

Cognitive decline

Age Cohorts	Older
Surveys	Survey 3
Derived Variable	MACQ
Definition	6-item, summed scale measuring cognitive decline
Source Items (Index Numbers)	COGN1- COGN6 (COGN-001 to COGN-006)
Statistical Form	Continuous variable
Index Number	COGN-007
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Background

Especially among the elderly, analysis of health issues such as the need for assistance with daily tasks and use of health care services may be incomplete when the impact of cognitive function is not assessed. From a methodological standpoint, measures of cognition may provide a check on the quality of other data. In self report surveys, cognitive dysfunction may give rise to inconsistency of responses and to higher levels of missing data. This means that if such respondents are omitted from the analyses there will be over-representation of those who are cognitively intact. But including them may increase noise without avoiding this bias.

Population surveys of older people indicate that complaints about difficulty with memory are much more prevalent than diagnosable memory disorders¹. Memory clinics are frequented by the "worried well" suggesting that distress about memory exceeds actual memory problems in the normal older adult population.¹

Correlations between self-reported memory impairment and performance on standardised memory assessment instruments vary greatly¹. Correlation between self-reported memory impairments and every day memory performance is a little higher than the correlation with standardised instruments. Scales looking at meta-memory (one's knowledge about one's own memory performance) also predict memory performance in some studies, despite the fact that meta-memory skills are generally lower with increased age.¹

Self-reported memory complaints in general have not been strongly predictive of the eventual development of dementia and cognitive decline¹. However, complaints about memory are correlated with depression but not performance on memory tests while performance is correlated with dementia but not depression.¹ Making complaints about memory is associated with personality and self-efficiency for some people; self-reporting is an opportunity to complain.¹ People do not judge their own memory performance in absolute terms but relative to what they consider typical for their same age peers; they are not making accuracy judgements.

Numerous measures of memory performance have been developed and they tend to be lengthy and require specialised settings for completion. An example of such a measure is the MAC-S (Memory Assessment Clinical Self-rated scale)², a 42-item scale measuring memory skills in an environment free of distractions or noise. Of the 42 items, 38 concern specific memory skills, while 4 make global assessments of memory. The broad range of memory skills sampled, include remote personal memory, numerical recall, everyday task-oriented memory, word and fact recall/semantic memory, spatial/topographical memory, attention/concentration, general forgetfulness and facial recognition. The items also concern memory strategies, beliefs about memory, etc. The scale is internally consistent, has concurrent validity, test-retest reliability and is

correlated with memory performance (i.e. canonical correlation of 0.53 between MAC-S factor scores and memory test scores).

The size of scales such as the MAC-S makes them unsuitable for inclusion in large, omnibus surveys such as the ALSWH and so a shorter scale, the MAC-Q³ measuring memory decline was selected.

The MAC-Q³

The MAC-Q (Memory Assessment Clinic-Q) is a 6-item scale measuring age-related memory decline. Items are framed to assess change relative to the respondent's own baseline at age twenty. Unlike the MAC-S, it is not a measure of current memory ability. Scale items (shown below) were based on clinical experience and empirical evidence concerning age-related memory. Five items are about specific situations frequently reported as troublesome among those suffering memory losses with age. One item is a global item assessing overall memory decline.

MACQ Items

As compared to when you were in high school or college, how would you describe your ability to perform the following tasks involving your memory?

COGN1	a	Remembering the name of a person just introduced to you.
COGN2	b	Recalling telephone numbers or zip codes that you use on a daily or weekly basis.
COGN3	c	Recalling where you put objects (such as keys) in your home or office.
COGN4	d	Remembering specific facts from a newspaper or magazine article you have just finished reading.
COGN5	e	Remembering the item(s) you intend to buy when you arrive at the grocery store or pharmacy.
COGN6	f	In general, how would you describe your memory compared to when you were in high school?

Each item is rated on a 5-point Likert scale with scoring as shown below.

Code	Response
1	Much better now
2	Somewhat better now
3	About the same
4	Somewhat poorer now
5	Much poorer now

Index Calculations

An overall index of cognitive decline is calculated by summing scores for all 6 items, with double weighting for item f; higher scores indicate greater decline in memory.

Validation

The scale was validated among 232 participants in a trial of medication for age-associated memory impairment. Participants were both male (n=115) and female (n=117), with a mean age of 59 years (range 50 to 80 years). All participants met diagnostic criteria for age-associated memory impairment and scored at least one standard deviation below the mean for young adults on a battery of memory tests. An additional criterion for inclusion was an MAC-Q score of 25 or more which was taken as a rational indicator of age-associated memory decline since it would require several items to be scored as 'somewhat poorer'.

MAC-Q scores were moderately correlated with the MAC-S scores (0.4) and were not significantly associated with depression (Hamilton Depression Scale) having adjusted for seven measures of memory, including the MAC-S. MAC-Q scores were not significantly correlated with age, education or vocabulary; although mean scores for women (29.5) were significantly higher than men (28.8).

Source items

MAC-Q items and response codes were adapted for Australian use and framed for an elderly sample. Differences between the original items and those used in the Older cohort of the ALSWH are shown below.

	MAC-Q	Adaptations - Older ALSWH Cohort
<i>Introduction</i>	As compared to when you were in high school or college, how would you describe your ability to perform the following tasks involving your memory?	Replaced by 'Compared with when you were in your twenties, how good are you at:'
<i>Item b</i>	zip codes	Replaced by 'other numbers'
<i>Item c</i>		Removed 'and office'
<i>Item e</i>	grocery store or pharmacy	Replaced by 'shops'
<i>Item f</i>	in high school	Replaced by 'in your twenties'
<i>Responses</i>	Somewhat poorer now Much poorer now	Somewhat worse now Much worse now

Scale Evaluation

The ALSWH first included the MAC-Q on the third survey of the Older cohort conducted in 2002. Properties of the MAC-Q in that dataset are shown below.

Item Responses

Responses to one or more items from the MAC-Q were available for 8 596 women (Table 1). The modal response (47-50%) for items concerning recall of numbers, location of objects, newly acquired facts and intentions to buy (b to e) was 'about the same' as when they were in their twenties. In relation to remembering names and to memory overall, the modal response was 'somewhat poorer now' (46% and 51% respectively). Low percentages of women reported better cognitive abilities than when they were in their twenties (maximally 5% for recall of telephone and other numbers). The mean (3.5 to 3.9) and standard deviation (0.7 to 0.8) of response scores were similar for all items.

Non- response was low for individual items, ranging from 1.0% for global memory (f) to 2.5% for recently read facts (d) (Table 1); most women (95%) completed all 6 items (Table 2).

Table 2 Number and percent of MAC-Q items missing

Number of missing items	Number	Percent	Cumulative Percent
0	8 249	95.4	95.4
1	194	2.2	97.7
2	47	0.5	98.2
3	28	0.3	98.5
4	20	0.2	98.8
5	58	0.7	99.4
6	50	0.6	100.0

Scale Reliability

Inter-item correlations ranged from 0.49 to 0.60 (Table 3) older-age women completing all 6 items. Cronbach's alpha of 0.88 (Table 4) suggests internal consistency of the 6 items and meets ALSWH protocol criterion of 0.6. High correlations with item totals were maintained when individual items were deleted (Table 4); all exceed the ALSWH protocol criterion of 0.5.

Factor Analysis

Factor analysis was performed on responses from 8 249 older-age women completing all 6 items. Table 5 shows that all tests suggest a single factor which explains approximately 63% of the variance. Factor loadings and communality estimates (Table 6) all exceed the criteria (0.5 and 0.5 respectively) specified in the ALSWH protocol.

These analyses demonstrate that the 6 MAC-Q items operate as a single factor in the Older cohort data from Survey 3.

Table 1 Percent and mean (SD) of responses and percent missing for MAC-Q items among 8 646 women from the Older cohort who completed Survey 3

		Percent					Mean (SD)	Number (percent) missing
		Much better now	Somewhat better now	About the same	Somewhat worse now	Much worse now		
a	Remembering the name of a person just introduced to you?	1.0	1.1	33.9	46.4	17.7	3.8 (0.8)	165 (1.9)
b	Recalling telephone numbers or other numbers that you use on a daily or weekly basis?	2.3	2.8	50.0	33.5	11.4	3.5 (0.8)	195 (2.3)
c	Recalling where you put objects (such as keys) in your home?	1.8	2.1	47.4	38.8	9.9	3.5 (0.8)	180 (2.1)
d	Remembering specific facts from a newspaper or magazine article you have just finished reading?	1.6	2.8	48.5	37.9	9.1	3.5 (0.8)	215 (2.5)
e	Remembering the item(s) you intend to buy when you arrive at the shops?	1.6	2.3	50.3	38.1	7.8	3.5 (0.7)	199 (2.3)
f	In general, how would you describe your memory compared to when you were in your twenties?	0.7	1.3	25.6	51.4	21.0	3.9 (0.8)	88 (1.0)

Table 3 Inter-item correlations for 6 items from the MAC-Q

Item	b	c	d	e	f
a	0.57	0.49	0.54	0.49	0.64
b		0.52	0.51	0.50	0.54
c			0.55	0.58	0.56
d				0.62	0.60
e					0.60

Table 4 Correlation with item-total and Cronbach's alpha for standardized variables with deletion of individual items

Deleted Item	Correlation with Total	Cronbach's Alpha
None		0.88
a	0.68	0.86
b	0.65	0.87
c	0.67	0.87
d	0.71	0.86
e	0.70	0.86
f	0.74	0.85

Table 5 Results of Factor Analysis

Factor	Eigenvalue	Difference	Proportion	Simulated Eigenvalue ^a		Average ^b
				Mean	95 th Percentile	Squared Correlation
						0.31
1	3.77	3.18	0.63	1.04	1.05	0.05
2	0.60	0.10	0.10	1.02	1.03	0.11
3	0.50	0.07	0.08	1.01	1.01	0.23
4	0.43	0.06	0.07	1.00	1.00	0.42
5	0.38	0.05	0.06	0.98	0.99	1.00
6	0.33		0.05	0.96	0.98	

^a Parallel Analysis^b Velicer's MAP test

Table 6 Factor loadings, communality estimates and scoring coefficient from un-rotated factor analyses of 6 MAC-Q items

Item	Factor loading	Communality Estimate	Scoring Coefficient
a	0.78	0.62	0.21
b	0.76	0.58	0.20
c	0.77	0.60	0.21
d	0.81	0.65	0.21
e	0.80	0.64	0.21
f	0.83	0.70	0.22

Derived Variable

Scores

The properties of factor scores and summed scores were investigated for women with complete data. A factor score was calculated as the total of item codes, weighted by the standardised scoring coefficients from the un-rotated factor analysis (Table 6). A summed score was calculated according to the recommendation of the developers of the MAC-Q³ as the sum of item response codes, with item f double weighted.

Both measures had similar coefficients of variation and skewness; both were approximately normally distributed (p value for Kolmogorov-Smirnov statistic <0.01 did not reach the significance level of 0.005). The factor and summed scores were strongly correlated (0.99). Summed scores covered the full theoretical range (7-35), with a mean of 25.6, median of 26.0 and mode of 21.0. Distributional properties of these scores are shown in Table 7.

Since the correlation between summed and the factor scores was high and since the summed score was recommended by the score's developers (and so is likely to be comparable with other published data), the summed MAC-Q score is used as a measure of cognitive decline.

Table 7 Distributional properties of summed score and factor scores among women with complete data

Score	Mean	SD	Coefficient of Variation	Median	Skewness	Range
<i>Complete data (n = 8 249)</i>						
Factor score	3.6	0.7	19.4	3.6	0.07	0.9 – 5.3
Summed score	25.6	4.3	16.8	26.0	-0.16	7 - 35
<i>Up to 1 item Imputed (n = 8 429)</i>						
Summed score	25.5	4.3	16.9	25.0	-0.16	7 - 35

Missing items

Crook, Feher and Larrabee³ provided no guidance regarding the treatment of missing items. Arbitrarily, an item response was imputed where only one of the first 5 items (a to e) was missing; the imputed value was the mean of non-missing items, rounded to the nearest coded value to avoid non-integer scores. An item response was not imputed where the global item assessing overall memory decline (f) was missing. The distributional properties of the summed score were unchanged by imputing values for a single missing item.

Categorisation

Two sets of cut-points were defined. Firstly, noting that the scores of 21, 28 and 35 correspond with having all items marked as 'About the same', 'Somewhat poorer' and 'Much poorer' respectively, scores were assigned to 3 categories as shown in Table 8. The cut-point used by Crooke et al³ to identify age related memory loss is also shown. Because both of these methods assign about 60% of this elderly female sample to the same category, this approach may not be useful analytically and any categorisation of MAC-Q scores is discouraged without adequate validation.

Table 8 Potential categories for MAC-Q scores

Potential categories	Scores	Number	Percent
<i>Scale based cut-points</i>			
All items 'The same' or improved	7-21	1 619	19.2
At least 1 item 'Somewhat poorer'	22-28	4 963	58.8
At least 1 item 'Much poorer'	29-35	1 861	22.0
<i>As per Crook, Feher and Larrabee</i>			
No Age associated memory decline	7-24	3 299	39.1
Age associated memory decline	25-35	5 144	60.9

Recommendation for usage

The score preferred form for statistical analysis is a continuous variable.

The SAS code defining the MAC-Q variable is:

```
array macq6{6} o3q33a o3q33b o3q33c o3q33d o3q33e o3q33f ;
array macq5{5} o3q33a o3q33b o3q33c o3q33d o3q33e ;
array macqcalc{5} itema itemb itemc itemd iteme ;

/* calculate number of missing values */;
nummiss = nmiss (of macq6 {*} );

/* impute response if 1 of 5 items a-e is missing */;
if (nmiss(of macq5{**}) = 1 and o3q33f ne .) then do i = 1 to 5 ;
    if macq5{i}= . then macqcalc{i}=round ((sum (of macq6{**})/5),1);
    else macqcalc{i}=macq5{i};
end ;

/* calculate summed score, allowing imputation when
1 of the first 5 (a-e)items is missing */;
if o3q33f = . then o3macqA = . ;
else if nmiss(of macq6{**}) = 0 then o3macqA= sum (of macq5 {*} ) + 2*o3q33f
;
else if nmiss(of macq5{**}) = 1 then o3macqA= sum (of macqcalc {*} ) +
2*o3q33f ;
else o3macqA = . ;
```

Note: The SAS code was revised in April 2006

References

1. Niederehe G. The significance of memory complaints in later life. Methodological and theoretical consideration. In: J Lomranz (Ed) *Handbook of Aging and Mental Health. An Integrative Approach* (pages 417-434) Plenum Press; 1998
2. Crook TH, Larrabee GJ. A self-rating scale for evaluating memory in everyday life. *Psychology and Aging* 1990; 5(1):48-57
3. Crook TH, Feher EP, Larrabee GJ. Assessment of memory complaint in age-associated memory impairment: The MAC-Q. *International Psychogeriatrics* 1992;4(2):165-175