# ADNI Cogstate Data – File Format and Data Description

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# 1 Background

This document describes all variables in the Cogstate ADNI_CBBRESULTS dataset. This document can be used by customers programming databases to receive Cogstate data and by statisticians to understand and analyze Cogstate data.

Each row of the Cogstate Data Extract represents one test that has at least been partially completed by the subject, and each column represents a variable code that may reflect study summary information, session summary information, or Cogstate battery results.

Note that not all Cogstate tests produce the same outcome variables; therefore some columns for some tests will remain blank, indicating that the variable is not present for that test. Refer to Table 4 for a summary of the outcome variables that are reported for each test.

The following sections contain information on the Cogstate tests included in the ADNI battery, followed by a detailed description of outcome variables generated from each test and how these should be interpreted.

# 2 Cogstate Tests

Each row in the data extract represents one test in the Cogstate battery for a single subject at a single session. Tests are identified in the data extract by a test code (column name: ”TestCode”). Table 1 summarizes each of Cogstate tests.

*Table 1: Test Descriptions*

| Test Name | Code Name (“TestCode” column) | Cognitive Function Measured | Description |
|---|---|---|---|
| Detection | Detection | Psychomotor function | Has the card turned over?<br><br>In this test, a playing card is presented face-down in the center of the screen. After a random interval, the card will turn over so that is it face-up (revealing a Joker card – this same card is used throughout the test). The subject is asked to press the “YES” button as soon as the card turns face-up. |
| Identification | Identification | Attention | Is the card red?<br><br>In this test, a playing card is presented face-down in the center of the screen. After a random interval, the card will turn over so that is it face-up. Either a red Joker card or black Joker card will be revealed. As soon as the card turns face-up, the subject decides whether the card displayed is red. If the card is red, the subject should press the “YES” button, if it is not red they should press “NO”. |

| Test Name | Code Name ("TestCode" column) | Cognitive Function Measured | Description |
|---|---|---|---|
| One Card Learning | OneCardLearning | Visual learning | Have you seen this card before?<br><br>In this test, a playing card is presented face-down in the center of the screen. After a random interval, the card will turn over so that is it face-up. A regular playing card from a French deck is revealed. As soon as the card turns face-up, the subject must decide whether the current card has been seen before in the test. The subject should press the "YES" button if they have seen the card before in the test, or "NO" if they have not. |
| One Back | OneBack | Working memory – simple | Is this card the same as the previous card?<br><br>In this test, a playing card is presented face-down in the center of the screen. After a random interval, the card will turn over so that is it face-up. A regular playing card from a French deck is revealed. As soon as the card turns face-up, the subject must decide whether the current card is the same as the previous card. The subject should press the "YES" button if the current card is the same as the one presented immediately before it, or "NO" if it is not the same. |

## 2.1 Primary Outcome Variables for each Test

Although each cognitive test yields multiple outcome measures, Cogstate's own research has identified a set of measures that are optimal for the detection of cognitive change in clinical trials at both the group and individual level [1-3].

For each cognitive test, a single primary outcome measure was selected to minimize experiment-wise error rates. Each primary outcome measure was selected because it has been shown to be optimal for the detection of change because:

a) it is drawn from a data distribution that contains only a small probability of floor or ceiling effects and no restriction in the range of possible performance values.
b) it is drawn from a distribution that is distributed normally or which can be corrected to normal through the use of appropriate mathematical transformation (e.g., logarithmic base 10 or arcsine transformation).

Table 2 summarizes the primary outcome measures for all Cogstate tests. It is these variables that are recommended for use in statistical analyses.

*Table 2: Primary Outcome Measures per Test*

| Test | Primary Outcome Variable Code | Unit of Measurement | Description and Interpretation of Scores |
|---|---|---|---|
| Detection | ReactionTime | Log10 milliseconds | Speed of performance; mean of the log10 transformed reaction times for correct responses.<br>Lower score = better performance |
| Identification | ReactionTime | Log10 milliseconds | Speed of performance; mean of the log10 transformed reaction times for correct responses.<br>Lower score = better performance |
| One Card Learning | Accuracy | Arcsine square root proportion correct | Accuracy of performance; arcsine transformation of the square root of the proportion of correct responses.<br>Higher score = better performance |
| One Back* | Accuracy/ ReactionTime | Accuracy:<br>Arcsine square root proportion correct<br><br>ReactionTime:<br>Log10 milliseconds | Accuracy:<br>Accuracy of performance; arcsine transformation of the square root of the proportion of correct responses.<br>Higher score = better performance<br><br>ReactionTime:<br>Speed of performance; mean of the log10 transformed reaction times for correct responses.<br>Lower score = better performance |

**Note: for the One Back test, either accuracy or speed of performance can be used as the primary outcome measure, depending on the study population and research questions of interest.*

# 3 Full Description of Data File

A full description of each column in the data file is presented in Table 3.

Please note that study/session data are common to all rows (i.e., reported for all tests at all time points).

*Table 3: Description of Variables Populated in the Data File*

| Serial No. | Column Header | Description | Unit of Measurement/Format |
|---|---|---|---|
| 1. | ProtocolID | Study reference. | ADNI2/ADNI3 |
| 2. | RID | Participant roster ID. | Numeric |
| 3. | SessionID | Identification number for the session.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 4. | EXAMDATE | Date at the start of the test session. | MM/DD/YYYY |
| 5. | TestTime | Time at the start of the test session. | hh:mm:ss |
| 6. | Visit | Visit label. The visit options are:<br>In Clinic = indicates the session was completed in the clinic.<br>Remote = indicates the session was completed remotely (i.e., at-home)<br>Unknown = it is not known whether the session was completed in the clinic or remotely (Unknown visit labels may change to In Clinic/ Remote over time as data is queried and clarified by sites).<br><br>*Note: this is only applicable for ADNI3 data.* | Character |
| 7. | SessionAttempt | The cumulative total of attempts of the Cogstate battery (including the current assessment). | Numeric |
| 8. | SessionDuration | The total duration of the current session. | Numeric (milliseconds) |
| 9. | SessionCompletionPass | Session completion criteria.<br>(i) Yes = all tests in session met completion criteria. If a test is attempted multiple times within the session, TestCompletionPass must = Yes for at least one of the attempts.<br>(ii) No = at least one test in the session did not meet completion criteria. If a test is attempted multiple times within the session, TestCompletionPass = No for all attempts.<br>(iii) If one or more tests in the battery do not have any data for the real test (and therefore, the test does not appear in the extract), SessionCompletionPass = No. | Yes/No |

| Serial No. | Column Header | Description | Unit of Measurement/Format |
|---|---|---|---|
| 10. | SessionPerformancePass | Session performance criteria.<br>(i) Yes = all tests in the session met the performance check. If a test is attempted multiple times within the session, TestPerformancePass must = Yes for the most recent attempt that passed completion.<br>(ii) No = at least one test in the session did not meet performance check. If a test is attempted multiple times within the session, TestPerformancePass = No for the most recent attempt that passed completion.<br>(iii) If TestCompletionPass = No for all attempts for a particular test, SessionPerformancePass = No.<br>(iv) If one or more tests in the battery do not have any data for the real test (and therefore, the test does not appear in the extract), SessionPerformancePass = No.<br><br>*Note: this is only applicable for ADNI3 data.* | Yes/No |
| 11. | SessionIntegrityPass | Session integrity criteria.<br>(i) Yes = all tests in the session met the integrity check. If a test is attempted multiple times within the session, TestIntegrityPass must = Yes for the most recent attempt that passed completion.<br>(ii) No = at least one test in the session did not meet the integrity check. If a test is attempted multiple times within the session, TestIntegrityPass = No for the most recent attempt that passed completion.<br>(iii) If TestCompletionPass = No for all attempts of a test that contributes to the integrity checks, SessionIntegrityPass = No.<br>(iv) If one or more tests in the battery that contribute to the integrity checks do not have any data for the real test (and therefore, the test does not appear in the extract), SessionIntegrityPass = No.<br><br>*Note: this is only applicable for ADNI3 data.* | Yes/No |
| 12. | TestCode | Code name for the test. | Character |
| 13. | TestAttempt | Tests in the Cogstate battery have been configured to repeat if the test completion and/or performance criteria are not met. TestAttempt indicates the attempted number of the test in the current session.<br>Tests can repeat a maximum of 3 times. | Numeric |

| Serial No. | Column Header | Description | Unit of Measurement/Format |
|---|---|---|---|
| 14. | TestCompletionScore | The completion score for the test [(TotalTrials/required correct responses) x 100; required correct responses is 35 for Detection, 30 for Identification, 80 for One Card Learning and 31 for One Back].<br><br>*Note: this is only applicable for ADNI2 data.* | Numeric |
| 15. | TestPerformanceScore | The performance score for the test [reflects raw accuracy of performance; (TotalCorrect/TotalResponse) x 100]<br><br>*Note: this is only applicable for ADNI2 data*. | Numeric |
| 16. | TestCompletionPass | Test completion criteria (Yes = met completion check; No = did not meet completion check). Refer to section 5.2 for further details on these criteria.<br><br>*Note: this is only applicable for ADNI3 data.* | Yes/No |
| 17. | TestPerformancePass | Test performance criteria (Yes = met performance check; No = did not meet performance check). Refer to section 5.3 for further details on these criteria.<br><br>*Note: this is only applicable for ADNI3 data.* | Yes/No |
| 18. | TestIntegrityPass | Test integrity criteria (Yes = met integrity check; No = did not meet integrity check). Refer to section 5.5 for further details on these criteria.<br><br>*Note: this is only applicable for ADNI3 data.* | Yes/No |
| 19. | TestDuration | The total time *(ms)* from test start until the end of the test.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric (milliseconds) |
| 20. | ReactionTime | Mean of $\log_{10}$ transformed reaction times of correct responses. | Numeric (milliseconds) |
| 21. | RawReactionTime | Mean of reaction times of correct responses.<br><br>*Note: this is only applicable for ADNI3 data*. | Numeric (milliseconds) |
| 22. | RTVariability | Standard deviation of $\log_{10}$ transformed reaction times of correct responses. | Numeric (milliseconds) |
| 23. | RawRTVariability | Standard deviation of reaction times of correct responses.<br><br>*Note: this is only applicable for ADNI3 data*. | Numeric (milliseconds) |
| 24. | Accuracy | Accuracy of performance (arcsine square root proportion correct) | Numeric |

| Serial No. | Column Header | Description | Unit of Measurement/Format |
|---|---|---|---|
| 25. | RawAccuracy | Accuracy of performance (proportion of correct responses).<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 26. | TotalCorrect | Number of correct responses. | Numeric |
| 27. | TotalCorrectExclPant | Number of correct responses after Pant (post-anticipatory) responses have been excluded.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 28. | TotalErrors | Number of errors. | Numeric |
| 29. | LegalErrors | Number of legal errors (errors that are not breaking rules of test).<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 30. | RuleBreakErrors | Number of errors that break the rules of the test.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 31. | TotalAnticipatory | Number of Anticipatory responses (i.e., responding before the card turns face-up).<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 32. | TotalPost | Number of Post responses (i.e., responding during the response feedback period and before the beginning of the next trial).<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 33. | TotalMaxOut | Number of MaxOut responses (i.e., when a response is not provided within the maximum trial duration).<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 34. | TotalResponses | Number of responses provided. | Numeric |
| 35. | TotalTrials | Number of trials completed. | Numeric |
| 36. | StandardScoreZ | Standardized z-score for the primary outcome measure for each test as defined in Table 2. For the One Back test, Accuracy is used for this outcome.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |

| Serial No. | Column Header | Description | Unit of Measurement/Format |
|---|---|---|---|
| 37. | StandardScoreT | Standardized T-score (mean = 100, SD = 10) for the primary outcome measure for each test as defined in Table 2. For the One Back test, Accuracy is used for this outcome.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 38. | AltStandardScoreZ | Standardized z-score for One Back using Reaction Time as the outcome measure.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 39. | AltStandardScoreT | Standardized T-score (mean = 100, SD = 10) for One Back using Reaction Time as the outcome measure.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 40. | Psyattstdscr | The score on the Psychomotor Function/Attention composite, incorporating ReactionTime as the outcome measure for the Detection and Identification tests, relative to age-matched normative data.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 41. | LearnWMStdScr | The score on the Learning/Working Memory composite, incorporating Accuracy as the outcome measures for the One Card Learning and One Back tests, relative to age-matched normative data.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 42. | AltLearnWMStdScr | The score on the Learning/Working Memory composite, incorporating Accuracy as the outcome measure for the One Card Learning test and ReactionTime as the outcome measure for the One Back test, relative to age-matched normative data.<br><br>*Note: this is only applicable for ADNI3 data.* | Numeric |
| 43. | update_stamp | Date the extract was last updated on LONI. | DD-MM-YYYY hh:mm:ss AM/PM |

# 4 Outcome Variables Matrix

The table below summarizes the outcome variables that are reported for each test.

*Table 4: Outcome Variables Reported per Test*

| Outcome Variable | Detection | Identification | One Card Learning | One Back |
|---|---|---|---|---|
| TestCompletionScore[1] | ✓ | ✓ | ✓ | ✓ |
| TestPerformanceScore[1] | ✓ | ✓ | ✓ | ✓ |
| TestCompletionPass[2] | ✓ | ✓ | ✓ | ✓ |
| TestPerformancePass[2] | ✓ | ✓ | ✓ | ✓ |
| TestIntegrityPass[2] | ✓ | - | - | - |
| TestDuration[2] | ✓ | ✓ | ✓ | ✓ |
| ReactionTime | ✓ | ✓ | ✓ | ✓ |
| RawReactionTime[2] | ✓ | ✓ | ✓ | ✓ |
| RTVariability | ✓ | ✓ | ✓ | ✓ |
| RawRTVariability[2] | ✓ | ✓ | ✓ | ✓ |
| Accuracy | ✓ | ✓ | ✓ | ✓ |
| RawAccuracy[2] | ✓ | ✓ | ✓ | ✓ |
| TotalCorrect | ✓ | ✓ | ✓ | ✓ |
| TotalCorrectExclPant[2] | ✓ | ✓ | ✓ | ✓ |
| TotalErrors | ✓ | ✓ | ✓ | ✓ |
| LegalErrors[2] | - | ✓ | ✓ | ✓ |
| RuleBreakErrors[2] | ✓ | ✓ | ✓ | ✓ |
| TotalAnticipatory[2] | ✓ | ✓ | ✓ | ✓ |
| TotalPost[2] | ✓ | ✓ | ✓ | ✓ |
| TotalMaxOut[2] | ✓ | ✓ | - | ✓ |
| TotalResponses | ✓ | ✓ | ✓ | ✓ |
| TotalTrials | ✓ | ✓ | ✓ | ✓ |
| StandardScoreZ[2] | ✓ | ✓ | ✓ | ✓ |
| StandardScoreT[2] | ✓ | ✓ | ✓ | ✓ |
| AltStandardScoreZ[2] | - | - | - | ✓ |
| AltStandardScoreT[2] | - | - | - | ✓ |
| Psyattstdscr[2] | ✓ | ✓ | ✓ | ✓ |
| LearnWMStdScr[2] | ✓ | ✓ | ✓ | ✓ |
| AltLearnWMStdScr[2] | ✓ | ✓ | ✓ | ✓ |

[1] *This outcome is only applicable to ADNI2 data.*

[2] *This outcome is only applicable to ADNI3 data.*

# 5 Additional Test Information Important for Statistical Analyses

## 5.1 Missing Data

There are two instances when test information will not be provided in the data extract: a) when the subject misses a study visit/testing session entirely, or b) when the subject is present for a study visit/testing session but does not perform one or more of the tests.

## 5.2 Test Completion

Test completion refers to whether or not a test that has been started can be considered complete.

This information is crucial in the analysis of data when scores are based on only a small number of trials, as these scores are not as reliable as those based on a large number of trials and are less likely to accurately reflect the subject's performance level.

Test completion is indicated in the column entitled TestCompletionPass, where a value of "Yes" or "No" is used to indicate whether a score is derived from a completed test or not.

The definition of completion for each test is as follows:

| Test | Completion Criteria (criteria to pass) | Expected number of trials |
|---|---|---|
| Detection | 100% of the correct responses required for the test to terminate were provided.[1] | 35 |
| Identification | 100% of the correct responses required for the test to terminate were provided.[1] | 31 |
| One Card Learning | 100% of the trials were performed.[1] | 80 |
| One Back | 100% of the correct responses required for the test to terminate were provided.[1] | 31 |

[1] For ADNI2 data, this is reflected by a TestCompletionScore value of ≥ 100

## 5.3 Test Performance

The test performance check is a measure of whether or not a subject performed in accord with the test requirements. When a particular test administration fails to meet criteria for test performance, this suggests with high probability that the observed score may not reflect the study population.

The criteria for test performance are derived statistically and assigned *a priori* to study start-up by the Cogstate Science Team such that when trained and supervised appropriately, subjects from the relevant study population will typically achieve the said criteria for each test. Given that test data performance criteria are based on probabilistic estimates, it is possible that individual subjects who understand the test requirements, are well motivated, and are well supervised have a performance that fails test data performance. Infrequent and random failures of test data performance do not threaten the validity of cognitive data in a study or clinical trial.

Test performance is indicated in the column entitled "TestPerformancePass", where a value of "Yes" or "No" is used to reflect whether a score is derived from a test that passed the performance check or not.

The definition of performance for each test is as follows:

| Test | Performance Criteria (criteria to pass) |
|---|---|
| Detection | Accuracy ≥ 70% |
| Identification | Accuracy ≥ 70% |
| One Card Learning | Accuracy ≥ 40% |
| One Back | Accuracy ≥ 50% |

*Note: Cogstate suggests that a sensitivity analysis be run with test performance failures excluded if the performance failure rate is over 10%.*

## 5.4 TestCompletionPass and TestPerformancePass Flag Columns – Data Extract Design

Test performance criteria are applied only when a sufficient number of responses were recorded to allow computation of reliable outcome measures (i.e., for data that satisfy test completion criteria). Thus, there are three possible outcomes associated with test completion and performance failure flags in a data extract:

- A particular test administration can have a “Yes” in both of the “TestCompletionPass” and “TestPerformancePass” columns (i.e., indicating that both criteria were passed).
- A particular test administration can have a “Yes” in the “TestCompletionPass” column and have a “No” in the “TestPerformancePass” column (i.e., a performance failure).
- A particular test administration can have “No” in the “TestCompletionPass” column and have a blank in the “TestPerformancePass” column (i.e., a completion failure).

## 5.5 Test Integrity

The test integrity check applies to the Detection test only and assess the integrity of the data by comparing performance on the Detection test with the Identification test. Given the Detection test uses a simple reaction time paradigm (compared to choice reaction time for Identification), it is expected that response speed would be faster on the Detection test compared to Identification. When a particular test administration fails to meet criteria for test integrity, it suggests that the result for the Detection test may not be reflective of the subject’s true performance.

Test integrity is indicated in the column titled “TestIntegrityPass” , where a value of “Yes” or “No” is used to reflect whether a score is derived from a test that passed the integrity check or not.

The test integrity check is only applied when both the Detection and Identification tests have passed the test completion check (that is, “TestIntegrityPass” will only populated when “TestCompletionPass” is “Yes” for both the Detection and Identification tests).

# 6 References


1. Falleti MG, Maruff P, Collie A, & Darby DG. (2006). Practice effects associated with the repeated session of cognitive function using the Cogstate battery at 10-minute, one week and one-month test retest intervals. Journal of Clinical and Experimental Neuropsychology, 28, 1095-1012.

2. Falleti MG, Maruff P, Collie A, Darby DG, & McStephen M. (2003). Qualitative similarities in cognitive impairment associated with 24 h of sustained wakefulness and a blood alcohol concentration of 0.05%. Journal of Sleep Research, 12, 265-274.

3. Maruff P, Thomas E, Cysique L, Brew B, Collie A, Snyder P, Pietrzak RH (2009). Validity of the Cogstate brief battery: Relationship to standardized tests and sensitivity to cognitive impairment in mild traumatic brain injury, schizophrenia, and AIDS dementia complex. Archives of Clinical Neuropsychology, 24, 165-178.