

## **Derived Variables – Reliable Change Scores (Baseline to First Follow-up) for Cognitive Scores (COG) Normed for Age, Sex, Education Level, and Language (Tracking Assessment)**

Reliable change scores are essentially normed change scores – what change is expected in cognitively healthy people and did the participant change more than would be expected?

Measuring change in cognition is a critical component of longitudinal aging studies, but there has been a gap between longitudinal aging studies and clinical practice because many methods measure change at the group level. To be clinically useful, longitudinal methods need to measure change at the level of the individual patient. Accounting for error in measurement is a critical component of clinical utility. Reliable change methods create comparison standards for cognitive change, which translate longitudinal data into clinically useful data that can be applied to individual patients. Reliable change methods can create comparison standards that can be used by clinicians and can be a platform for research on cognition within the CLSA. Creation of reliable change methods for the baseline and first follow up of the CLSA are critical in the determination of trajectories of cognitive impairment, such as cognitive decline due to dementia. Here we describe the derived reliable change indices (RCIs) for the cognition tests in the CLSA using methods that account for error in measurement and expected practice effects (O’Connell et al., submitted).

Four cognitive tests, producing five scores, are in the neuropsychological battery used with the Tracking cohort: Immediate recall (REY I), delayed recall (REY II), animal naming task (AFT, with two scores based on strict scoring AF1 or lenient scoring AF2), and the mental alteration test (MAT).

Seventeen derived variables are created that summarize each participant’s change in performance, from baseline to first follow-up on the cognitive tests in the Tracking battery. These are normed for age, sex, and education level, and are based on standard regression-based modeling that considers the time interval between baseline and follow-up testing, all of which is done separately for English- and French-speaking CLSA participants. (Note: the normative comparison standards applied are the baseline norms, and practice effects are accounted for in the reliable change formulae. These were developed in a development sample, which were based on a random sample of half the robustly healthy normative sample and cross validated on the other half – with excellent fit. Finally, we performed these separately for English- and French-speaking participants because of the difference in precision (i.e., O’Connell et al., 2021) for these samples, but the normed scores are invariant to language of administration. See O’Connell et al., 2022.

**For each cognitive test, two variables are created**, relative to the norming sample (i.e., those who were neurologically healthy at both baseline and first follow-up):

- the person’s reliable change index Z-score (referred to as ‘change Zscore’) that indicates the standardized and normed change in performance from baseline to first follow-up; and
- the person’s reliable change index indicator (referred to as ‘RCI’) which is a classification of his/her performance into one of three categories: performance declined (-1), remained stable (0), or improved (+1) over time.

In addition, the same two derived variables are computed for changes in three composite scores constructed from the cognitive tests – memory (construct based on REY I and REY II), executive function (construct based on AF2 and MAT), and an overall cognition (construct based on all four tests).

Throughout this document, “neuro-healthy norming sample” refers to CLSA participants who were neuro-healthy at baseline and at follow-up testing. Separate norming samples were selected for consistent English and French language use on all tests.

The derivation of the change and RCI variables require normed test scores, which are described in the Cognition (COG) Normative Data (Tracking Assessment) documentation [CLSA document: Norming COG TRM \(clsa-elcv.ca\)](#). Here we assume that the normed variables have all been created and exist in the dataset.

### 1. Time Interval between baseline and follow-up testing

**Derived Variable Name:** delta\_T\_months

**Description:** Used for computing the person’s predicted score on a cognitive test. The interval is the difference in month from baseline to follow-up.

**Based on:** startdate\_TRM, startdate\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
Startdate_TRF1 – startdate_TRM	Both dates not missing	Number of months elapsed from baseline test date to follow-up test date.

### 2. REY I Reliable Change Z-score

**Derived Variable Name:** COG\_REYI\_CHNG\_ZSCORE\_TRF1

**Description:** This variable indicates the participant’s change in performance on the REY I (immediate recall) test between baseline testing and follow-up. It is normed for age, sex and education level and standardized (M=0, SD=1), relative to the neurologically healthy norming CLSA subsample. Norming and standardizing is done separately for English- and French-speaking participants.

**Based on:**

COG\_REYI\_STARTLANG\_TRM, COG\_REYI\_LANG\_TRM,  
 COG\_REYI\_STARTLANG\_TRF1, COG\_REYI\_LANG\_TRF1,  
 COG\_REYI\_NORMED\_ZSCORE\_TRM, COG\_REYI\_NORMED\_ZSCORE\_TRF1,  
 delta\_T\_months

**Temporary Variables:** Four temporary variables are created. Three language variables are created for coding English or French test administration at baseline (REYI\_LANG\_TRM), at follow-up (REYI\_LANG\_TRF1) and at both times (REYI\_LANG). The variable REYI\_FU1\_pred is the participant’s predicted test score based on her/his language of administration, baseline

test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

<b>Value</b>	<b>Condition(s)</b>	<b>Description</b>
REYI_LANG_TRM (or TRF1) = 1	COG_REYI_STARTLANG_TRM (or TRF1) = 'en' and COG_REYI_LANGUAGE_TRM (or TRF1) = 'en'	REY I language of administration is English
REYI_LANG_TRM (or TRF1) = 2	COG_REYI_STARTLANG_TRM (or TRF1) = 'fr' and COG_REYI_LANGUAGE_TRM (or TRF1) = 'fr'	REY I language of administration is French
REYI_LANG = 1	IF REYI_LANG_TRM = 1 and REYI_LANG_TRF1 = 1	REY I was conducted in English at both baseline and at follow-up
REYI_LANG = 2	IF REYI_LANG_TRM = 2 and REYI_LANG_TRF1 = 2	REY I was conducted in French at both baseline and at follow-up
	The conditions above were not met.	REY I language variables are missing or inconsistent
$REYI\_FU1\_pred = CONSTANT + COEFF1 * COG\_REYI\_NORMED\_ZSCORE\_TRM + COEFF2 * \Delta T\_months,$ where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro-healthy norming sample	(REYI_LANG = 1 or 2)	Regression-based predicted REY I score (using participant's normed REY I Z-score at baseline and time interval between tests)

**Derived Variable Specifications:**

Value	Condition(s)	Description
(COG_REYI_NORMED_ZSCORE_TRF1 - REYI_FU1_pred) / SD_residual where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	(REYI_LANG = 1 or 2)	The standardized difference between the participant's observed and predicted FU1 scores.

**3. REY I Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_REYI\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_REYI\_CHNG\_ZSCORE\_TRF1 into one of three categories indicating the participant's change in performance since baseline: declined (-1), remained stable (0), or improved (+1) over time. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups. When we analyze reliable change indices across a neuropsychological battery (i.e., did cognition improve, stay the same, or decline overall) we adjust for the frequency of change scores, which helps to offset this more lenient cut-off applied at the level of the individual test score).

**Based on:** COG\_REYI\_CHNG\_ZSCORE\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_REYI_CHNG_ZSCORE_TRF1 < -1.645	On REY I, participant's performance at follow-up declined since baseline.
0	COG_REYI_CHNG_ZSCORE_TRF1 $\geq$ -1.645 and COG_REYI_CHNG_ZSCORE_TRF1 < +1.645	On REY I, participant's performance at follow-up remained stable compared with baseline.
+1	COG_REYI_CHNG_ZSCORE_TRF1 > +1.645	On REY I, participant's performance at follow-up improved since baseline.

**4. REY II Reliable Change Z-score**

**Derived Variable Name:** COG\_REYII\_CHNG\_ZSCORE\_TRF1

**Description:** This variable indicates the participant's change in performance on the REY II (delayed recall) test between baseline testing and follow-up. It is normed for age, sex and education level and standardized ( $M=0$ ,  $SD=1$ ), relative to the neurologically healthy norming CLSA subsample. Norming and standardizing is done separately for English- and French-speaking participants.

**Based on:**

COG\_REYII\_STARTLANG\_TRM, COG\_REYII\_LANG\_TRM,  
 COG\_REYII\_STARTLANG\_TRF1, COG\_REYII\_LANG\_TRF1,  
 COG\_REYII\_NORMED\_ZSCORE\_TRM, COG\_REYII\_NORMED\_ZSCORE\_TRF1,  
 delta\_T\_months

**Temporary Variables:** Four temporary variables are created. Three language variables are created for coding English or French test administration at baseline (REYII\_LANG\_TRM), at follow-up (REYII\_LANG\_TRF1) and at both times (REYII\_LANG). The variable REYII\_FU1\_pred is the participant's predicted test score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

Value	Condition(s)	Description
REYII_LANG_TRM (or TRF1) = 1	COG_REYII_STARTLANG_TRM (or TRF1) = 'en' and COG_REYII_LANGUAGE_TRM (or TRF1) = 'en'	REY II language of administration is English
REYII_LANG_TRM (or TRF1) = 2	COG_REYII_STARTLANG_TRM (or TRF1) = 'fr' and COG_REYII_LANGUAGE_TRM (or TRF1) = 'fr'	REY II language of administration is French
REYII_LANG = 1	IF REYII_LANG_TRM = 1 and REYII_LANG_TRF1 = 1	REY II was conducted in English at both baseline and at follow-up
REYII_LANG = 2	IF REYII_LANG_TRM = 2 and REYII_LANG_TRF1 = 2	REY II was conducted in French at both baseline and at follow-up
	The conditions above were not met.	REY II language variables are missing or inconsistent
REYII_FU1_pred = CONSTANT + COEFF1 * COG_REYI_NORMED_ZSCORE_TRM + COEFF2 * delta_T_months, where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro-healthy norming sample	(REYII_LANG = 1 or 2)	Regression-based predicted REY II score (using participant's normed REY II Z-score at baseline and time interval between tests)

**Derived Variable Specifications:**

Value	Condition(s)	Description
(COG_REYII_NORMED_ZSCORE_TRF1 - REYII_FU1_pred) / SD_residual  where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	(REYII_LANG = 1 or 2)	The standardized difference between the participant's observed and predicted FU1 scores.

**5. REY II Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_REYII\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_REYII\_CHNG\_ZSCORE\_TRF1 into one of three categories indicating the participant's change in performance since baseline: declined (-1), remained stable (0), or improved (+1) over time. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups. When we analyze reliable change indices across a neuropsychological battery (i.e., did cognition improve, stay the same, or decline overall) we adjust for the frequency of change scores, which helps to offset this more lenient cut-off applied at the level of the individual test score).

**Based on:** COG\_REYII\_CHNG\_ZSCORE\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_REYII_CHNG_ZSCORE_TRF1 < -1.645	On REY II, participant's performance at follow-up declined since baseline.
0	COG_REYII_CHNG_ZSCORE_TRF1 ≥ -1.645 and COG_REYII_CHNG_ZSCORE_TRF1 < +1.645	On REY II, participant's performance at follow-up remained stable compared with baseline.
+1	COG_REYII_CHNG_ZSCORE_TRF1 > +1.645	On REY II, participant's performance at follow-up improved since baseline.

**6. AF1 Reliable Change Z-score**

**Derived Variable Name:** COG\_AF1\_CHNG\_ZSCORE\_TRF1

**Description:** This variable indicates the participant's change in performance on the AFT – strict scoring (AF1) test between baseline testing and follow-up. It is normed for age, sex and education level and standardized ( $M=0$ ,  $SD=1$ ), relative to the neurologically healthy norming CLSA subsample. Norming and standardizing is done separately for English- and French-speaking participants.

**Based on:**

COG\_AFT\_STARTLANG\_TRM, COG\_AFT\_LANG\_TRM,  
 COG\_AFT\_STARTLANG\_TRF1, COG\_AFT\_LANG\_TRF1,  
 COG\_AF1\_NORMED\_ZSCORE\_TRM, COG\_AF1\_NORMED\_ZSCORE\_TRF1,  
 delta\_T\_months

**Temporary Variables:** Four temporary variables are created. Three language variables are created for coding English or French test administration at baseline (AFT\_LANG\_TRM), at follow-up (AFT\_LANG\_TRF1) and at both times (AFT\_LANG). The variable AF1\_FU1\_pred is the participant’s predicted test score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation

Value	Condition(s)	Description
AFT_LANG_TRM (or TRF1) = 1	COG_AFT_STARTLANG_TRM (or TRF1) = 'en' and COG_AFT_LANGUAGE_TRM (or TRF1) = 'en'	AFT language of administration is English
AFT_LANG_TRM (or TRF1) = 2	COG_AFT_STARTLANG_TRM (or TRF1) = 'fr' and COG_AFT_LANGUAGE_TRM (or TRF1) = 'fr'	AFT language of administration is French
AFT_LANG = 1	IF AFT_LANG_TRM = 1 and AFT_LANG_TRF1 = 1	AFT was conducted in English at both baseline and at follow-up
AFT_LANG = 2	IF AFT_LANG_TRM = 2 and AFT_LANG_TRF1 = 2	AFT was conducted in French at both baseline and at follow-up
.	The conditions above were not met.	AFT language variables are missing or inconsistent
AF1_FU1_pred = CONSTANT + COEFF1 * COG_AF1_NORMED_ZSCORE_TRM + COEFF2 * delta_T_months, where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro-healthy norming sample	(AFT_LANG = 1 or 2)	Regression-based predicted AF1 score (using participant’s normed AF1 Z-score at baseline and time interval between tests)

**Derived Variable Specifications:**

Value	Condition(s)	Description
(COG_AF1_NORMED_ZSCORE_TRF1 – AF1_FU1_pred) / SD_residual where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	(AFT_LANG = 1 or 2)	The standardized difference between the participant's observed and predicted FU1 scores.

**7. AF1 Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_AF1\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_AF1\_CHNG\_ZSCORE\_TRF1 into one of three categories indicating the participant's change in performance since baseline: declined (-1), remained stable (0), or improved (+1) over time. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups).

**Based on:** COG\_AF1\_CHNG\_ZSCORE\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_AF1_CHNG_ZSCORE_TRF1 < -1.645	On AF1, participant's performance at follow-up declined since baseline.
0	COG_AF1_CHNG_ZSCORE_TRF1 ≥ -1.645 and COG_AF1_CHNG_ZSCORE_TRF1 < +1.645	On AF1, participant's performance at follow-up remained stable compared with baseline.
+1	COG_AF1_CHNG_ZSCORE_TRF1 > +1.645	On AF1, participant's performance at follow-up improved since baseline.

**8. AF2 Reliable Change Z-score**

**Derived Variable Name:** COG\_AF2\_CHNG\_ZSCORE\_TRF1

**Description:** This variable indicates the participant's change in performance on the AFT – lenient scoring (AF2) test between baseline testing and follow-up. It is normed for age, sex and education level and standardized ( $M=0$ ,  $SD=1$ ), relative to the neurologically healthy norming CLSA subsample. Norming and standardizing is done separately for English- and French-speaking participants



**Based on:**

COG_AFT_STARTLANG_TRM,	COG_AFT_LANG_TRM,
COG_AFT_STARTLANG_TRF1,	COG_AFT_LANG_TRF1,
COG_AF2_NORMED_ZSCORE_TRM,	COG_AF2_NORMED_ZSCORE_TRF1,
delta_T_months	

**Temporary Variables:** Four temporary variables are created. Three language variables are created for coding English or French test administration at baseline (AFT\_LANG\_TRM), at follow-up (AFT\_LANG\_TRF1) and at both times (AFT\_LANG). The variable AF2\_FU1\_pred is the participant’s predicted test score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

Value	Condition(s)	Description
AFT_LANG_TRM (or TRF1) = 1	COG_AFT_STARTLANG_TRM (or TRF1) = 'en' and COG_AFT_LANGUAGE_TRM (or TRF1) = 'en'	AFT language of administration is English
AFT_LANG_TRM (or TRF1) = 2	COG_AFT_STARTLANG_TRM (or TRF1) = 'fr' and COG_AFT_LANGUAGE_TRM (or TRF1) = 'fr'	AFT language of administration is French
AFT_LANG = 1	IF AFT_LANG_TRM = 1 and AFT_LANG_TRF1 = 1	AFT was conducted in English at both baseline and at follow-up
AFT_LANG = 2	IF AFT_LANG_TRM = 2 and AFT_LANG_TRF1 = 2	AFT was conducted in French at both baseline and at follow-up
.	The conditions above were not met.	AFT language variables are missing or inconsistent
AF2_FU1_pred = CONSTANT + COEFF1 * COG_AF2_NORMED_ZSCORE_TRM + COEFF2 * delta_T_months,  where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro-healthy norming sample	AFT_LANG = 1 or 2	Regression-based predicted AF2 score (using participant’s normed AF2 Z-score at baseline and time interval between tests)

**Derived Variable Specifications:**

Value	Condition(s)	Description
$(\text{COG\_AF2\_NORMED\_ZSCORE\_TRF1} - \text{AF2\_FU1\_pred}) / \text{SD\_residual}$  where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	(AFT_LANG = 1 or 2)	The standardized difference between the participant's observed and predicted FU1 scores.

**9. AF2 Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_AF2\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_AF2\_CHNG\_ZSCORE\_TRF1 into one of three categories indicating the participant's change in performance since baseline: declined (-1), remained stable (0), or improved (+1) over time. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups. When we analyze reliable change indices across a neuropsychological battery (i.e., did cognition improve, stay the same, or decline overall) we adjust for the frequency of change scores, which helps to offset this more lenient cut-off applied at the level of the individual test score).

**Based on:** COG\_AF2\_CHNG\_ZSCORE\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	$\text{COG\_AF2\_CHNG\_ZSCORE\_TRF1} < -1.645$	On AF1, participant's performance at follow-up declined since baseline.
0	$\text{COG\_AF2\_CHNG\_ZSCORE\_TRF1} \geq -1.645$ and $\text{COG\_AF2\_CHNG\_ZSCORE\_TRF1} < +1.645$	On AF1, participant's performance at follow-up remained stable compared with baseline.
+1	$\text{COG\_AF2\_CHNG\_ZSCORE\_TRF1} > +1.645$	On AF1, participant's performance at follow-up improved since baseline.

**10. MAT Reliable Change Z-score**

**Derived Variable Name:** COG\_MAT\_CHNG\_ZSCORE\_TRF1

**Description:** This variable indicates the participant's change in performance on the MAT test between baseline testing and follow-up. It is normed for age, sex and education level and standardized ( $M=0$ ,  $SD=1$ ), relative to the neurologically healthy norming CLSA subsample. Norming and standardizing is done separately for English- and French-speaking participants.

**Based on:**

COG\_MAT\_STARTLANG\_TRM, COG\_MAT\_LANG\_TRM,  
 COG\_MAT\_STARTLANG\_TRF1, COG\_MAT\_LANG\_TRF1,  
 COG\_MAT\_NORMED\_ZSCORE\_TRM, COG\_MAT\_NORMED\_ZSCORE\_TRF1,  
 delta\_T\_months

**Temporary Variables:** Four temporary variables are created. Three language variables are created for coding English or French test administration at baseline (MAT\_LANG\_TRM), at follow-up (MAT\_LANG\_TRF1) and at both times (MAT\_LANG). The variable MAT\_FU1\_pred is the participant's predicted test score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

Value	Condition(s)	Description
MAT_LANG_TRM (or TRF1) = 1	COG_MAT_STARTLANG_TRM (or TRF1) = 'en' and COG_MAT_LANGUAGE_TRM (or TRF1) = 'en'	MAT language of administration is English
MAT_LANG_TRM (or TRF1) = 2	COG_MAT_STARTLANG_TRM (or TRF1) = 'fr' and COG_MAT_LANGUAGE_TRM (or TRF1) = 'fr'	MAT language of administration is French
MAT_LANG = 1	IF MAT_LANG_TRM = 1 and MAT_LANG_TRF1 = 1	MAT was conducted in English at both baseline and at follow-up
MAT_LANG = 2	IF MAT_LANG_TRM = 2 and MAT_LANG_TRF1 = 2	MAT was conducted in French at both baseline and at follow-up
.	The conditions above were not met.	MAT language variables are missing or inconsistent
MAT_FU1_pred = CONSTANT + COEFF1 * COG_MAT_NORMED_ZSCORE_TRM + COEFF2 * delta_T_months,  where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro-healthy norming sample	(MAT_LANG = 1 or 2)	Regression-based predicted MAT score (using participant's normed MAT Z-score at baseline and time interval between tests)

**Derived Variable Specifications:**

Value	Condition(s)	Description
(COG_MAT_NORMED_ZSCORE_TRF1 – MAT_FU1_pred) / SD_residual where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	MAT_LANG = 1 or 2	The standardized difference between the participant's observed and predicted FU1 scores.

**11. MAT Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_MAT\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_MAT\_CHNG\_ZSCORE\_TRF1 into one of three categories indicating the participant's change in performance since baseline: declined (-1), remained stable (0), or improved (+1) over time. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups. When we analyze reliable change indices across a neuropsychological battery (i.e., did cognition improve, stay the same, or decline overall) we adjust for the frequency of change scores, which helps to offset this more lenient cut-off applied at the level of the individual test score).

**Based on:** COG\_MAT\_CHNG\_ZSCORE\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_MAT_CHNG_ZSCORE_TRF1 < -1.645	On MAT, participant's performance at follow-up declined since baseline.
0	COG_MAT_CHNG_ZSCORE_TRF1 $\geq$ -1.645 and COG_MAT_CHNG_ZSCORE_TRF1 < +1.645	On MAT, participant's performance at follow-up remained stable compared with baseline.
+1	COG_MAT_CHNG_ZSCORE_TRF1 > +1.645	On MAT, participant's performance at follow-up improved since baseline.

**12. MAT Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_CONSTR\_MEM\_CHNG\_TRF1

**Description:** This variable indicates the participant's change in performance on memory, a latent variable constructed from REY I and REY II scores normed for age, sex and education level. It is based on the change in the constructed memory latent variables from baseline to the first follow-up. The memory change score is a z-score, standardized relative to the neuro-healthy norming sample (separately for English and French). It is only available for participants who have normed scores on Rey I and Rey II at both baseline and follow-up.

**Based on:**

COG\_CONSTR\_MEM\_TRM,  
REYI\_LANG,  
REYII\_LANG,  
delta\_T\_months

COG\_CONSTR\_MEM\_TRF1,  
AFT\_LANG,  
MAT\_LANG,

**Temporary Variables:** Two temporary variables are created. One is a language variable, COG\_4TESTS\_LANG, created for coding English or French test administration at baseline and at follow-up. It uses the temporary variables for language of administration created for the individual tests, as described above: REYI\_LANG, REYII\_LANG, AFT\_LANG, and MAT\_LANG. The second variable, MEM\_FU1\_pred, is the participant’s predicted memory score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

Value	Condition(s)	Description
COG_4TESTS_LANG = 1	REYI_LANG = 'en' and REYII_LANG = 'en' and AFT_LANG = 'en' and MAT_LANG = 'en'	Language of administration of all 4 tests at both baseline and FU1 is English
COG_4TESTS_LANG = 2	REYI_LANG = 'fr' and REYII_LANG = 'fr' and AFT_LANG = 'fr' and MAT_LANG = 'fr'	Language of administration of all 4 tests at both baseline and FU1 is French
.	The conditions above were not met.	Language variables are missing or inconsistent
MEM_FU1_pred = CONSTANT + COEFF1 * COG_CONSTR_MEM_TRM + COEFF2 * delta_T_months,  where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro- healthy norming sample	COG_4TESTS_LANG = 1 or 2	Regression-based predicted MEM score

**Derived Variable Specifications:**

Value	Condition(s)	Description
$(\text{COG\_CONSTR\_MEM\_TRF1} - \text{MEM\_FU1\_pred}) / \text{SD\_residual}$  where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	COG_4TESTS_LANG = 1 or 2	The standardized difference between the participant’s observed and predicted FU1 scores.

### 13. Memory Composite (MEM) Reliable Change Indicator (RCI)

**Derived Variable Name:** COG\_CONSTR\_MEM\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_CONSTR\_MEM\_CHNG\_TRF1 into one of three categories indicating the participant’s change since baseline: declined (-1), remained stable (0), or improved (+1) over time. The recoding is language invariant. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups).

**Based on:** COG\_CONSTR\_MEM\_CHNG\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_CONSTR_MEM_CHNG_TRF1 < -1.645	Participant’s memory performance at follow-up declined since baseline.
0	COG_CONSTR_MEM_CHNG_TRF1 ≥ -1.645 and COG_CONSTR_MEM_CHNG_TRF1 < 1.645	Participant’s memory performance at follow-up remained stable compared with baseline.
+1	COG_CONSTR_MEM_CHNG_TRF1 ≥ 1.645	Participant’s memory performance at follow-up improved since baseline.

### 14. Executive Function (EF) Composite Reliable Change Z-score

**Derived Variable Name:** COG\_CONSTR\_EF\_CHNG\_TRF1

**Description:** This variable indicates the participant’s change in performance on executive function, a latent variable constructed from AF2 and MAT scores normed for age, sex and education level. It is based on the change in the constructed executive function latent variables from baseline to the first follow-up. The executive function change score is a z-score, standardized relative to the neuro-healthy norming sample (separately for English and French).

It is only available for participants who have normed scores on the AFT and MAT at both baseline and follow-up.

**Based on:**

COG_CONSTR_EF_TRM,	COG_CONSTR_EF_TRF1,
REYI_LANG,	AFT_LANG,
REYII_LANG,	MAT_LANG,
delta_T_months	

**Temporary Variables:** Two temporary variables are created. One is a language variable, COG\_4TESTS\_LANG, created for coding English or French test administration at baseline and at follow-up, same as for the memory construct above. The second variable, EF\_FU1\_pred, is the participant’s predicted executive function score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

Value	Condition(s)	Description
COG_4TESTS_LANG = 1	REYI_LANG = 'en' and REYII_LANG = 'en' and AFT_LANG = 'en' and MAT_LANG = 'en'	Language of administration of all 4 tests at both baseline and FU1 is English
COG_4TESTS_LANG = 2	REYI_LANG = 'fr' and REYII_LANG = 'fr' and AFT_LANG = 'fr' and MAT_LANG = 'fr'	Language of administration of all 4 tests at both baseline and FU1 is French
.	The conditions above were not met.	Language variables are missing or inconsistent
EF_FU1_pred = CONSTANT + COEFF1 * COG_CONSTR_EF_TRM + COEFF2 * delta_T_months,  Where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro- healthy norming sample	COG_4TESTS_LANG = 1 or 2	Regression-based predicted EF score

**Derived Variable Specifications:**

Value	Condition(s)	Description
(COG_CONSTR_EF_TRF1 – EF_FU1_pred) / SD_residual  where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro- healthy norming sample	COG_4TESTS_LANG = 1 or 2	The standardized difference between the participant's observed and predicted FU1 scores.

**15. Executive Function (EF) Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_CONSTR\_EF\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_CONSTR\_EF\_CHNG\_TRF1 into one of three categories indicating the participant's change since baseline: declined (-1), remained stable (0), or improved (+1) over time. The recoding is language invariant. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups).

**Based on:** COG\_CONSTR\_EF\_CHNG\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_CONSTR_EF_CHNG_TRF1 < -1.645	Participant's executive function performance at follow-up declined since baseline.
0	COG_CONSTR_EF_CHNG_TRF1 ≥ -1.645 and COG_CONSTR_EF_CHNG_TRF1 < 1.645	Participant's executive function performance at follow-up remained stable compared with baseline.
+1	COG_CONSTR_EF_CHNG_TRF1 ≥ 1.645	Participant's executive function performance at follow-up improved since baseline.

**16. Overall Cognition (OVERALLCOG) Composite Reliable Change Z-score**

**Derived Variable Name:** COG\_CONSTR\_OVERALLCOG\_CHNG\_TRF1

**Description:** This variable indicates the participant's change in performance on overall cognition, a latent variable constructed from all four test scores normed for age, sex and education level. It is based on the change in the constructed overall cognition latent variables from baseline to the first follow-up. The change score is a z-score, standardized relative to the neuro-healthy norming sample (separately for English and French). It is only available for participants who have normed scores on the all four tests at both baseline and follow-up.

**Based on:**

COG\_CONSTR\_OVERALLCOG\_TRM, COG\_CONSTR\_OVERALLCOG\_TRF1,  
REYI\_LANG, AFT\_LANG,  
REYII\_LANG, MAT\_LANG,  
delta\_T\_months

**Temporary Variables:** Two temporary variables are created. One is a language variable, COG\_4TESTS\_LANG, created for coding English or French test administration at baseline and at follow-up, same as for the memory construct above. The second variable, OVERALL\_FU1\_pred, is the participant's predicted overall cognition score based on her/his language of administration, baseline test score and time interval between testing. These variables are not included in the CLSA dataset but the procedures are included to detail the steps used in derivation.

Value	Condition(s)	Description
COG_4TESTS_LANG = 1	REYI_LANG = 'en' and REYII_LANG = 'en' and AFT_LANG = 'en' and MAT_LANG = 'en'	Language of administration of all 4 tests at both baseline and FU1 is English
COG_4TESTS_LANG = 2	REYI_LANG = 'fr' and REYII_LANG = 'fr' and AFT_LANG = 'fr' and MAT_LANG = 'fr'	Language of administration of all 4 tests at both baseline and FU1 is French



Value	Condition(s)	Description
.	The conditions above were not met.	Language variables are missing or inconsistent
$OVERALL\_FU1\_pred = CONSTANT + COEFF1 * COG\_CONSTR\_OVERALLCOG\_TRM + COEFF2 * delta\_T\_months,$ where CONSTANT, COEFF1 and COEFF2 are estimates from linear regression models obtained from the neuro-healthy norming sample	COG_4TESTS_LANG = 1 or 2	Regression-based predicted overall cognition score

**Derived Variable Specifications:**

Value	Condition(s)	Description
$(COG\_CONSTR\_OVERALLCOG\_TRF1 - OVERALL\_FU1\_pred) / SD\_residual$  where SD_RESID is the standard deviation of the residuals (predicted – observed) obtained from the neuro-healthy norming sample	COG_4TESTS_LANG = 1 or 2	The standardized difference between the participant's observed and predicted FU1 scores.

**17. Overall Cognition (OVERALL) Reliable Change Indicator (RCI)**

**Derived Variable Name:** COG\_CONSTR\_OVERALLCOG\_RCI\_TRF1

**Description:** This variable is a recoding of COG\_CONSTR\_OVERALLCOG\_CHNG\_TRF1 into one of three categories indicating the participant's change since baseline: declined (-1), remained stable (0), or improved (+1) over time. The recoding is language invariant. (Note: the convention in reliable change indices is to use a cut-off of  $z=1.645$ . You can apply any cut-off you wish and create your own three groups).

**Based on:** COG\_CONSTR\_OVERALLCOG\_CHNG\_TRF1

**Derived Variable Specifications:**

Value	Condition(s)	Description
-1	COG_CONSTR_OVERALLCOG_CHNG_TRF1 < -1.645	Participant's overall cognition at follow-up declined since baseline.
0	COG_CONSTR_OVERALLCOG_CHNG_TRF1 ≥ -1.645 and COG_CONSTR_OVERALLCOG_CHNG_TRF1 < 1.645	Participant's overall cognition at follow-up remained stable compared with baseline.

Value	Condition(s)	Description
+1	COG_CONSTR_OVERALLCOG_CHNG_TRF1 ≥ 1.645	Participant's overall cognition at follow-up improved since baseline.

**References:**

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