. A more extensive neuropsychological

battery including additional tests in these 3 key domains might help to clarify further the nature of any associations in this area. The literature also presents conflicting findings on the relationship between mood and awareness. Possible links between depression and awareness have been extensively investigated, with approximately equal numbers of studies finding and not finding an association [3]. In this study, reports of depressed mood did not differ across the 3 groups. It was anxiety that appeared related to awareness, with the low awareness group reporting significantly less anxiety than the moderate awareness group. This is consistent with the findings of the majority of previous studies [14, 16, 49], although some did not find this association [50]. Some studies have reported an association with self-reported quality of life in dementia [6], but others have found no such association [7]. Measurement of awareness in these quality of life studies is often particularly limited [6]. The present study found no difference in quality of life according to level of awareness. Finally, level of awareness has important implications for care provision, and an association between lower awareness and greater carer

stress and burden is a frequent, if not fully consistent, finding [4] in studies of awareness. The present study supports this finding, as carers of the lower awareness group scored higher on a specific measure of carer stress. There was no difference in levels of distress at symptoms recorded on the Neuropsychiatric Inventory Questionnaire; this may reflect the fact that participants were all in the early stages of dementia with relatively little differentiation in extent or severity of symptoms.

The approach used in this study was based on a clearly defined theoretical framework supporting a comprehensive approach to assessing awareness at different levels and in relation to a range of objects. However, there were some limitations with regard to suitable measurement approaches. Performance monitoring was evaluated only in relation to memory, whereas evaluative judgement was assessed in relation to memory, ADLs and social functioning, and metacognitive reflection in relation to a more general appraisal of the salience, impact and implications of the condition. Future work could seek to compare the same objects across levels and assessment methods; however, this would require considerable effort in terms of measure development. Innovative approaches to measurement were introduced in the present study, in the form of the indirect vignette method and the emotional Stroop task. As these were adopted here for the first time, it will be helpful in future to gather more evidence about the utility of these methods for assessing awareness. Assessment of possible correlates of awareness is a key feature in the majority of studies of awareness, and the present study included a number of frequently investigated factors. However, factors such as depression or quality of life are in themselves complex constructs which could be measured in many different ways, and future work could take this into account with a more comprehensive approach to assessment. Similarly, while important neuropsychological variables were investigated, there is scope for a more comprehensive approach to assessment of executive function in particular in future studies. A further issue is the extent to which cluster analysis of this type of data can encapsulate all individuals. The resulting clusters encompassed 85 of 87 included participants (98%), but 2 participants could not be included due to high variability in scores on the different awareness measures. It would be of interest with a larger sample to identify whether there is a subgroup of such participants. Finally, all 6 measures were essential contributors to the cluster analysis. While this reflects a comprehensive approach, it may not always be practical to conduct such an extensive assessment.

Conclusions

This study has been the first to apply cluster analysis techniques within a multidimensional approach in order to assess awareness in early-stage dementia. The findings from this study suggest that if we are serious about wanting to understand and meaningfully evaluate the degree of awareness shown by a PwD, it is not enough to take one measure and to assume this is an index of some general phenomenon of awareness. As long as this practice continues, confusing and contradictory findings will continue to appear in the literature. Where single measures are used, it is important to specify precisely the type of awareness phenomenon that is being examined, and to restrict conclusions to this, rather than making unwarranted global statements. The present findings support the value of a multidimensional approach to assessment of awareness, and indicate that such an approach is worthy of further investigation.

Acknowledgements

We are grateful to Clinical Studies Officers Julia Roberts and Martin Wynne Jones and the staff of Memory Clinics across North Wales for assistance with participant recruitment, and we acknowledge the support of Neurodem Cymru. We also thank Emma Naylor for assistance in the early stages of the study. This study was funded by Economic and Social Research Council grant RES-062-23-0371 to L. Clare (PI), R.T. Woods, I.S. Markova, R.G. Morris and I. Roth.

Disclosure Statement

The authors declare no actual or potential conflicts of interest.

References

- 1 Marková IS: *Insight in Psychiatry*. Cambridge, Cambridge University Press, 2005.
- 2 Starkstein SE, Jorge R, Mizrahi R, Robinson RG: A diagnostic formulation for anosognosia in Alzheimer's disease. *J Neurol Neurosurg Psychiatry* 2006;77:719–725.
- 3 Aalten P, van Valen E, Clare L, Kenny G, Verhey F: Awareness in dementia: a review of clinical correlates. *Aging Ment Health* 2005; 9:414–422.
- 4 Rymer S, Salloway S, Norton L, Malloy P, Correia S, Monast D: Impaired awareness, behavior disturbance, and caregiver burden in Alzheimer disease. *Alzheimer Dis Assoc Disord* 2002;16:248–253.
- 5 Seltzer B, Vasterling JJ, Yoder J, Thompson KA: Awareness of deficit in Alzheimer's disease: relation to caregiver burden. *Gerontologist* 1997;37:20–24.

- 6 Hurt CS, Banerjee S, Tunnard C, Whitehead DL, Tsolaki M, Mecocci P, Kloszewska I, Soininen H, Vellas B, Lovestone S: Insight, cognition and quality of life in Alzheimer's disease. *J Neurol Neurosurg Psychiatry* 2010; 81:331–336.
- 7 Ready R, Ott B, Grace J: Insight and cognitive impairment: effects on quality-of-life reports from mild cognitive impairment and Alzheimer's disease patients. *Am J Alzheimers Dis Other Demen* 2006;21:242–248.
- 8 Ecklund-Johnson E, Torres I: Unawareness of deficits in Alzheimer's disease and other dementias: operational definitions and empirical findings. *Neuropsychol Rev* 2005;15: 147–166.
- 9 Morris R, Hannesdottir K: Loss of 'awareness' in Alzheimer's disease; in Morris R, Becker J (eds): *Cognitive Neuropsychology of Alzheimer's Disease*. Oxford, Oxford University Press, 2004, pp 275–296.
- 10 Weinstein EA, Friedland RP, Wagner EE: Denial/unawareness of impairment and symbolic behavior in Alzheimer's disease. *Neuropsychiatry Neuropsychol Behav Neurol* 1994;7:176–184.
- 11 Clare L: The construction of awareness in early-stage Alzheimer's disease: a review of concepts and models. *Br J Clin Psychol* 2004; 43:155–175.
- 12 Clare L, Markova I, Verhey F, Kenny G: Awareness in dementia: a review of assessment methods and measures. *Aging Ment Health* 2005;9:394–413.
- 13 Ott BR, Lafleche G, Whelihan WM, Buongiorno GW, Albert MS, Fogel BS: Impaired awareness of deficits in Alzheimer disease. *Alzheimer Dis Assoc Disord* 1996;10:68–76.
- 14 Derouesne C, Thibault S, Lagha-Pierucci S, Baudouin-Madec V, Ancrì D, Lacomblez L: Decreased awareness of cognitive deficits in patients with mild dementia of the Alzheimer type. *Int J Geriatr Psychiatry* 1999;14: 1019–1030.
- 15 Vasterling JJ, Seltzer B, Foss JW, Vanderbrook V: Unawareness of deficit in Alzheimer's disease: domain-specific differences and disease correlates. *Neuropsychiatry Neuropsychol Behav Neurol* 1995;8:26–32.
- 16 Verhey FRJ, Rozendaal N, Ponds RWHM, Jolles J: Dementia, awareness and depression. *Int J Geriatr Psychiatry* 1993;8:851–856.
- 17 Migliorelli R, Petracca G, Teson A, Sabe L, Leiguarda R, Starkstein SE: Neuropsychiatric and neuropsychological correlates of delusions in Alzheimer's disease. *Psychol Med* 1995;25:505–513.
- 18 Wagner MT, Spangenberg KB, Bachman DL, O'Connell P: Unawareness of cognitive deficit in Alzheimer disease and related dementias. *Alzheimer Dis Assoc Disord* 1997;11: 125–131.
- 19 Larrabee GJ, West RL, Crook TH: The association of memory complaint with computer-simulated everyday memory performance. *J Clin Exp Neuropsychol* 1991;13: 466–478.
- 20 Trosset MW, Kaszniak AW: Measures of deficit unawareness for predicted performance experiments. *J Int Neuropsychol Soc* 1996;2: 315–322.
- 21 McGlynn SM, Kaszniak AW: Unawareness of deficits in dementia and schizophrenia; in Prigatano GP, Schacter DL (eds): *Awareness of Deficit after Brain Injury: Clinical and Theoretical Issues*. New York, Oxford University Press, 1991, pp 84–110.
- 22 Green J, Goldstein FC, Sirockman BE, Green RC: Variable awareness of deficits in Alzheimer's disease. *Neuropsychiatry Neuropsychol Behav Neurol* 1993;6:159–165.
- 23 Correa DD, Graves RE, Costa L: Awareness of memory deficit in Alzheimer's disease patients and memory-impaired older adults. *Aging Neuropsychol Cognit* 1996;3:215–228.
- 24 Duke LM, Seltzer B, Seltzer JE, Vasterling JJ: Cognitive components of deficit awareness in Alzheimer's disease. *Neuropsychology* 2002;16:359–369.
- 25 Reed BR, Seab JP, Jagust WJ: Dementia severity, memory impairment, and awareness of memory loss in Alzheimer's disease. *J Clin Exp Neuropsychol* 1992;14:21.
- 26 Clare L, Wilson BA, Carter G, Roth I, Hodges JR: Assessing awareness in early-stage Alzheimer's disease: development and piloting of the Memory Awareness Rating Scale. *Neuropsychol Rehabil* 2002;12:341–362.
- 27 Clare L: Managing threats to self: awareness in early-stage Alzheimer's disease. *Soc Sci Med* 2003;57:1017–1029.
- 28 Howorth P, Saper J: The dimensions of insight in people with dementia. *Aging Ment Health* 2003;7:113–122.
- 29 Hannesdottir K, Morris RC: Primary and secondary anosognosia for memory impairment in patients with Alzheimer's disease. *Cortex* 2007;43:1020–1030.
- 30 Okwonko OC, Spitznagel MB, Alosco ML, Tremont G: Associations among measures of awareness of cognitive deficits in dementia. *Alzheimers Dement* 2010;6:312–318.
- 31 Clare L, Rowlands J, Bruce E, Surr C, Downs M: 'I don't do like I used to do': a grounded theory approach to conceptualising awareness in people with moderate to severe dementia living in long-term care. *Soc Sci Med* 2008;66:2366–2377.
- 32 Martyr A, Clare L, Nelis SM, Roberts JL, Robinson JU, Roth I, Markova IS, Woods RT, Whitaker CJ, Morris RG: Dissociation between implicit and explicit manifestations of awareness in early stage dementia: evidence from the emotional Stroop effect for dementia-related words. *Int J Geriatr Psychiatry* 2011;26:92–99.
- 33 Lamar M, Lasarev MR, Libon DJ: Determining levels of unawareness in dementia research. *J Neuropsychiatry Clin Neurosci* 2002;14:430–437.
- 34 Folstein MF, Folstein SE, McHugh PR: 'Mini-mental state': a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975;12:189–198.
- 35 Wilson BA, Baddeley AD, Cockburn J: *Rivermead Behavioural Memory Test*, ed 2. Bury St Edmunds, Thames Valley Test Company, 2003.
- 36 Clare L, Whitaker C, Nelis SM: Appraisal of memory functioning and memory performance in healthy ageing and early-stage Alzheimer's disease. *Aging Neuropsychol Cognit* 2010;17:462–491.
- 37 Pfeffer RI, Kurosaki TT, Harrah CH, Chance JM, Filos S: Measurement of functional activities in older adults in the community. *J Gerontol* 1982;37:323–329.
- 38 Bramham J, Morris R, Hornak J, Bullock P, Polkey C: Social and emotional functioning following bilateral and unilateral neurosurgical prefrontal cortex lesions. *J Neuropsychol* 2009;3:125–143.
- 39 Bondi MW, Serody AB, Chan AS, Ebersohn-Shumate SC, Delis DC, Hansen LA, Salmon DP: Cognitive and neuropathological correlates of Stroop color-word test performance in Alzheimer's disease. *Neuropsychology* 2002;16:335–343.
- 40 Wechsler D: *Wechsler Memory Scale*, ed 3. San Antonio, Psychological Corporation, 1997.
- 41 McKenna P, Warrington EK: *Graded Naming Test: Manual*. Cambridge, Cambridge Cognition Ltd, 1983.
- 42 Delis DC, Kaplan E, Kramer JH: *Delis-Kaplan Executive Function System (D-KEFS)*. London, Pearson, 2001.
- 43 Snaith RP, Zigmond AS: *The Hospital Anxiety and Depression Scale*. Windsor, NFER-Nelson, 1994.
- 44 Logsdon R, Gibbons LE, McCurry SM, Teri L: Assessing quality of life in older adults with cognitive impairment. *Psychosom Med* 2002;64:510–519.
- 45 Kaufer DCJ, Ketchel P, Smith V, MacMillan A, Shelley T, Lopez O, De Kosky S: Validation of the NPI-Q, a brief clinical form of the Neuropsychiatric Inventory. *J Neuropsychiatry Clin Neurosci* 2000;12:233–239.
- 46 Greene JG, Smith R, Gardiner M, Timbury GC: Measuring behavioural disturbance of elderly demented patients in the community and its effects on relatives: a factor analytic study. *Age Ageing* 1982;11:121–126.
- 47 Aalten P, van Valen E, de Vugt M, Lousberg R, Jolles J, Verhey FRJ: Awareness and behavioral problems in dementia patients: a prospective study. *Int Psychogeriatr* 2006;18:3–17.
- 48 Clare L: Awareness in early-stage Alzheimer's disease: a review of methods and evidence. *Br J Clin Psychol* 2004;43:177–196.
- 49 Harwood DG, Baker WW, Ownby RL, Duara R: Relationship of behavioural and psychological symptoms to cognitive impairment and functional status in Alzheimer's Disease. *Int J Geriatr Psychiatry* 2000;15: 393–400.
- 50 Seltzer B, Vasterling JJ, Hale MA, Khurana R: Unawareness of memory deficit in Alzheimer's disease: relation to mood and other disease variables. *Neuropsychiatry Neuropsychol Behav Neurol* 1995;8:176–181.