Component Description

Cognitive health has emerged as an important public health concern, most notably for the nation’s aging population (1, 2). Decline in cognitive functioning has been associated with quality of life, personal relationships, and independence resulting in increased health care needs, as well as major caregiving and financial challenges (3). Cognitive functioning has been measured periodically in NHANES surveys, either during the household interview or as a component in the Mobile Examination Center. In 2011-12, a series of assessments in NHANES (variable name prefix CFQ) were re-introduced, including: 1) word learning and recall modules from the Consortium to Establish a Registry for Alzheimer’s disease (CERAD); 2) the Animal Fluency test; and 3) the Digit Symbol Substitution test (DSST). Although cognitive assessments cannot replace a diagnosis based on a clinical examination, they are useful to examine the association of cognitive functioning with the many medical conditions and risk factors measured during the NHANES examination.

Each assessment is described, in brief:

The CERAD Word Learning subtest (CERAD W-L) assesses immediate and delayed learning ability for new verbal information (memory sub-domain) (4). It has been used in major epidemiologic studies with diverse racial and cultural communities (5-8). The test consists of three consecutive learning trials, and a delayed recall. For the learning trials, participants are instructed to read aloud 10 unrelated words, one at a time, as they are presented. Immediately following the presentation of the words, participants recall as many words as possible. In each of the three learning trials, the order of the 10 words is changed. The maximum score possible on each trial is 10. In NHANES, the words for the learning trials were presented in large bolded letters on a computer monitor. Participants who were unable to read, due to literacy or visual impairment, were asked to repeat each word after it was read by the interviewer. The delayed word recall occurred after the other two cognitive exercises (Animal Fluency and DSST) were completed (approximately 8-10 minutes from the start of the word learning trials). In addition to scores for each word learning trial and the delayed word recall, a score for the number of intrusions (incorrect words that were not on the list) is included in the data file.

The Animal Fluency test examines categorical verbal fluency, a component of executive function (9). Scores have been shown to discriminate between persons with normal cognitive functioning compared with those with mild cognitive impairment and more severe forms of cognitive impairment, such as Alzheimer’s disease (10-12). The test demands awareness (e.g., naming animals), regardless of cultural context, that is not absolutely reliant on formal educational experiences of a particular culture (8). The Animal Fluency test has been used in large-scale screenings and epidemiologic studies (11-13). Participants are asked to name as many animals as possible in one minute. A point is given for each named animal. In NHANES, participants first were asked to name three items of clothing, another verbal fluency category, as a practice test. Participants who could not name three articles of clothing did not continue with the Animal Fluency exercise.

The Digit Symbol Substitution test (DSST), a performance module from the Wechsler Adult Intelligence Scale (WAIS III), relies on processing speed, sustained attention, and working memory (14). The DSST has been used in large screenings, epidemiological and clinical studies (15-17), and was administered during the household interview to participants 60 years and over during NHANES 1999-2002. The exercise is conducted using a paper form that has a key at the top containing 9 numbers paired with symbols. Participants have 2 minutes to copy the corresponding symbols in the 133 boxes that adjoin the numbers. The score is the total number of correct matches. A sample practice test is administered before the participants begin the main test. In NHANES, participants who could not correctly match the symbols with the numbers on their own during the pretest practice did not continue. Details on scoring can be found in the 1999-2000 NHANES CFQ questionnaire data file documentation <https://wwwn.cdc.gov/Nchs/Nhanes/1999-2000/CFQ.htm>.

Eligible Sample

Participants aged 60 years and older were eligible. Participants who did not understand or read English, Spanish, Korean, Vietnamese, traditional or simplified Mandarin, or Cantonese, or participants who needed a proxy informant were not administered the assessments. An overall completion status variable (CFASTAT) provides the completion codes for the full component, indicating persons who were either not eligible or did not take part in this component as a Mobile Examination Center (MEC) participant. Note that all participants did not complete every assessment. For more details on the overall component status, see Analytic Notes: CFASTAT.

Among eligible participants, if consent to audio-record was denied (requested for both quality control and scoring purposes), participants only were administered the DSST.

Interview Setting and Mode of Administration

The assessments were administered by trained interviewers at the beginning of the face-to-face private interview in the Mobile Examination Center (MEC Interview). At that time, interviewers asked participants for consent to audio-record the entire interview which included other questions on health and life style. This is a change from 2011-12 NHANES when participants were asked to consent to audio-record only the Cognitive Functioning assessments.

Participants self-selected their preferred language (English, Spanish, Korean, Vietnamese, Chinese). All CERAD-WL words presented on the computer monitor were in the language chosen by the participant. Because the interviewers were bilingual only in English and Spanish, interpreters provided instructions for assessments administered in Korean, Vietnamese, and Chinese.

Quality Assurance & Quality Control

For interviews in English and Spanish, two interviewers transcribed verbatim responses from the audio recordings and scored the CERAD-WL and Animal fluency assessments. Transcription and scoring usually were done on the same day assessments were conducted. Tests conducted in Korean, Vietnamese and Chinese were transcribed verbatim and scored by consultants in those languages at a later date. The majority of DSST were also independently scored by two interviewers. Inconsistent scores were adjudicated by a third party, as necessary.

In addition, review of the audio-recordings of assessments were evaluated for consistency of interviewer instructions and to determine test score accuracy. Approximately 10% of recorded interviews were independently reviewed over the course of the data collection cycles.

Data Processing and Editing

Edits were made to ensure the completeness, consistency, and analytic usefulness of the data. When available, extensive review of the recorded interviews were conducted to clarify inconsistent responses, to evaluate the quality of the data, and to finalize the data set.

Analytic Notes

Non-response to this component varied by age, education, race-ethnicity, and other factors. Because non-response to cognitive assessments may be related to cognitive functioning itself, analysts are encouraged to conduct a thorough non-response bias analysis of these data as part of their preliminary research plan.

Sample sizes availability differ for each assessment. Analysts are encouraged to combine NHANES data cycles, if possible, to increase sample sizes.

MEC exam sample weights should be used for the analyses and are available on the NHANES website at: <https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2013>.

Please refer to the [NHANES Analytic Guidelines](https://wwwn.cdc.gov/nchs/nhanes/analyticguidelines.aspx) and the on-line [NHANES Tutorial](https://www.cdc.gov/nchs/tutorials/) for further details on the use of sample weights and other analytic issues.

CFASTAT: This summary variable describes response rates and the completion status for the entire component. As the codes demonstrate, MEC participants did not always attempt or complete all of the tests. For the code CFASTAT=1, participants have scores for one or more of the CERAD-WL recalls, a summary result for the Animal fluency and DSST practice pretests. Scores for the Animal fluency and the DSST are available only for those who passed the practice pretests (CFDAPP=1 and CFDDPP=1). For codes CFASTAT= 1, 2 or 3, analysts are encouraged also to consult the CERAD administrative completion status variable (CFDCCS) and the animal fluency and DSST practice pretest summary result (CFDAPP, CFDDPP) codes to determine the sample size available for each assessment. CFASTAT coded as 4, 5, 6 indicate persons who did not do any of the assessments due to ineligibility or other reasons. These persons are coded as missing throughout the remainder of the data set. As is the case with other NHANES MEC components, some sample persons did not have the opportunity to participate (e.g., limited by time constraints) or did not have an interest in taking part in the cognitive component (e.g., refused).

CFALANG: The cognitive functioning component was conducted only in English, Spanish, Korean, Vietnamese, and Chinese. Language was determined by the participant at the time of the testing. In order to protect confidentiality, the language of participants speaking Chinese, Korean or Vietnamese is coded as “Asian language” (CFALANG=3).

CFDCCS and CFDCRNC: Complete data (3 learning trials and delayed recall) are not available for a small portion of participants. A reason code is provided for these participants (CFDCRNC) as well as for persons who did not perform any of the CERAD-WL assessments.

CFDCIT1, CFDCIT2, CFDCIT3, CFDCIR: These variables provide a count of incorrect words named during the three learning trial recalls or during the delayed recall.

CFDAPP: This variable provides a summary result for the practice pretest that took place before the animal fluency was administered. Persons who were unable to pass the pretest (CFDAPP=2) will have a missing score for Animal Fluency test (CFDAST=”.”).

CFDDPP: This variable provides a summary result for the practice pretest that took place before the DSST was administered. Persons who were unable to pass the pretest (CFDDPP=2) will have a missing score for DSST (CFDDS=”.”).

Questions on self-perceived cognitive functioning are included in MCQ\_H of the Household Interview Questionnaire.

References

* 1. Alzheimer’s Association and Centers for Disease Control and Prevention. The Healthy Brain Initiative: The Public Health Road Map for State and National Partnerships, 2013–2018: Chicago, IL: Alzheimer’s Association; 2013.
* 2. Centers for Disease Control and Prevention. The Healthy Brain Initiative: The Public Health Road Map for State and National Partnerships, 2013-2018, Interim Progress Report; Atlanta, GA: CDC, 2015. <https://www.cdc.gov/aging/pdf/2013-healthy-brain-initiative-interim-report.pdf>[Accessed on: 3/14/2017]
* 3. Anderson LA, McConnell SR. Cognitive health: an emerging public health issue, Alzheimer’s & Dementia. 2007;S70-S73.
* 4. Morris JC, Heyman A, Mohs RC, et al. The Consortium to Establish a Registry for Alzheimer’s disease (CERAD). Part 1. Clinical and neuropsychological assessment of Alzheimer’s disease. Neurology. 1989;39:1159-1165.
* 5. Fillenbaum GG, van Belle G, Morris JC, et al. Consortium to Establish a Registry for Alzheimer’s Disease (CERAD): The first twenty years. Alzheimer’s & Dementia. 2008;4:96-109.
* 6. Gao S, Jin Y, Unverzagt FW, et al. Hypertension and cognitive decline in rural elderly Chinese. Journal of the American Geriatrics Society. 2009;57:1051-1057.
* 7. Lee DY, Lee KU, Lee JH, et al. A normative study of the CERAD neuropsychological assessment battery in the Korean elderly. Journal of the International Neuropsychological Society. 2004;10(1):72-81.
* 8. Prince M, Acosta D, Chiu H, Scazufca M, Varghese M. Dementia Research Group. Dementia diagnosis in developing countries: a cross-cultural validation study. Lancet. 2003;361:909-917.
* 9. Strauss E, Sherman EMS and Spreen O. (2006) A Compendium of Neuropsychological Tests: Administration, Norms and Commentary (3rd edition). New York: Oxford University Press.
* 10. Henry JP, Crawford JR, Phillips LH. Verbal fluency performance in dementia of the Alzheimer’s type: a meta-analysis. Neuropsychologia. 2004;42:1212-1222.
* 11. Clark LJ, Gatz M, Zheng L, et al. Longitudinal verbal fluency in normal aging, preclinical and prevalent Alzheimer’s disease. American Journal of Alzheimer’s Disease and Other Dementia. 2009;24:461-468.
* 12. Duff Canning SJ, Leach L, Stuss D, et al. Diagnostic utility of abbreviated fluency measures in Alzheimer disease and vascular dementia. Neurology. 2004;62(4):556-562.
* 13. Grundman M, Petersen RC, Ferris SH, et al. Mild cognitive impairment can be distinguished from Alzheimer disease and normal aging for clinical trials. Archives of Neurology. 2004;61(1):59-66.
* 14. Wechsler D. WAIS Manual – Third Edition. New York: Psychological Corporation. 1997.
* 15. Bienias JL, Beckett LA, Bennett DA,et al. Design of the Chicago Health and Aging Project (CHAP). Journal of Alzheimer’s Disease. 2003;5:349-355.
* 16. Plassman BL, Langa KM, Fisher GG, et al. Prevalence of dementia in the United States, the Aging, Demographics, and Memory Study. Neuroepidemiology. 2007;29:125-132.
* 17. Proust-Lima C, Amieva H, Dartigues J and Jacqmin-Gadda H. Sensitivity of four psychometric tests to measure cognitive changes in brain aging-population-based studies, American Journal of Epidemiology. 2007;165(3):344-350.

Codebook and Frequencies

SEQN - Respondent sequence number

**Variable Name:**

SEQN

**SAS Label:**

Respondent sequence number

**English Text:**

Respondent sequence number

**Target:**

Both males and females 60 YEARS - 150 YEARS

CFASTAT - Cognitive functioning status

**Variable Name:**

CFASTAT

**SAS Label:**

Cognitive functioning status

**English Text:**

Cognitive functioning status

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | 3 tests | 1638 | 1638 |  |
| 2 | 2 tests | 44 | 1682 |  |
| 3 | 1 test | 4 | 1686 |  |
| 4 | Ineligible, proxy | 19 | 1705 | End of Section |
| 5 | Ineligible, other language | 16 | 1721 | End of Section |
| 6 | No test done | 64 | 1785 | End of Section |
| . | Missing | 0 | 1785 |  |

CFALANG - Language - Cognitive Functioning

**Variable Name:**

CFALANG

**SAS Label:**

Language - Cognitive Functioning

**English Text:**

Language - Cognitive Functioning

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | English | 1488 | 1488 |  |
| 2 | Spanish | 167 | 1655 |  |
| 3 | Asian language | 31 | 1686 |  |
| . | Missing | 99 | 1785 |  |

CFDCCS - CERAD: Completion Status

**Variable Name:**

CFDCCS

**SAS Label:**

CERAD: Completion Status

**English Text:**

CERAD: Number of recalls completed

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Four completed recalls | 1672 | 1672 | CFDCST1 |
| 2 | One to three completed recalls | 9 | 1681 |  |
| 3 | Not done | 5 | 1686 |  |
| . | Missing | 99 | 1785 |  |

CFDCRNC - CERAD: Reason Not Complete

**Variable Name:**

CFDCRNC

**SAS Label:**

CERAD: Reason Not Complete

**English Text:**

CERAD: Reason Not Complete

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Did not consent to audio record | 0 | 0 |  |
| 2 | Communication problem | 4 | 4 |  |
| 3 | Physical limitation | 1 | 5 |  |
| 4 | Quit or gave up | 8 | 13 |  |
| 5 | Refused | 0 | 13 |  |
| 6 | Equipment failure | 1 | 14 |  |
| 7 | Other | 0 | 14 |  |
| . | Missing | 1771 | 1785 |  |

CFDCST1 - CERAD: Score Trial 1 Recall

**Variable Name:**

CFDCST1

**SAS Label:**

CERAD: Score Trial 1 Recall

**English Text:**

CERAD: Score Trial 1 Recall

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 10 | Range of Values | 1681 | 1681 |  |
| . | Missing | 104 | 1785 |  |

CFDCST2 - CERAD: Score Trial 2 Recall

**Variable Name:**

CFDCST2

**SAS Label:**

CERAD: Score Trial 2 Recall

**English Text:**

CERAD: Score Trial 2 Recall

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 10 | Range of Values | 1678 | 1678 |  |
| . | Missing | 107 | 1785 |  |

CFDCST3 - CERAD: Score Trial 3 Recall

**Variable Name:**

CFDCST3

**SAS Label:**

CERAD: Score Trial 3 Recall

**English Text:**

CERAD: Score Trial 3 Recall

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 10 | Range of Values | 1674 | 1674 |  |
| . | Missing | 111 | 1785 |  |

CFDCSR - CERAD: Score Delayed Recall

**Variable Name:**

CFDCSR

**SAS Label:**

CERAD: Score Delayed Recall

**English Text:**

CERAD: Score Delayed Recall

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 10 | Range of Values | 1672 | 1672 |  |
| . | Missing | 113 | 1785 |  |

CFDCIT1 - CERAD: Intrusion word count Trial 1

**Variable Name:**

CFDCIT1

**SAS Label:**

CERAD: Intrusion word count Trial 1

**English Text:**

CERAD: Intrusion word count Trial 1

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 4 | Range of Values | 1681 | 1681 |  |
| . | Missing | 104 | 1785 |  |

CFDCIT2 - CERAD: Intrusion word count Trial 2

**Variable Name:**

CFDCIT2

**SAS Label:**

CERAD: Intrusion word count Trial 2

**English Text:**

CERAD: Intrusion word count Trial 2

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 5 | Range of Values | 1678 | 1678 |  |
| . | Missing | 107 | 1785 |  |

CFDCIT3 - CERAD: Intrusion word count Trial 3

**Variable Name:**

CFDCIT3

**SAS Label:**

CERAD: Intrusion word count Trial 3

**English Text:**

CERAD: Intrusion word count Trial 3

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 6 | Range of Values | 1674 | 1674 |  |
| . | Missing | 111 | 1785 |  |

CFDCIR - CERAD: Intrusion word count Recall

**Variable Name:**

CFDCIR

**SAS Label:**

CERAD: Intrusion word count Recall

**English Text:**

CERAD: Intrusion word count Recall

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 8 | Range of Values | 1672 | 1672 |  |
| . | Missing | 113 | 1785 |  |

CFDAPP - Animal Fluency: Sample Practice Pretest

**Variable Name:**

CFDAPP

**SAS Label:**

Animal Fluency: Sample Practice Pretest

**English Text:**

Animal Fluency: Sample Practice Pretest

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Passed | 1661 | 1661 | CFDAST |
| 2 | Failed | 11 | 1672 | CFDDPP |
| 3 | Not done | 14 | 1686 |  |
| . | Missing | 99 | 1785 |  |

CFDARNC - Animal Fluency: Reason Not Done

**Variable Name:**

CFDARNC

**SAS Label:**

Animal Fluency: Reason Not Done

**English Text:**

Animal Fluency: Reason Not Done

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Did not consent to audio record | 0 | 0 | CFDDPP |
| 2 | Communication problem | 1 | 1 | CFDDPP |
| 3 | Physical limitation | 0 | 1 | CFDDPP |
| 5 | Refused | 2 | 3 | CFDDPP |
| 6 | Equipment failure | 11 | 14 | CFDDPP |
| 7 | Other | 0 | 14 | CFDDPP |
| . | Missing | 1771 | 1785 |  |

CFDAST - Animal Fluency: Score Total

**Variable Name:**

CFDAST

**SAS Label:**

Animal Fluency: Score Total

**English Text:**

Animal Fluency: Score Total

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 3 to 39 | Range of Values | 1661 | 1661 |  |
| . | Missing | 124 | 1785 |  |

CFDDPP - Digit Symbol: Sample Practice Pretest

**Variable Name:**

CFDDPP

**SAS Label:**

Digit Symbol: Sample Practice Pretest

**English Text:**

Digit Symbol Coding: Sample Practice Pretest

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 1 | Passed | 1592 | 1592 | CFDDS |
| 2 | Failed | 61 | 1653 | End of Section |
| 3 | Not done | 33 | 1686 |  |
| . | Missing | 99 | 1785 |  |

CFDDRNC - Digit Symbol: Reason Not Done

**Variable Name:**

CFDDRNC

**SAS Label:**

Digit Symbol: Reason Not Done

**English Text:**

Digit Symbol Coding: Reason Not Done

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 2 | Communication problem | 3 | 3 | End of Section |
| 3 | Physical limitation | 7 | 10 | End of Section |
| 5 | Refused | 23 | 33 | End of Section |
| 6 | Equipment failure | 0 | 33 | End of Section |
| 7 | Other | 0 | 33 | End of Section |
| . | Missing | 1752 | 1785 |  |

CFDDS - Digit Symbol: Score

**Variable Name:**

CFDDS

**SAS Label:**

Digit Symbol: Score

**English Text:**

Digit Symbol Coding: Score

**Target:**

Both males and females 60 YEARS - 150 YEARS

| **Code or Value** | **Value Description** | **Count** | **Cumulative** | **Skip to Item** |
| --- | --- | --- | --- | --- |
| 0 to 105 | Range of Values | 1592 | 1592 |  |
| . | Missing | 193 | 1785 |  |