Critique of Cognitive Measures in the Health Retirement Study (HRS) and the Asset and Health Dynamics among the Oldest Old (AHEAD) Study

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Cognitive functioning is a key indicator of overall individual health, yet large-scale, epidemiological studies of aging typically do not examine cognition. Cognitive measures are often not included in survey instruments because it is assumed that reliable assessments are too difficult and time-consuming to administer in a survey format by lay interviewers, especially over the telephone. The AHEAD/HRS study effort to include cognitive measures in their telephone survey instrument was indeed groundbreaking. HRS/AHEAD has successfully assessed multiple aspects of cognitive functioning by telephone with over 50,000 observations during the past 10 years. The data generated provide important information about the cognitive functioning of the participants as well as the non-respondents and dropouts. The data are useful primarily for identifying possible cognitive deficits and dementia-related declines, but are limited in their ability to provide a clear diagnosis or a broad assessment of theoretically-relevant cognitive and neuropsychological aspects of aging. Although the HRS/AHEAD battery does not provide a comprehensive assessment of cognitive functioning, it does provide, given the time and other logistical constraints of a large-scale survey, a reasonably broad sampling of cognitive functioning measures appropriate for later life. Suggestions are made for further validation of the cognitive battery, and for utilizing the existing data to address important questions about aging.

Rationale for Inclusion of Cognitive Measures in the HRS/AHEAD

The HRS/AHEAD study designers recognized the central role of cognitive functioning in relation to functional impairment, disability, and health care utilization among the elderly. They also considered the possible economic consequences of limitations in cognitive abilities, especially involving work and decision-making and planning for retirement. Finally, it was recognized that cognitive difficulties needed to be identified as they could compromise the data quality for the entire survey. Thus, it is clear that inclusion of cognitive assessments was an important contribution to the overall mission of the HRS/AHEAD. The substantive goals for the cognitive assessments were to examine the impact of cognitive performance and decline on key domains of interest (e.g., health and daily functioning, retirement, economic and health decision making, use of economic and social resources), and to identify respondents who experience cognitive impairment (Ofstedal, McAuley, & Herzog, 2002). It was also thought that the cognitive assessments could be used to screen for early signs of dementia and to track its subsequent progression. Less emphasis has been placed on the examination of cognitively intact or high functioning individuals, who make up the majority of the sample.

The HRS/AHEAD Cognitive Battery

The HRS/AHEAD cognitive battery (Ofstedal et al., 2002) was designed to be administered by telephone, and includes the following measures:

Memory

- Immediate recall was assessed using one of 4 10-word lists (a 20-word list was used in HRS 92/94)
- Delayed recall of the above words was assessed after 5 minutes of intermediate tasks
- Serial 7's (subtract 7 from 100, and continue for a total of 5 trials)
- Two questions were asked to obtain self-assessments of memory, one current memory and the other memory compared to 2 years ago. (Note: These questions do not assess meta-memory per se, but are more accurately described as perceived memory.)

Mental Status

- Backwards counting (count backwards, as quickly as possible, from either 20 or 86, for 10 numbers)
- Date (month, day, year, day of week)
- Object naming ("What do you usually use to cut paper?"; "What do you call the kind of prickly plant that grows in the desert?")
- Name the current President and Vice President of the United States.

Dementia

- Beginning with HRS/AHEAD 98, the respondent was asked whether they had ever been diagnosed with dementia

Other (these two are not consistently included in the battery)

- similarities (for 7 pairs of words, how are the two alike?)
- vocabulary (adapted from WAIS-R, define 5 words from either of 2 sets)

For those who were unable to respond, a proxy informant was asked to rate the respondent's memory, judgment, organization of time, and complete Jorm's 16-item IQCODE which is used to assess dementia.

Evaluation of Cognitive Dimensions

The goals for the cognitive measures in the HRS/AHEAD studies were to (a) provide descriptive information on a range of cognitive functions, (b) span all difficulty levels from competent to impaired cognitive functioning, (c) be sensitive to change over time, (d) be conducive to a telephone survey by lay interviewers, and (e) to require a short administration time yet be reliable and valid (Herzog & Wallace, 1997). These goals have been met with varying degrees of success.

Many of the items in the HRS/AHEAD cognitive battery were adapted from the Telephone Interview of Cognitive Status (TICS; Brandt et al., 1988), which is a version of the MMSE (Folstein et al., 1975) adapted for telephone administration. Some of the TICS items used were taken from a version used by Breitner et al. (1995), or from the Iowa EPESE. Some items were later modified during HRS/AHEAD, e.g., the use of 4 alternate word lists for the recall tasks. The battery is heavily focused on knowledge and orientation items, which are most useful for identifying those with some degree of cognitive impairment. The immediate and delayed free recall tests, the serial sevens, and the counting backwards test are adequate indices of episodic and working memory. These are important dimensions to include as there is strong evidence to suggest that

these are among the first cognitive functions to decline during healthy aging (Backman et al., 2000).

The tests included do not provide a state-of-the-art cognitive assessment, but are reasonable given the constraints of time and mode of administration. The battery provides an acceptable set of items to assess dementia, although it does not allow for clear cutoffs and diagnosis. Given the decision to adopt telephone administration, it was necessary to exclude nonverbal tests from consideration. While reasonable given the circumstances, this decision came at some cost to the representativeness of the battery, limiting its ability to assess some cognitive functions (e.g., response speed) that are likely to show decline with age. The battery has worked reasonably well over the telephone, although the extent to which poor hearing might affect response on the battery is unclear, as is the impact of English as a second language. These considerations might affect cognitive performance to a greater extent than other aspects of the interview, and should be carefully considered.

Challenges and Opportunities for Cognitive Assessment via Telephone

Traditionally, assessment of cognitive functioning is carried out in-person, often with large time-consuming batteries that include multiple measures of each cognitive domain of interest. In survey research, such batteries typically require 20 to 30 minutes; in laboratory settings, often 2 or more hours. Thus, many survey researchers have been reluctant to include cognitive assessment in their batteries. In interdisciplinary research such as HRS/AHEAD, with a focus on multiple aspects of functioning, it is not feasible to spend more than 10 to 15 minutes on any given domain such as cognition. Thus, it is critical to select highly reliable tests that are sensitive to variation and individual differences within the full range of cognitive functioning Due to rising costs and reluctance of respondents to talk with interviewers in person or in their homes, there has been increasing use of telephone rather than face-to-face data collection. Thus, it becomes critical to develop inexpensive and non-intrusive cognitive batteries which are short enough to be included in national surveys, and which are appropriate for use with telephone administration. HRS/AHEAD is one of largest nationally representative studies of older adults that includes cognitive measures obtained by telephone (see Table 1-3). Most studies comparable in scope collect data by face-to-face, in-person interview (e.g., Atherosclerosis Risk in Communities [Cerhan et al.,1998], Cardiovascular Health Study (Haan et al., 1999) Framingham Study [Elias et al., 1997], Medical Research Council's Cognitive Function and Ageing Study [MRC-CFAS, 1998]).

Historically, attempts to assess cognitive functioning by telephone focused on diagnosis of dementia and other cognitive pathologies. A summary of these and other telephone measures is provided in Tables 1-3 below. The TICS, one of the sources for the HRS/AHEAD battery, is but one of a growing number of telephone assessments of cognitive status, including the TCAB, TICS-M, ALFI-MMSE, IMC, STIDA, TAMS, and SPMSQ (see Table 1). With relatively simple and brief measures, it is possible to obtain a reasonable estimate of dementia status.

The HRS/AHEAD telephone battery does not provide a true clinical assessment of dementia, nor is it clear that it is appropriate as a dementia screen because it has not been validated for this purpose. The proposed dementia supplement (ADAMS) will address this, by administering in-home assessment using a state of the art battery. ADAMS will be conducted on a subsample of 850 HRS respondents aged 70 or older. A detailed neuropsychological battery will be administered, with a rigorous clinical assessment of dementia and mild cognitive impairment. This supplement will permit validation of the telephone battery as a dementia screener. Further, this supplement will provide the opportunity to link detailed cognitive assessments with information on functional status and health service utilization, with the aim of understanding the costs and economic consequences of mild cognitive impairment and dementia. The results of this subsample also can be used to impute the probability of dementia and its severity for other HRS/AHEAD respondents.

To assess variations in normal cognitive aging, however, more sensitive measures and broader selection of tasks are required. The use of telephone assessment for normal cognitive aging is novel and provides a useful way to implement cognitive assessment in survey research. Thus, the HRS/AHEAD researchers were on the cutting edge in including a battery that focused on both dementia and normal cognitive aging. But much remains to be done to develop assessments for detection of individual differences in cognitive functioning and changes within the normal range.

Longitudinal research by Schaie (1996) and others has demonstrated clearly that much of cognitive functioning is stable and there is limited cognitive decline well into the 70's, especially on verbal abilities. Thus, it should be recognized that many participants will show relatively little decline over time. Moreover, given that a relatively small proportion of the study participants are expected to have or develop dementia, it is important to focus on those with normal levels of cognitive aging, or those who maintain adequate cognitive function well into their later years. Thus, the HRS/AHEAD battery would be more useful if it not only provides an assessment of dementia or impairment but also can characterize cognition within the normal range.

If one is interested in prevention, it becomes important to think about identifying risk factors for cognitive decline, rather than focusing only on the consequences of decline. If individual differences in cognitive functioning for those in the normal range can be measured well, it would enable tracking over time and identification of predisposing factors associated with decline. This would provide much needed information about the emergence of cognitive impairments and preclinical status in later life.

Proposed additions to the battery. In parallel to the ADAMS supplement focusing on dementia, it would be of interest to consider a supplement that studies normal cognitive aging. Among the objectives might be to (a) validate the telephone battery against a broader and more detailed (in-person) assessment of cognitive function, (b) provide a forum for extending the scope of the existing telephone battery to include key cognitive functions such as speed of response and executive function, (c) examine how stability of cognitive function during advanced age is related to maintenance of health and wealth,

and (d) identify aspects of cognitive functioning that serve a protective effect for well-being and economic and health outcomes in later life.

To assess executive function, one option would be to include a 30- or 60-second version of verbal fluency tasks (assessing either semantic or phonemic fluency with either animals or FAS tasks, or both. In the MIDUS II telephone cognitive battery, we have found it useful to assess categories and letters, as well as an alternating version with both letters and categories (see Tun & Lachman, 2002). These could then be scored for total number of correct responses, as well as for clustering, switching, and percent of perseverations (Troyer et al., 1997).

Speed of processing (reaction time) could be included using relatively new computerized techniques to permit telephone assessment such as the Telecog voice-recognition system (Tennstedt, Salthouse, & Lachman, in preparation). For Telecog we have used Salthouse's odd-even, high-low attention switching tasks. In the MIDUS II followup project, we are using a simple reaction time task, as well as response time on paired associated and letter series. Answers to the prompts are tape recorded and later analyzed for latencies (Tun & Lachman, 2000).

Methodological Issues

In developing a cognitive battery for use in a survey, and particularly in one conducted by telephone, several methodological issues must be considered. These include the issue of mode effects (i.e., differences in response between face-to-face and telephone assessment); use of proxy respondents (what questions should be asked and of whom?); reliability and validity (e.g., how to control administration in a manner that minimizes learning or cheating (e.g., are alternate forms available, and is their equivalence demonstrated?), and the issue of retest effects.

Mode effects. One of the first questions to be addressed is whether the measurement validity is comparable across assessment modes. The work by HRS/AHEAD has provided invaluable information, suggesting that mode of assessment did not affect results. This is useful for the field of cognitive aging, and opens up a whole new arena for investigating cognitive change using telephone administration.

Although HRS/AHEAD provides some evidence that mode of assessment did not affect the results, the methods used to determine this were less than ideal. They administered the tests to different participants, and there were selection issues in who received the different assessment modes (Herzog & Wallace, 1997). Initially, those ages 69 and under were assigned to face-to-face assessment, while those aged 70 to 79 were assessed by telephone. Some participants were allowed to choose their assessment mode. In the second wave of AHEAD, a different strategy was adopted, with a random half of the respondents between 78 and 81 given different assessment modes. However, it is not clear whether the modes were given to the same persons, nor whether the order was counterbalanced. Thus, it is not possible to determine conclusively to what extent the tests yield similar results across modes.

Proxy Respondents. For respondents unable to participate due to physical or cognitive problems, proxy interviews were conducted. This is preferable to complete omission or non-response. However, it seems that proxies were used to provide estimates of the respondent's cognitive status using the IQCODE. Thus, the presumption is that most proxies were conducted because the respondent was cognitive impaired, but there does not seem to be direct evidence that this was the case. It would be useful to know the extent of different reasons for which proxy interviews might have been conducted, e.g., hearing or speech impairment, physical or cognitive limitations, lack of interest or time by the respondent.

Reliability and Validity. The use of telephone administration poses certain problems with respect to both the reliability and validity of the cognitive measures. By selecting items from well-validated scales, a certain degree of content validity is obtained. However, there remains some concern that cognitive measures administered by telephone are not accurate assessments of respondents' abilities, because of opportunities for cheating (e.g., respondents could write down answers on the word list recall or for use in the next interview, or solve the serial 7's task using paper and pencil). It is difficult to monitor background noise or other distractions which are typically controlled in lab settings, and can affect performance. Although some modifications were made to the battery to deal with the possibility that the spouse was in the same room, it is unclear whether the use of different items or lists was sufficient to reduce item contamination.

Several issues resulted from the dynamic nature of the HRS/AHEAD design, in that the cognitive battery, initially different between the two studies, was expanded and modified over time. Although it seems that all measures are given to all respondents since 1998, earlier waves were hampered by a limited number of items or by differences between the studies.

The psychometric properties of the measure as reported by Ofstedal et al. (2002) are not very encouraging. A number of the orientation and knowledge items (e.g., date, names of President and Vice President) were answered correctly by 90% or more, indicating problems with ceiling effects. Thus, these items do not discriminate well within the range of normal aging, but they might be differentiating impaired or demented respondents from others. One suggestion is to consider developing the cognitive battery as a two-part measure. The initial cognitive item might be date or names of President and Vice President. Respondents who fail to answer these items correctly can be given items appropriate for assessing for dementia; those who answer them correctly would then receive the items appropriate for assessing normal cognitive functioning.

The two-dimensional nature of the existing battery might account in part for the low internal consistency reliabilities reported by Ofstedal et al. (2002) in Table 13; all are .65 or less. More informative perhaps would be the reliabilities of the two constructs based on the factor analysis reported in Table 12, which indicated a memory factor and a general mental status factor. It is less informative to report an internal consistency reliability for a measure that is clearly multidimensional.

Retest Effects. A salient issue in longitudinal studies is retest effects, which result from administering the same task repeatedly. To a certain extent, even with a 2-year interval, it is likely that respondents will do better on subsequent occasions than on the initial occasion. They might recall the words used at the end of the interview, and then look up in a dictionary those they did not know. They might rehearse strategies to improve recall, knowing that they will be asked to recall a word list. Given a design in which both spouses are tested, the issue of contamination also arises. Thus, it is necessary to consider the use of alternate forms for as many measures as possible. In the current version of the battery, there are alternate forms for the recall tasks, More work is needed to insure that the alternate forms used are equivalent.

Proposed Validation Study

We recommend that HRS/AHEAD conduct a validation study, in an independent sample obtained from the same frame. Such a study would have multiple goals.

- Validate the telephone battery against a broader battery that includes standard cognitive constructs in administered in standard fashion as in a cognitive lab. In addition, such a study would enhance the value of the existing telephone battery for cognitive scientists, as the results could be linked to measures with which they are more familiar.
- Extend the scope of the telephone battery by selecting brief measures of other salient cognitive constructs such as processing speed and executive function.
- Provide a factor-analytic model (derived from the more detailed, in-person administration) that can serve as the basis for defining separate scales for the telephone battery. The conceptual model of the cognitive tasks should be used to derive the factors rather than the reverse; confirmatory rather than exploratory analysis should be conducted. For example, the two-pronged model of cognitive mechanics and pragmatics has been useful in studying the oldest old in the Berlin Aging study (Baltes & Mayer, 1999).

Opportunities for the Research with the Current Data Set

The cognitive data obtained in the HRS/AHEAD studies provide a multitude of rich opportunities for the study of aging. There are few existing data sets with a large representative sample using multiple cognitive measures collected longitudinally. Nevertheless, it is clear that the HRS/AHEAD data are underutilized. A search of the phrases “cognition” or “cognitive” in the HRS/AHEAD bibliography[1] identified 10 (2%) with those in the title.

The existing data can provide normative information on selected aspects of cognitive functioning. An unpublished paper by Fillenbaum, Burchett, and Welsh (1993) provides norms on the 20-item word list by age, educational level, and race. This information is useful, and perhaps worthy of publication (cf. Cerhan et al., 1998, who published normative data on three tasks administered in the Cardiovascular Health Study). Demographic variations in cognitive functioning, in particular due to age or race,

[1] http://hrsonline.isr.umich.edu/papers/sho_papers.php?hfyle=bib_all

are of great interest. It would also be very interesting to examine the role of cognition in the SES-health gradient.

The research goals originally proposed by HRS/AHEAD for the cognitive battery specified cognitive functioning primarily as an antecedent of physical and economic outcomes. The main concern was that those with compromised cognitive functioning would have difficulty with their financial affairs and health care utilization. Another important focus has been to use cognitive data to assess the validity of survey responses, presuming that those with cognitive deficits might not provide valid responses to the questionnaire (Knauper, Belli, Hill, & Herzog, 1997).

However, little attention has been given to cognitive functioning as an important resource for later life functioning. For example, cognitive abilities can serve as a moderator of social class differences in health and retirement outcomes. Relationships between cognitive functioning and other important factors such as health, economic well-being, and depression can be examined with the HRS/AHEAD data. Cognitive functioning and changes are interesting outcomes in their own right. Relatively little is known about predictors of change over time in cognitive functioning, or the transition from normal cognition to cognitive impairment to dementia.

There are a host of other topics and questions that could be asked with the current data set. For example, it would be possible to examine:

- What are the relationships between cognitive functioning and health, including health-damaging behaviors such as smoking and alcohol use, or health-promoting behaviors such as physical activity and exercise?
- What is the impact of medication use on cognition?
- Is better cognitive functioning associated with more or with less use of health services, or with different kinds of use?
- What is the relation between self-rated vision and hearing on the one hand, and cognition on the other? Does it change with age?
- Does cognitive decline predict study dropout or mortality?
- Is there a link between perceived memory or memory change and actual memory or memory change? Is recall worse among those who believe that their memory has declined?
- Does social involvement and activity lead to maintenance of cognitive function?
- Does cognitive capacity affect the ability to plan and process information related to retirement decisions?

Summary: Evaluation of the HRS/AHEAD cognitive battery

The cognitive data collected in the HRS/AHEAD survey offer the research community a rich opportunity to study aging with a multifaceted approach. It is rare to have cognitive data on a large representative sample of older adults. There are of course both strengths and weaknesses to the data set and design. We are fortunate to have the data available, and certainly more can be done to mine the richness in the existing resource. There also are a number of new ventures and improvements that could be made with some investment to enrich the cognitive measures, and ultimately to provide a more

complete and accurate view of the aging individual in the context of health and economic issues.

Major Strengths (Advantages). The HRS/AHEAD cognitive battery:

1. Provides data on a large representative sample with multiple cohorts and multiple measurement occasions that can be used to provide population based estimates or norms by age, gender, and education for selected tasks.
2. Can be administered by lay interviewers over the telephone.
3. Includes a range of measures, appropriate for assessing some aspects of normal cognitive functioning and a putative dementia diagnosis.
4. Shows preliminary evidence for the validity of telephone assessment.
5. Data are presented in an accessible manner via the website including useful information, and codebooks, questionnaires, data.
6. Enables comparison of abilities across different socioeconomic levels as well as race/ethnic groups.
7. Memory measures seem quite useful, and are similar to those used by cognitive researchers.
8. Affords the ability to link cognitive data to a broad array of information on health and wealth.
9. Provides a useful comparison to other data sets with similar measures such as the ACL and EPESE.

Major Weaknesses (Disadvantages). The HRS/AHEAD cognitive battery is limited in that:

1. Different tasks were administered during the early years (However, since 1998, HRS and AHEAD have used the same battery, and since 1995 the two were fairly similar).
2. It lacks a conceptual model of cognition and aging grounded in current cognitive and neuropsychological theory
3. It overlooks the positive contribution of cognitive function as an asset or resource, focusing instead on problems, decline and dementia
4. The age ranges of the respondents and sample sizes are not easily determined.
5. Validation against traditional cognitive measures is incomplete
6. Reliability is low or unclear at best
7. It is not clear if it can be used to provide a diagnosis of dementia
8. It does not seem to discriminate well among the normal range of cognition
9. It has a limited range of cognitive constructs
10. There are ceiling effects for some items
11. There are possible learning or retest effects
12. There has been underutilization of the cognitive data by research community.
13. Only self-rated vision and hearing were assessed. It is not clear if hearing difficulties affected response to telephone battery.

Recommendations:

To maximize the value of the HRS/AHEAD cognitive battery for the study of aging, we offer the following recommendations.

1. Expand the battery to assess additional constructs based on cognitive aging theory (e.g., response speed, executive function), which are more sensitive to normal aging, and show greater variability among younger and cognitively intact respondents. This could be achieved by adopting measures such as those to be used in MIDUS II and Telecog (e.g., fluency; simple reaction time).

2. Develop a more adequate model of cognitive functions based on confirmatory rather than exploratory factor analysis, and validate the model in an independent sample.

3. Consider developing the cognitive battery as a two-part measure. The initial cognitive item might be designed to discriminate those with low functioning. Respondents who fail to answer these basic items correctly can be given items appropriate for dementia diagnosis; those who answer them correctly would then receive the items appropriate for assessing normal cognitive functioning.

4. Substantive focus should be on cognitive function as an asset and not just a liability in relation to health and wealth.

5. Standardize testing by digitized recording of administration and responses. This would also enable analysis of response speed.

6. Assess hearing prior to administering the cognitive battery. This could be done simply with a short list of words with varying levels of difficulty. Respondents would be required to correctly repeat a minimum number before administering the battery. If there are sound problems, adjustments can be made in volume and background noise.

7. Convene a meeting with cognitive scientists and aging researchers to motivate their interests, and to get their input into revising the battery to better assess key cognitive constructs. Develop short modules to supplement the existing data for implementation in future waves.

8. Publicize the data set. Make it clear to researchers what is available and encourage more interdisciplinary work. Offer interdisciplinary workshops on use of the data, or small startup grants for beginning academics to use the data.

The HRS/AHEAD is one of the major social science efforts conducted by the Federal government. As such, it provides a valuable opportunity for studying cognitive aging in the context of important social issues such as work, retirement, and health.

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Table 1. Telephone Measures, Dementia vs. Normal Cognitive Functioning

COGNITIVE BATTERY	REFERENCE	NUMBER OF PARTICIPANTS	AGE OF PARTICIPANTS	COGNITIVE SUBTESTS
HRS/AHEAD study	Herzog, A.R.; Wallace, R.B. (1997)	6,500 +	70+ years old	Immediate free recall test, Delayed free recall test, Serial 7s test, Counting Backwards, Naming the day of the week and date, Naming objects, Naming President and Vice President of the United States, Modified Similarities test from WAIS-R, Self-rating of Memory
Minnesota Cognitive Acuity Screen (MCAS)	Knopman, D.; Knudson, D.; Yoes, M.; Weiss, D. (2000)	228	M= 82.4 years old	Orientation, Delayed word recall, Verbal fluency, Computation, Judgment
Mini-Mental State Examination	Jorm, AF; Fratiglioni, L; Winblad, B. (1993)		74+ years old	
Telephone Interview of Cognitive Status (TICS)	Brandt, J.; Spencer, M.; Folstein, M. (1988)	133		
	Desmond, D.; Tatemichi, T.; Hanzawa, L. (1994)	72	M=72.1 years old	
	Grodstein, F. et al (2000)	2,138 females	70-78 years old	
	Jaervenpaeae, T.; Rinne, J.; Raeihae, I.; Koskenvuo, M.; Loeppoenen, M.; Hinkka, S.; Kaprio, J. (2002)	56	52-80 years old	
TICSm Computer	Buckwalter, J.G.;	3,681 females	80+ years old	

COGNITIVE BATTERY	REFERENCE	NUMBER OF PARTICIPANTS	AGE OF PARTICIPANTS	COGNITIVE SUBTESTS
Assisted Telephone Interview (CATI)	Crooks, V.; Petitti, D. (2002)			
Telephone Screening Device	Chumbler, N.; Zhang, M. (1998)	48	65+ years old	Validity of a modified telephone screening device against the Mini-Mental State Examination (MMSE)
TELE self-report interview	Jaervenpaeae, T.; Rinne, J.; Raeihae, I.; Koskenvuo, M.; Loeppoenen, M.; Hinkka, S.; Kaprio, J. (2002)	56	52-80 years old	

Table 2. Telephone Measures, Normal Cognitive Functioning

COGNITIVE BATTERY	REFERENCE	NUMBER OF PARTICIPANTS	AGE OF PARTICIPANTS	COGNITIVE SUBTESTS
Mini-Mental State Examination (MMSE)	Roccaforte, WH; Burke, WJ; Bayer, BL; Wengel, SP (1992)	100		Validity of Telephone version of the MMSE; brief neuropsychological screening test (BNPS); MMSE as part of the Adult Lifestyles and Function Interview (ALFI-MMSE)
Modified Mini-Mental State Exam (3MS)	Norton, M.C.; Tschanz, J.A.; Fan, X; Plassman, B.L.; Welsh-Bohmer, K.A.; West, N.; Wyse, B.W.; Breitner, JC (1999)	263	63-93 years old	Modified Mini-Mental State Exam and the Telephone Modified Mini-Mental State Exam
Nurses Health Study	Grodstein, F.; Chen, J.; Pollen, D.; Albert, M.; Wilson, R.; Folstein, M.; Evans, D.; Stampfer, M. (2000)	2,138 females	70-78 years old	East Boston Memory Test (EBMT), Immediate and delayed recall of EBMT, Immediate recall of the TICS, 10-word list, Verbal Fluency
Telephone assessed cognitive ability measures	Nesselroade, J.R.; Pedersen, N.; McClearn, G.; Plomin, R.; et al (1988)	194 pairs of twins	27.5-82 years old	Analogies and future logic, Forward and backward digit span, Information and synonyms
Telephone Cognitive Battery Tests	Kent, J; Plomin, R (1987)	212	9-15 years old	

Table 3. Telephone Measures, Dementia

COGNITIVE BATTERY	REFERENCE	NUMBER OF PARTICIPANTS	AGE OF PARTICIPANTS	COGNITIVE SUBTESTS
Blessed Telephone Information Memory-Concentration (TIMC)	Kawas, C.; Karagiozis, H.; Resau, L.; Corrada, M.; et.al (1995)	49	50-98 years old	TIMC when administered by phone instead of in person.
Reliability of instruments for assessment of Alzheimer's by telephone	Monterio, I.M.; Boksay, I.; Auer, S.; Torossian, C.; Sinaiko, E.; Reisberg, B. (1998)	34 (17 females, 17 males)	M = 76.8 (females) M = 77.6 (males)	-- Global Deterioration Scale -- Functional Assessment Staging -- Behavioral Pathology In Alzheimer's Disease Rating Scale -- Brief Cognitive Rating Scale -- Mini-Mental State Examination
Short Portable Mental Status Questionnaire	Roccaforte, WH; Burke, WJ; Bayer, BL; Wengel, SP (1994)			Reliability of Telephone version of SPMSQ
Structured Telephone Interview for Dementia (STIDA)	Go, Rodney C.P.; Duke, L.; Harrell, L.; Cody, H.; Bassett, S.; Flolstein, M.; Albert, M.; Foster, J.; Sharrow, N.; Blacker, D. (1997)		60-88 years old	The NIMH Genetics Initiative -- Clinical Dementia Rating Scale (CDR
Swedish Twins Study	Gatz, M.; Pedersen, N.; Berg, S.; Johansson, B.; Johansson, K.; Mortimer, J.; Posner, S.; Viitanen, M.; Winblad, B.; Ahlbom, A. (1997)	65 pairs of twins	55+ years old	MMSE TELE including the Mental Status Questionnaire (MSQ)

COGNITIVE BATTERY	**REFERENCE**	**NUMBER OF PARTICIPANTS**	**AGE OF PARTICIPANTS**	**COGNITIVE SUBTESTS**
Telephone- Assessed Mental State	Lanska, DJ; Schmitt, FA; Stewart, JM; Howe, JN (1993	30		
TICSm (TICS Modified)	Buckwalter, JG et.al (2002)	3,681 women	80+ years old	**TICSm (TICS Modified)**