REVIEW

The Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE): a review

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ABSTRACT

Background and aims: The IQCODE is widely used as a screening test for dementia, particularly where the subject is unable to undergo direct cognitive testing or for screening in populations with low levels of education and literacy. This review draws together research on the psychometric properties and validity of the IQCODE.

Method: A systematic search of the literature was carried out using three databases.

Results: The review shows that the questionnaire has high reliability and measures a single general factor of cognitive decline. It validly reflects past cognitive decline, performs at least as well at screening as conventional cognitive screening tests, predicts incident dementia, and correlates with a wide range of cognitive tests. A particular strength is that the IQCODE is relatively unaffected by education and pre-morbid ability or by proficiency in the culture's dominant language. The disadvantage of the IQCODE is that it is affected by informant characteristics such as depression and anxiety in the informant and the quality of the relationship between the informant and the subject.

Conclusions: Because the IQCODE provides information complementary to brief cognitive tests, harnessing them together can improve screening accuracy.

Brief cognitive screening tests for dementia, such as the Mini-mental State Examination (MMSE), are widely used both in research and clinical practice. However, informant-based screening tests provide a complementary approach. They have proved particularly useful for individuals who are unable to undergo

direct cognitive testing because of acute illness, lack of co-operation or death, and for screening in populations with low levels of education and literacy. Informant-based methods can also be harnessed together with cognitive screening tests to provide better screening. There are a large number of informant instruments available (Jorm, 1996), but most have not come into widespread use. The purpose of this article is to review the evidence on the IQCODE, which is the most widely used of these informant instruments in the literature.

Method

A systematic search of the literature was made using the following methods: (1) PubMed and PsycInfo were searched up to June 2003, using the search term IQCODE OR "informant questionnaire on cognitive decline in the elderly" (2) Web of Science was searched up to June 2003 for papers which cited two key references on the IQCODE (Jorm and Jacomb, 1989; Jorm, 1994). These searches produced 185 unique references. A small number of additional references were added from the author's personal file of reprints. The resulting papers were all searched and included in this review if they covered any of the following: initial development of the questionnaire, reliability, validity, item properties (including factor analysis), correlations with other cognitive or informant tests, scoring methods or cutoffs, norms, influence of subject characteristics (e.g. education, pre-morbid ability, anxiety, depression), influence of informant characteristics, variants on the IQCODE (including non-English versions), feasibility of use, and novel uses. The aim was to exclude studies that used the IQCODE as a tool but did not add to knowledge of the questionnaire itself.

Results

Development of the IQCODE

The IQCODE was developed as a way of measuring cognitive decline from a pre-morbid level using informant reports. The initial item pool consisted of 39 questions which were sampled to cover two aspects of memory (acquisition of new information and retrieval of existing knowledge), and two aspects of intelligence (verbal and performance) (Jorm and Korten, 1988). Items had to be rated for change over the previous 10 years. The 10-year time frame was chosen because it was a convenient reference point and because the duration of dementia is often less than 10 years. These 39 items were administered by interview to the informants of 64 elderly volunteers, some of whom lived in the community and others in residential care. From these data, some items were

eliminated because too many informants found them difficult to rate, and one item was eliminated because it did not correlate well with the other items, leaving a final list of 26 items. Despite the initial selection of items to cover different aspects of memory and intelligence, the various sub-scales inter-correlated very highly, indicating that the questionnaire was measuring a single dimension of cognitive decline.

Subsequently, the 26 items were made into a questionnaire for self-completion and given the name *IQCODE* (Jorm *et al.*, 1989). Each item was rated on a 5-point scale from 1-"much better" to 5-"much worse" and the ratings were averaged over the 26 items to give a 1–5 score, with 3 representing no change on any item. The rating scale was deliberately designed to reflect cognitive improvement as well as cognitive decline, to allow for the questionnaire to be used in treatment trials and following acute illnesses. However, subsequent experience showed that a small minority of informants misinterpreted "better" as meaning "much better 10 years ago" rather than "much better now than 10 years ago". For this reason, the wording of the positive pole of the rating scale was changed to "improved" (Jorm, 1994).

Variations on the original

There have been a number of variations on the IQCODE in the literature. Although it was developed for informant self-completion, it has also been used as a face-to-face interview and as a telephone interview.

Versions of the IQCODE have been produced other languages, including Chinese, Dutch, Finnish, French, Canadian French, German, Italian, Japanese, Korean, Norwegian, Polish, Spanish and Thai. Downloadable copies in these languages are available at http://www.anu.edu.au/iqcode/.

Another variation involves the 10-year time frame. Some users have found difficulty in finding informants who have the required contact with the subject over 10 years. This has led them to use a five-year time frame (Barba *et al.*, 2000; Pisani *et al.*, 2003) or to be flexible in relation to the time frame (Patel *et al.*, 1993). There is no evidence on whether these modifications affect validity. However, one modification that was clearly unsuccessful was using a two-year time frame for a study of day program staff rating older mentally retarded adults (Shultz *et al.*, 1998). This modification had modest reliability and validity.

Another variant is the Retrospective IQCODE which asks about cognitive change leading up to some critical event like the subject's death or onset of an acute illness. The Retrospective IQCODE has been used to assess people who have donated brains but did not have relevant data collected before death (Thomas *et al.*, 1994; Rockwood *et al.*, 1998), to assess participants in prospective studies of dementia who die between waves of assessment (Rockwood *et al.*, 1998), and to assess cognitive decline preceding a stroke

(Hénon *et al.*, 1997), delirium (Cole *et al.*, 2002), or admission to intensive care (Pisani *et al.*, 2003).

There have also been a number of short forms developed. Jorm (1994) used a number of data sets to develop the Short IQCODE, a 16-item version which correlated 0.98 with the full version and had comparable validity when judged against clinical diagnosis. Later studies have found similar very high correlations between the short and long forms, both in English (Jorm *et al.*, 1996a) and Dutch (de Jonghe *et al.*, 1997). Because the validity of the Short IQCODE is virtually identical to the 26-item version, there is little to be gained in using the longer version. There has also been work on short forms in languages other than English. Morales and colleagues (1995) developed a short Spanish version (called the SS-IQCODE) using the 17 items with the highest item-total correlations. Twelve of these items are also in the English-language Short IQCODE. The SS-IQCODE was found to have the same ability to predict dementia and the same independence from education and pre-morbid ability as the full Spanish version. Using a Chinese version of the IQCODE, Fuh and colleagues (1995) used discriminant analysis to select the best sub-set of items and found 17 that would perform as well as the full 26 (12 of these 17 were also in the English-language Short IQCODE). However, they found that the best two items (recalling conversations a few days later; handling financial matters, e.g. the pension, dealing with the bank) alone gave almost as high screening accuracy for dementia. In a study with the Thai IQCODE, Senanarong and co-workers (2001) found that three items contributed significantly to the prediction of dementia in a logistic regression analysis (remembering what day and month it is, learning how to use a new gadget, and handling other everyday arithmetic problems). The three-item scale had a sensitivity of 85% and a specificity of 92%. While these very short versions look promising, they require cross-validation in new samples.

Scoring of the IQCODE

The original scoring involved summing the items and dividing by 26 to give a score from 1 to 5. This method was used because the averaged numbers have an intuitive meaning in terms of the item rating scale. If there were missing items it was also easy to pro-rate by dividing by the number of completed items. However, some users have preferred to sum the ratings to give a score from 26 to 130 (Morales *et al.*, 1995; Hénon *et al.*, 1997). There have been differences in the number of items that users have allowed before counting the IQCODE as invalid. In the original research with the questionnaire, up to three missing values were allowed for the IQCODE and two for the Short IQCODE. However, others have allowed up to five or six missing responses (Law and Wolfson, 1995; Lim *et al.*, 2003; Tang *et al.*, 2003).

Norms and cut-offs

Jorm and Jacomb (1989) presented percentile rank norms for 5-year age groups from 70–74 up to 85+, using an Australian electoral roll sample of informants. However, in practice these norms appear to have not been used, with most users preferring to classify subjects using an absolute cut-off score. As shown in Table 1, a variety of cut-offs have been proposed for dementia screening. In general, cut-offs have been lower for detecting dementia in community samples (cut-off range 3.3–3.6) than in patient samples (range 3.4–4.0), probably reflecting the milder cases seen in the community. For the Short IQCODE, cut-offs have been generally higher than in the full version because the items included in the short version are more sensitive to change (see Table 2). Given this variety, how should a user select a cut-off for a particular application? The best approach is probably to take the cut-off from the study in Table 1 or 2 which has a sample closest in composition to the population the user wants to screen.

Reliability

Coefficient alpha has been calculated in seven studies covering a range of populations and languages and was uniformly high, with a range from 0.93–0.97 (de Jonghe *et al.*, 1997; Fuh *et al.*, 1995; Jorm *et al.*, 1989; Jorm and Jacomb, 1989; Jorm and Korten, 1988; Morales *et al.*, 1997; Tang *et al.*, 2003). Retest reliability has been reported as 0.96 over three days and 0.75 over one year (Jorm *et al.*, 1991; Jorm and Jacomb, 1989). The only exception to this high reliability was in a study of mentally retarded older adults in which the informants were day program staff and the IQCODE was modified to have a two-year time frame because the staff had limited knowledge of the subjects (Schultz *et al.*, 1998). In this study, alpha was 0.86, retest reliability over four weeks was 0.55 and inter-rater reliability was −0.21. It is evident that the IQCODE is not a suitable measure in these circumstances.

Factor analysis

There have been five studies reporting a principal components analysis of the IQCODE items, covering a diversity of populations and languages (de Jonghe *et al.*, 1997; Fuh *et al.*, 1995; Jorm *et al.*, 1989; Jorm and Jacomb, 1989; Morales *et al.*, 1997). All have found a large general factor accounting for between 42% and 61% of the variance (median 48%), with subsequent factors accounting for much smaller percentages (e.g. 7–10% for the second factor). These findings show that the IQCODE is measuring a broad general factor of cognitive decline. Despite the original selection of the items to cover particular cognitive processes, these have not emerged in any of the factor analyses.

Table 1. Performance of the IQCODE as a screening test for dementia

STUDY	SAMPLE	DIAGNOSTIC CRITERIA	IQCODE CUTOFF	SENSITIVITY	SPECIFICITY	AREA UNDER ROC
Jorm *et al.* (1991)	69 patients with a mean age of 80 seen by a geriatrician (Australia)	ICD-10 Dementia DSM-IIIR Dementia	3.60+ 3.60+	80% 69%	82% 80%	0.87 0.77
Jorm *et al.* (1994)	684 persons aged 70+ sampled for an epidemiological survey (Australia)	DSM-IIIR Dementia or Delirium	3.30+	79%	83%	0.85
Law and Wolfson (1995)	237 persons with a mean age of 81 sampled for an epidemiological survey (Quebec, Canada)	DSM-IIIR Dementia	3.6+	76%	96%	Not given
Fuh *et al.* (1995)	399 non-demented community residents and 61 dementia patients, with a mean age of 69 (Taiwan)	DSM-IIIR Dementia	3.4+	89%	88%	0.91
Morales *et al.* (1997)	97 persons from an urban epidemiological study (mean age 75) and 160 from a rural epidemiological study (mean age 74) (Spain)	DSM-IIIR Dementia	3.27+ (urban) 3.31+ (rural)	82% 83%	90% 83%	0.89 0.83
Jorm *et al.* (1996a)	144 ex-servicemen with a mean age of 73, half of whom were former prisoners of war, from an epidemiological study (Australia)	ICD-9 Dementia	3.30+	79%	65%	0.77
Mulligan *et al.* (1996)	76 geriatric patients with a mean age of 82 (Switzerland)	DSM-IIIR Dementia	3.60+	76%	70%	0.86
Del-Ser *et al.* (1997)	53 outpatients with a mean age of 69 from a neurological clinic (Spain)	DSM-IIIR Dementia	3.62+	84%	73%	0.81
Flicker *et al.* (1997)	299 memory clinic patients mean age of 73 78 patients with a mean age of 80, assessed by an aged care assessment team (Australia)	DSM-IIIR Dementia Psychiatrist's diagnosis (criteria unspecified)	3.90+ 3.90+	74% 79%	71% 78%	Not given Not given
de Jonghe *et al.* (1997)	82 psychiatric patients, with a mean age of 78, 49 of whom had dementia (Netherlands)	DSM-IIIR Dementia	3.90+	88%	79%	Not given
Senanarong *et al.* (2001)	87 community elderly and 73 with dementia, with age range of 52-85 (Thailand)	DSM-IV Dementia	All possible	Not given	Not given	0.93
Lim *et al.* (2003)	100 cognitively normal volunteers and 53 patients with dementia (age not stated) (Singapore)	DSM-IV Dementia	3.40+	94%	94%	Not given
Stratford *et al.* (2003)	577 patients from a memory clinic with a mean age of 73 (Australia)	ICD-10 Dementia	4.00+	Not given	Not given	0.82
Tang *et al.* (2003)	189 stroke patients with a mean age of 68 (China)	DSM-IV Dementia	3.40+	88%	75%	0.88

Table 2. Performance of the Short IQCODE as a screening test for dementia

STUDY	SAMPLE	DIAGNOSTIC CRITERIA	IQCODE CUTOFF	SENSITIVITY	SPECIFICITY	AREA UNDER ROC
Jorm (1994)	684 persons aged 70+ sampled for an epidemiological survey (Australia)	DSM-IIIR Dementia or Delirium	3.38+	79%	82%	0.85
Jorm *et al.* (1996a)	144 ex-servicemen with a mean age of 73, half of whom were former prisoners of war, from an epidemiological study (Australia)	ICD-9 Dementia	3.38+	75%	68%	0.77
Del-Ser *et al.* (1997)	53 outpatients with a mean age of 69 from a neurological clinic (Spain)	DSM-IIIR Dementia	3.88+*	79%	73%	0.77
Harwood *et al.* (1997)	177 medical inpatients aged 65+ (England)	DSM-IIIR Dementia	3.44+	100%	86%	Not stated

* SS-IQCODE was used.

Validation against measures of cognitive change

Jorm and co-workers (1996b) assessed scores on the IQCODE against change on cognitive tests over the previous 3.5 years and subsequently against change over the previous 7–8 years (Jorm *et al.*, 2000). IQCODE score was found to correlate 0.48 with change in MMSE score over the 7–8 years, 0.38 with change in episodic memory and 0.34 with change in mental speed, but there was no association with change on the National Adult Reading Test (NART). While these correlations are not high, they are similar in magnitude to the correlations that cognitive change scores have with each other (range 0.34–0.53) which indicates the feasible upper limit of correlations with the IQCODE.

Validation against clinical diagnosis

Table 1 summarizes findings on the IQCODE as a screening test for dementia and Table 2 summarizes finding on the Short IQCODE. There is a great diversity of findings, depending on the nature of the sample and the diagnostic criteria used as a standard. In evaluating screening test performance against this standard, it must be remembered that clinical diagnosis itself has an unknown degree of error.

A number of the studies in Table 1 have also included the MMSE, allowing a direct comparison of their performance. In a meta-analysis of seven of these studies, Jorm (1997) found a weighted mean "effectiveness" (standardized mean difference between cases and non-cases) of 1.75 (95% CI: 1.39–2.09) for the IQCODE compared to 1.48 (95% CI: 1.25–1.61) for the MMSE. Although the IQCODE performed better on average, there was considerable heterogeneity across studies in its performance.

Validation against neuropathology

Two studies have compared the Retrospective IQCODE to neuropathological diagnosis. Thomas *et al.* (1994) found a sensitivity of 73% and specificity of 75% for a cut-off of 3.7+ using conventional neuropathological diagnosis of Alzheimer's disease (AD) as the standard, and a sensitivity of 68% and specificity of 80% using immunohistochemistry. Rockwood *et al.* (1998) found a sensitivity of 97% and a specificity of 33% for a cut-off of 3.42+, using pathological diagnoses of AD, vascular or mixed dementia. Also relevant is the report by Thomas (1996) that the IQCODE was significantly correlated (*r* not reported) with 130 kDa amyloid precursor protein in the blood of AD patients.

Validation against neuroimaging

Two studies have looked at the association of IQCODE scores with CT variables. A study of an elderly community sample found significant correlations of 0.25

with width of the third ventricle, 0.37 with number of infarcts in the left hemisphere and 0.27 with infarcts in the right hemisphere, but non-significant associations with cortical, Sylvian and vermis atrophy (Jorm *et al.*, 1996a). In a study of stroke patients, the IQCODE correlated 0.38 with leukoaraiosis score, 0.45 with cerebral atrophy and 0.31 with medial temporal lobe atrophy (Cordoliani-Markowiak *et al.*, 2003). The higher correlations in the patient sample are probably due to the greater degree of pathology.

Validation against future cognitive decline, incident dementia and mortality

Several studies have examined the predictive validity of the IQCODE. Using a sample of informants drawn from an Alzheimer's association, Jorm and Jacomb (1989) found that the IQCODE predicted institutionalization over the following year, but not mortality.

Hénon *et al.* (1997) found that, when the IQCODE was used to assess pre-stroke cognitive decline in stroke patients, there was a greater death rate at six months in those scoring 4+, who were also more likely to suffer an acute confusional state (Hénon *et al.*, 1999). The IQCODE was also found to predict incident dementia in these stroke patients over the following three years (Hénon *et al.*, 2001).

Louis *et al.* (1999) followed up medical inpatients who did not meet criteria for DSM-IIIR Dementia at admission and found that those with an IQCODE score of >3.31 were more likely to develop dementia over the next 20 months. Those with low scores were also more likely to die, but the difference failed to reach statistical significance.

Barba *et al.* (2000) used the IQCODE to assess pre-stroke dementia in a series of stroke patients and found that scores predicted death and incident post-stroke dementia over the next three months.

In summary, the evidence is consistent that the IQCODE predicts incident dementia, but the evidence on prediction of mortality varies depending on the nature of the sample.

Correlations with cognitive tests

Table 3 summarizes the findings on correlations with cognitive screening tests. The most data are on the MMSE, with correlations in the range –0.37 to –0.78 (median –0.61) and the Abbreviated Mental Test Score, with a range of –0.54 to –0.62 (median –0.58). As would be expected, correlations tend to be lower in samples where dementia is less prevalent.

Three studies have examined correlations with measures of intelligence. Using an epidemiological sample, Morales and co-workers (1997) found correlations of –0.22 with the Abbreviated WAIS and –0.26 with Raven's Progressive Matrices.

Table 3. Correlations of IQCODE with cognitive screening tests

STUDY	SAMPLE	COGNITIVE SCREENING TEST	CORRELATION
Jorm and Korten (1988)	64 volunteers with a mean age of 79 from community and residential care (Australia)	MMSE	−0.74
Jorm *et al.* (1989)	31 persons in residential care with a mean age of 83 (Australia)	MMSE	−0.78
Bowers *et al.* (1990)	90 general practice patients aged 70+ (Australia)	MMSE Information/Orientation	−0.75 −0.78
Jorm *et al.* (1991)	69 patients seen by a geriatrician with a mean age of 80 (Australia)	MMSE	−0.54
Christensen and Jorm (1992)	29 healthy academics and scientists and 28 healthy former blue collar workers with a mean age of 77 (Australia)	MMSE	−0.37
Thomas *et al.* (1994)	50 necropsied patients with a mean age of 81 (Australia)	Abbreviated Mental Test Score	−0.58
Jorm *et al.* (1995)	600 participants aged 70+ in an epidemiological study (Australia)	Psychogeriatric Assessment Scales Cognitive Impairment	−0.45
Law and Wolfson (1995)	237 participants in an epidemiological study with a mean age of 81 (Quebec, Canada)	MMSE	−0.44
Fuh *et al.* (1995)	399 non demented community residents and 61 dementia patients with a mean age of 69 (Taiwan)	MMSE	−0.69
Jorm *et al.* (1996a)	144 ex-servicemen, half of whom were former prisoners of war, with a mean age of 73 (Australia)	MMSE	−0.41
Mulligan *et al.* (1996)	76 geriatric patients with a mean age of 82 (Switzerland)	MMSE	−0.48
Del-Ser *et al.* (1997)	53 outpatients from a neurological clinic with a mean age of 69 (Spain)	MMSE	−0.52
Flicker *et al.* (1997)	299 memory clinic patients with a mean age of 73 (Australia)	MMSE Abbreviated Mental Test Score	−0.56 −0.54
	78 patients with a mean age of 80 assessed by an aged care assessment team (Australia)	MMSE Abbreviated Mental Test Score	−0.65 −0.62
de Jonghe *et al.* (1997)	177 psychiatric patients with a mean age of 78 (Netherlands)	Amsterdam Dementia Screening Test	−0.62
Senanarong *et al.* (2001)	87 elderly from the community and 73 with dementia, aged 52–85 (Thailand)	MMSE	−0.68
Isella *et al.* (2002)	45 patients with dementia aged 70+ (Italy)	MMSE	−0.71
Lim *et al.* (2003)	234 community members aged 60+ (Singapore)	Elderly Cognitive Assessment Questionnaire	−0.41
Stratford *et al.* (2003)	392 memory clinic patients with a mean age of 73 (Australia)	MMSE CAMCOG Abbreviated Mental Test Score	−0.57 −0.60 −0.59

Note: All cognitive tests have been scored so that a high score indicates better functioning.

In a sample of elderly ex-servicemen, Jorm *et al.* (1996a) examined correlations with several WAIS-R subscales and found coefficients of −0.33 with Vocabulary, −0.28 with Block Design, −0.28 with Similarities, and −0.27 with Digit Span. This study also found a correlation of −0.40 with choice reaction time. In a study of former stroke patients, Starr and co-workers (2000) found correlations of −0.19 with verbal ability and −0.45 with non-verbal ability.

Three studies have looked at memory abilities. In a study of geriatric patients, Jorm (1992) found correlations of −0.65 with episodic memory and −0.25 with semantic memory. In a study of ex-servicemen, Jorm and colleagues (1996a) found correlations of −0.42 with Wechsler Memory Scale Revised Logical Memory, −0.25 with Benton Visual Retention and −0.35 with Rey Auditory Verbal Learning List A Recall. In a study of former stroke patients, Starr *et al.* (2000) found a correlation of −0.34 with the Auditory Verbal Learning Test.

It is notable that the IQCODE generally correlates more highly with short cognitive screening tests than with longer neuropsychological tests. A possible reason is that the screening tests are designed to discriminate within the lower range of cognitive ability where decline is more evident, whereas the neuropsychological tests cover the full range of cognitive ability, with the upper range of these tests primarily reflecting pre-morbid ability.

Correlations with other informant scales

The IQCODE has been found to have high correlations with a number of other informant-based scales for assessing dementia: 0.78 with the Cognitive Decline Scale of the Psychogeriatric Assessment Scales (Jorm *et al.*, 1995); 0.57–0.82 (median $r = 0.68$) with the Blessed Dementia Rating Scale (Morales *et al.*, 1997; Del-Ser *et al.*, 1997; Rockwood *et al.*, 1998; Pisani *et al.*, 2003); 0.71 with Nurses' Observation of Memory Disorders (de Jonghe *et al.*, 1997) and 0.62 with the Functional Assessment Staging Tool (Rockwood *et al.*, 1998). The IQCODE has also been found to have correlations in two samples of 0.74 and 0.33 with a nurses' rating scale for delirium (Schuurmans *et al.*, 2003).

Correlations with measures of activities of daily living (ADL) have generally been higher for instrumental ADL (0.50–0.70, median $r = 0.64$) than for personal care ADL (0.32–0.60, median $r = 0.47$), reflecting the greater cognitive demands of instrumental ADL (Jorm *et al.*, 1996; Rockwood *et al.*, 1998; Starr *et al.*, 2000; Stratford *et al.*, 2003).

Effect of subject's education, pre-morbid ability
and language proficiency

Twelve studies have reported on associations with education, using a variety of indicators of education (years of education, age of leaving school, level of

attainment) (Christensen and Jorm, 1992; de Jonghe *et al.*, 1997; Del-Ser *et al.*, 1997; Fuh *et al.*, 1995; Jorm, 1994; Jorm *et al.*, 1989; Jorm *et al.*, 1996a; Jorm and Jacomb, 1989; Jorm and Korten, 1988; Law and Wolfson, 1995; Morales *et al.*, 1997; Mulligan *et al.*, 1996). Of the 11 studies that reported correlation coefficients, the range was −0.20 to 0.07 with a median of −0.05, indicating that any association is negligible.

There have also been eight studies that have used the NART or other reading test as an indicator of pre-morbid ability (Christensen and Jorm, 1992; Jorm, 1994; Jorm *et al.*, 1991; Jorm *et al.*, 1996a; Jorm and Korten, 1988; Morales *et al.*, 1997; Mulligan *et al.*, 1996; Starr *et al.*, 2000). All but one of these studies reported a negative association. Correlations have ranged from −0.35 to 0.09 with a median of −0.18. The small association of the IQCODE with word-reading tests may occur because these tests are not completely resistant to decline in dementia. In studies using both the IQCODE and MMSE, correlations with word reading are much higher for the MMSE (Christensen and Jorm, 1992; Jorm, 1994; Jorm *et al.*, 1996b; Jorm *et al.*, 1996a; Jorm and Korten, 1988; Morales *et al.*, 1997; Mulligan *et al.*, 1996).

Only one study appears to have looked at the effect of proficiency in the country's dominant language. Bruce *et al.* (2001) found that reduced English speaking ability in a sample of Australian patients with Type 2 diabetes was associated with lower scores on the MMSE but not on the IQCODE.

Influence of subject's anxiety and depression

Eight studies that have examined associations with anxiety, depression or general psychological distress (Del-Ser *et al.*, 1997; Jorm, 1994; Jorm *et al.*, 1994; 1995; Morales *et al.*, 1997; Mulligan *et al.*, 1996; Starr *et al.*, 2000; Waltrowicz *et al.*, 1996). These studies have used a variety of measures, making them hard to compare directly. However, most have found a small positive association. It is known that depression affects a range of cognitive functions (Christensen *et al.*, 1997), so this association with the IQCODE may be valid. However, it is also possible that informants have difficulty distinguishing anxiety and depression from cognitive decline.

Effect of informant characteristics

Studies have shown that IQCODE scores are not influenced by length or type of relationship (Fuh *et al.*, 1995) or by age and education of the informant (Jorm *et al.*, 1996a). However, such findings do not address the issue of whether there

is differential validity for various types of informants. Jorm *et al.* (1991) looked at correlation with MMSE in those over or under 65 and found no significant difference in the magnitude of the correlation, but the sub-samples were not large, limiting power to detect differences.

Another way of examining informant characteristics is to compare the IQCODE with the MMSE for correlation with the characteristic. Jorm *et al.* (1996a) found that some informant characteristics were more strongly associated with the IQCODE than with the MMSE. The respective correlations were: informant anxiety ($r = 0.23$ vs -0.05), informant depression ($r = 0.22$ vs 0.14), how caring the subject was perceived to be ($r = -0.24$ vs 0.06) and how controlling the subject was perceived to be ($r = 0.34$ vs 0.07). Similarly, Stratford *et al.* (2003) found that the IQCODE had a higher correlation than the MMSE with the Burden Interview Schedule ($r = 0.49$ vs -0.16) and the informant's General Health Questionnaire score ($r = 0.36$ vs -0.09). By contrast, Waltrowicz *et al.* (1996) found that the Zarit Burden Scale and the informant's General Health Questionnaire score had low and non-significant correlations with both the IQCODE and MMSE ($r = 0.10$ vs 0.14 and 0.16 vs 0.21 respectively). These generally higher correlations with the IQCODE can be interpreted as reflecting contamination of the informant's ratings. An alternative more positive interpretation is that the IQCODE taps concerns that are associated with carer burden.

There have also been some qualitative observations that informant characteristics may affect ratings on the IQCODE. In a clinical sample, Del-Ser and co-workers (1997) observed that "some informants tended to emphasize the patient's cognitive defects, probably due to their own anxiety and uncertainty and to the aim of obtaining more clinical care and social support" (p. 7). On the other hand, in a Singaporean community survey, Lim and colleagues (2003) noted that "there were a few instances when the informant . . . appeared reluctant to 'mark down' their elderly relative" (p. 146).

Combining the IQCODE with other screening tests

Because the IQCODE and cognitive screening tests use complementary sources of information, there may be merit in using them together. Mackinnon and Mulligan (1998) examined various ways of combining the IQCODE and MMSE for the prediction of dementia in a clinical sample. They distinguished three methods: (1) the "Or" rule in which a person is classified as a case if positive on either test; (2) the "And" rule in which only persons positive on both tests are classified as cases; and (3) combining test values to give a single score which maximizes prediction, for example, by using discriminant

function analysis or logistic regression. In a clinical sample, the "And" rule was not found to improve performance over use of the MMSE alone. However, the "Or" rule led to improved sensitivity, while not significantly reducing specificity. A combination of test values using logistic regression also resulted in improved prediction of dementia, but had the disadvantage that logistic equations are awkward to implement in clinical practice. To overcome this problem, Mackinnon and Mulligan (1998) developed a simple graphical method of combining scores, the Demograph, which is available on the web at http://www.mhri.edu.au/biostats/demegraph. Mackinnon *et al.* (2003) later applied these same rules in a community sample. They again found that the "Or" rule and the weighted sum of scores were superior to the "And" rule. However, the optimal cut-points for combining test scores in this community sample were different from the earlier clinical sample, implying that these may not be generalizable across samples with very difference prevalence rates for dementia.

Flicker *et al.* (1997) have also examined the "And" and "Or" rules by combining the IQCODE with either the MMSE or the Abbreviated Mental Test Score. Using the "And" rule improved the specificity substantially, but at some expense to sensitivity, whereas using the "Or" rule improved sensitivity, but at the expense of specificity. Combination of test values has also been evaluated by Jorm *et al.* (1991). They divided IQCODE and MMSE scores into deciles and summed them. However, the combined scores were only marginally better at detecting dementia (using receiver operating characteristic (ROC) analysis) than the IQCODE alone.

Others have used the IQCODE as a second stage applied only to those who score positive on a cognitive screening test. For example, White *et al.* (1997) gave the Cognitive Abilities Screening Instrument (CASI) to participants in an epidemiological study and those who scored positive or intermediate were given a repeat of the CASI together with the IQCODE. The addition of the IQCODE to the repeated CASI improved diagnostic accuracy: ninety percent of those positive on the IQCODE were subsequently diagnosed with dementia, compared to only 23% of those with no decline on the IQCODE. Del-Ser *et al.* (1997) examined a similar two-stage approach in which a high cut-off was applied to the MMSE to maximize sensitivity, and then the IQCODE was applied to those who screened positive at the first stage. This two-stage procedure produced an area under the curve of 0.88, compared to 0.81 for the IQCODE alone and 0.86 for the MMSE alone.

Khachaturian *et al.* (2000) harnessed the IQCODE and the modified Mini-mental State (3MS) together in yet another way for a community survey of dementia. They used the 3MS as the primary screening tool, but used the IQCODE for subjects who were unable to take the 3MS (9% of the sample). The

main reason for inability to take the 3MS was dementia, which was subsequently diagnosed in nearly all those who did the IQCODE.

Conclusions

There is now quite a lot known about the IQCODE. The questionnaire has high reliability and measures a single general factor of cognitive decline. It validly reflects past cognitive decline, performs at least as well as a screening test for dementia as conventional cognitive screening tests, predicts incident dementia, and correlates with a wide range of cognitive tests, particularly those measuring the impaired range of ability and those measuring skills that drop with aging and dementia (episodic memory and mental speed). A particular strength compared to cognitive screening tests is that the IQCODE is relatively unaffected by education and pre-morbid ability or by proficiency in the culture's dominant language. The disadvantage of the IQCODE relative to cognitive screening tests is that it is affected by informant characteristics such as the mental health of the informant and the quality of the relationship between the informant and the subject. Because the IQCODE provides information complementary to cognitive tests, harnessing them together may improve screening accuracy.

What remains to be known about the IQCODE? The major weakness of the IQCODE is that some informants provide less valid data than others. However, little is known about which informants provide the best data. More information is needed on how validity is affected by variables like age, education, frequency of contact, and not living with the subject. Furthermore, little is known about how the purpose of the screening might affect informant ratings. For example, in a clinical situation where a carer wants support services, they might overrate cognitive decline, whereas in a community screening situation they may be reluctant to support a diagnosis of dementia in a loved one. There is also a need for the development of approaches to handling any lowered validity, whether by exclusion of certain informants or by adjustment of IQCODE ratings. Users typically exclude informants who exceed a certain threshold of missing items, but the appropriateness of these exclusion rules is unknown.

The other pressing need is for simple cross-validated methods of combining the IQCODE with cognitive screening tests like the MMSE. A graphical method has been developed, but the cut-points appear to be specific to the type of sample being screened, limiting generalizability. Web-based scoring of complex regression formulae is another possibility for simplifying implementation (Tierney *et al.*, 2003). The challenge is to be able to give probabilistic predictions of dementia status based on a range of information including multiple screening tests, informant characteristics and the prevalence of dementia in the sample being screened.

Recommendations for clinicians

Given the extensive evidence on the IQCODE reviewed above, what recommendations can be made for clinicians? Here are some basic guidelines:

1. The 16-item Short IQCODE is the preferred version in English. Similarly, in other languages, short versions appear to be as valid as the full questionnaire.
2. The IQCODE is a good choice of primary screening instrument where a patient has a language or culture other than the dominant one, has a very low level of education or has previous cognitive impairment.
3. For other patients, the IQCODE is best used in harness with a cognitive screening test like the MMSE. If both the IQCODE and the MMSE are given to all patients, they can be combined graphically using the Demograph or, alternatively, patients who score below cut-off on either test should be investigated more thoroughly.
4. In clinical situations, a screening cut-off of 3.44+ on the Short IQCODE is a reasonable compromise for balancing sensitivity and specificity.

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Conflict of interest

The author is the originator of the IQCODE.

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