NIH Toolbox

Technical Manual

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NIH Toolbox Technical Manual

Domain:

COGNITION

Subdomain:

LANGUAGE

Measure:

NIH Toolbox Oral Reading Recognition Test

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This Technical Manual contains the following informational sections:

Section 1:   Introduction to NIH Toolbox

Section 2:   Validation

Section 3:   Norming

Section 4:   NIH Toolbox and the National Children's Study (NCS)

Section 5:   Domain Definition

Section 6:   Subdomain Definition

Section 7:   Measure Description

Section 8:   Post-Validation/Post-Norming Changes to the Measure

Section 9:   The Measure's Scoring Model

Section 10:   Measure Norms-English

Section 11:   Measure Norms-Spanish

Section 1:   Introduction to NIH Toolbox

NIH Toolbox is a multidimensional set of brief measures assessing cognitive, emotional, motor, and sensory function from ages 3-85. This suite of on-line and royalty-free measures can be administered to study participants 3 to 85 years of age in two hours or less, across diverse study designs and settings.

What is the NIH Toolbox?

The NIH Toolbox provides a standard set of royalty-free, brief, and comprehensive assessment tools that can be used by researchers and clinicians in a variety of settings, with a particular emphasis on measuring outcomes in longitudinal epidemiologic studies and prevention or intervention trials across the lifespan (ages 3-85). The battery ensures that assessment methods and results can be used for comparisons across existing and future studies and provides a "common currency" for the study of neurological research that promotes economies of scale and enhanced efficiency in measurement. The NIH Toolbox can be used to monitor neurological and behavioral function over time and measure key constructs across developmental stages. This facilitates the study of functional changes across the lifespan, including evaluating intervention and treatment effectiveness.

The NIH Toolbox Batteries

The basic NIH Toolbox can be administered within two hours and divides tests into four domain batteries: Cognition, Emotion, Motor, and Sensation. In addition, within some domains, there are supplemental measures that are available to be administered.

Selection of the NIH Toolbox Domains and Subdomains

Four domains were selected for the NIH Toolbox: Cognition, Emotion, Motor, and Sensation. Subdomain selection was based upon literature reviews, expert interviews, and multiple formal Requests for Information (RFI) of NIH-funded researchers. Initial literature and database reviews and an RFI identified the subdomains for inclusion in the NIH Toolbox, existing measures relevant to the project goals, and criteria for instrument selection. NIH Project Team members, external content experts, and contract scientists met at a follow-up consensus meeting to discuss potential subdomains along with the criteria affecting instrument selection, creation, and norming. Additional expert interviews were undertaken to gather more detailed information from clinical and scientific experts to help further refine the list of possible subdomains. A second consensus group meeting was held and results directed the decision for the final NIH Toolbox to assess four core domain areas (cognitive, emotional, motor, and sensory health and function).

Selection of Measures for the NIH Toolbox

More than 1,400 existing measures were identified and evaluated for potential inclusion in the NIH Toolbox. The selection criteria included a measure's applicability across the life span,

psychometric soundness, brevity, ease of use, applicability in diverse settings and with different groups, and lack of intellectual property constraints. There was also a preference for instruments that were already validated and normed for use with individuals between 3 and 85 years old. Results of the instrument selection process yielded draft development plans established for the NIH Toolbox measures.

Early Childhood Use

NIH Toolbox measure development focused special attention on assessing young children, to ensure that all tests given are developmentally appropriate for ages 3-7. A special team of early childhood assessment consultants was engaged to provide testing guidelines for the very young, to offer input on measure development, and to review all NIH Toolbox measures to ensure they fit the needs of young children. Advanced statistical methods were used to emphasize continuity of measurement, allowing Toolbox users to confidently conduct longitudinal measurement from age 3 through the life span while assessing the same domain constructs.

Section 2: Validation

Validation studies were conducted for all NIH Toolbox Cognition domain measures, to assure that these important tools for research met rigorous psychometric standards. Studies were

conducted across the entire age range and were statistically compared against "gold standard" measures wherever available.

For specifics regarding Cognition domain measure validation, see Weintraub et al., Cognition Assessment Using the NIH Toolbox, *Neurology*, in press. This manuscript describes measure development studies undertaken (e.g., expert panels for content development and validation; cognitive interviews; small and large-scale pilot testing) and psychometric characteristics (e.g., internal consistency and test-retest reliability; convergent and divergent validity).

Section 3:   Norming

NIH Toolbox conducted a large national standardization study in both English and Spanish languages to allow for normative comparisons on each assessment. A sample of 4,859 participants, ages 3-85 – representative of the U.S. population based on gender, ethnicity, race, and socioeconomic status – was administered all of the NIH Toolbox measures at sites around the country (n = 2,917 English-speaking children, ages 3-17; n = 496 Spanish-speaking children, ages 3-7; n = 1,038 English-speaking adults, ages 18-85; n = 408 Spanish-speaking adults, ages 18-85). NIH Toolbox normative scores are now available for each year of age from 3 through 17, as well as for age ranges 18-29, 30-39, 40-49, 50-59, 60-69, and 70-85, allowing for targeted and accurate comparisons to the U.S. population.

Specifics regarding NIH Toolbox norming sampling methods (e.g., stratification by age, gender, and language preference; sampling a minimum of 25-100 individuals per targeted demographic and language subgroup) and norming analytic methods (e.g., post-stratification adjustment using iterative proportional fitting, i.e., "raking") can be found in the following publication: Beaumont et al., Norming Plans for the NIH Toolbox, *Neurology*, in press.

Section 4: NIH Toolbox and the National Children's Study (NCS)

In collaboration with NIH Toolbox scientists, NCS investigators selected measures from PROMIS and NIH Toolbox for a Maternal Health Profile, the Maternal Self-Reported Health Battery. This profile assesses Physical Health (Physical function, Fatigue, Sleep disturbance, Sleep-related impairment), Mental Health (Anger, Anxiety, Depression, Positive affect, Perceived stress, Self-efficacy), and Social Health (Social support and companionship, Social isolation). The Maternal Self-Reported Health Battery was field tested in fall 2011, using an online sample of 1000 women (200 pre-conception, 150 pregnant women (50 per trimester), and 650 mothers with a child between 0-36 months of age). In addition, NIH Toolbox norming was jointly sponsored by the NCS and included: 3,413 children in single-year age bands (from 3-17 years); 1,446 adults in seven age bands, including the mothers of children also being tested; and 105 pregnant women. The NIH Toolbox sampling plan matched distributions of race/ethnicity and level of education for each age band.

Section 5:　　Domain Definition

Domain:　　**COGNITION**

Cognition refers to the mental processes involved in gaining knowledge and comprehension. It includes processes such as thinking, knowing, remembering, judging, and problem-solving. These higher-level functions of the brain encompass language, imagination, perception, and the planning and execution of complex behaviors. Measurement of cognition is essential to any study of health and well-being and should be included in large-scale epidemiologic studies and experimental studies of health and development, even when the target of the study is not cognition itself. The Cognition domain includes measures of:

EXECUTIVE FUNCTION

Measured by:

NIH Toolbox Flanker Inhibitory Control and Attention Test

NIH Toolbox Dimensional Change Card Sort Test

ATTENTION

Measured by:

NIH Toolbox Flanker Inhibitory Control and Attention Test

EPISODIC MEMORY

Measured by:

NIH Toolbox Picture Sequence Memory Test

NIH Toolbox Auditory Verbal Learning Test (Rey) (Supplemental Measure)

LANGUAGE

Measured by:

NIH Toolbox Picture Vocabulary Test

NIH Toolbox Oral Reading Recognition Test

PROCESSING SPEED

Measured by:

NIH Toolbox Pattern Comparison Processing Speed Test

NIH Toolbox Oral Symbol Digit Test (Supplemental Measure)

WORKING MEMORY

Measured by:

NIH Toolbox List Sorting Working Memory Test

Section 6:   Subdomain Definition

Subdomain: LANGUAGE

Language refers to a set of mental processes that translate thought into symbols (e.g., words, gestures) that can be shared among individuals for purposes of communication. NIH Toolbox focuses on two aspects of language. The first is receptive word knowledge, which is fundamental to learning and has a very high association with overall intelligence (or what has been called the "g-factor"). The second aspect taps reading, which is defined as the cognitive process of deriving meaning from text, and is reflective of the level and quality of prior educational experiences. An oral reading measure provides a fairly robust indication of verbal intelligence that is relatively undisturbed by many medical conditions that affect the brain. In NIH Toolbox, Language is measured by:

> NIH Toolbox Picture Vocabulary Test
>
> NIH Toolbox Oral Reading Recognition Test

Section 7:   Measure Description

COGNITION Core Measure

In the NIH Toolbox Oral Reading Recognition Test (Reading), the participant is asked to read and pronounce letters and words as accurately as possible. The test administrator scores them as

right or wrong. For the youngest children, the initial items require them to identify letters (as opposed to symbols) and to identify a specific letter in an array of four symbols. The test is given via a computerized adaptive format and requires approximately three minutes. This test is recommended for ages 7-85, but is available for use as young as age 3, if desired. Separate but parallel reading tests have been developed in English and in Spanish.

Section 8: Post-Validation/Post-Norming Changes to the Measure

In addition to those changes previously reported on during the measure's development and validation phases (Weintraub et al., Cognition Assessment Using the NIH Toolbox, *Neurology*, in press), the following changes have been made to this measure:

Item exclusions: Based on follow-up psychometric evaluations, an additional 26 English-version items and 101 Spanish-version items were excluded (English-version item bank reduced from 289 to 263 items; Spanish-version item bank reduced from 263 to 162 items).

Item-level parameter changes: English item calibrations were updated and Spanish item calibrations were developed based on the norming sample.

The following item-selection rule for the computer adaptive test was chosen for all age groups: Select an item in the bank that the respondent has the probability=0.50 of a correct answer (given the current estimate of his/her ability level).

Test scoring changes:

The "ceiling rule" was changed to seven-in-a-row incorrect rather than 10 (i.e., testing is stopped when an examinee incorrectly answers seven successive items.

Test administration changes:

The test was changed to a variable-length computer-adaptive test with 20-30 items. Items are administered adaptively until a respondent has answered 20-30 items. The test is recommended for ages 7+, but it can successfully be administered to younger ages (i.e., ages 3-6).

Section 9:   The Measure's Scoring Model

Measurement theory applied for scoring:

Rasch/Item Response Theory (IRT)

Rasch/IRT model employed:

Rasch Dichotomous Model

Measure length:

Variable (computer-adaptive test: maximum 30 items)

Response data:

Dichotomous (correct, incorrect)

Scores computed/available*:

Rasch/IRT Theta Score

Age-Adjusted Scale Score (mean=100, standard deviation=15)

Fully Adjusted Scale Score (mean=100, standard deviation=15)

Unadjusted Scale Score (mean=100, standard deviation=15)

National Percentile Rank (corresponds to the Age-Adjusted Scale Score)

Computed Score (converted from Theta score; range from 200 to 2500)

*Details on these scores and their interpretations are available in the NIH Toolbox Scoring and Interpretation Guide.

Section 10:   Measure Norms-English

The following Tables and Figure present NIH Toolbox normative data associated with this measure:

Table 1.   **Measure Raw/Computed Score, Unadjusted Scale Score, and Fully Adjusted Scale Score Summary (N, Mean, Standard Deviation) by Age Group (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85, All)**

Table 2.   **Measure Raw/Computed Score Statistics (N, Mean, Standard Deviation, Minimum/Maximum Observed, 25th/50th/75th Percentile) per Age Group (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85, All)**

Figure 1.   **Measure Mean Unadjusted Scale Scores across All Age Groups (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85)**

Table 1. NIH Toolbox Oral Reading Recognition Test-English by Age Group	Oral Reading Recognition Test-English (theta)			Reading - English Unadjusted Scale Score			Reading - English Fully Adjusted Scale Score		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Age Group									
3	24	-16.41	2.45	24	69.94	3.03	24	72.09	6.74
4	37	-15.07	2.20	37	71.94	2.56	34	97.98	11.44
5	60	-11.89	3.03	60	75.16	3.01	58	97.99	15.35
6	97	-7.14	2.36	97	78.81	2.49	92	99.67	12.03
7	128	-4.24	2.11	128	82.97	3.29	121	99.68	9.88
8	183	-2.76	1.97	183	86.18	3.76	175	99.78	8.09
9	166	-0.99	1.43	166	90.85	3.86	159	98.75	6.63
10	186	-0.92	2.26	186	92.40	4.77	170	100.50	7.41
11	187	0.63	1.11	187	96.65	4.06	176	98.25	6.74
12	176	0.85	1.62	176	98.08	4.40	166	98.99	6.89
13	199	1.62	1.42	199	101.04	4.88	191	98.73	7.16
14	189	2.40	1.31	189	104.10	5.03	182	98.33	7.66
15	201	2.43	1.16	201	104.09	4.87	195	98.19	7.53
16	191	3.08	1.73	191	107.22	6.07	182	98.75	8.11
17	207	3.24	1.40	207	107.39	5.49	200	97.54	7.65
18 - 29	159	4.04	6.87	159	111.16	22.99	155	98.63	28.10
30 - 39	187	4.22	5.55	187	112.18	18.22	182	99.00	23.40
40 - 49	146	4.56	6.96	146	113.97	22.29	140	99.29	27.48
50 - 59	118	3.24	12.69	118	110.64	32.26	113	102.51	33.66
60 - 69	106	4.05	10.17	106	113.00	27.16	105	102.00	31.95
70 - 85	175	4.16	5.97	175	112.58	18.16	162	99.90	21.33
All	3122	3.08	5.44	3122	108.79	15.73	2982	99.75	16.28

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 3	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	13	11	24	0	0	0	13	11	24
Mean	-16.57	-16.15	-16.41				-16.57	-16.15	-16.41
Standard Deviation	2.58	2.39	2.45				2.58	2.39	2.45
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
50th Percentile (Median)	-16.55	-16.02	-16.02				-16.55	-16.02	-16.02
75th Percentile	-14.58	-15.33	-14.58				-14.58	-15.33	-14.58
Maximum Observed	-8.26	-7.62	-7.62				-8.26	-7.62	-7.62

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 4	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	23	14	37	0	0	0	23	14	37
Mean	-15.52	-14.12	-15.07				-15.52	-14.12	-15.07
Standard Deviation	2.11	2.31	2.20				2.11	2.31	2.20
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	-16.99	-15.40	-16.03				-16.99	-15.40	-16.03
50th Percentile (Median)	-16.02	-15.33	-15.33				-16.02	-15.33	-15.33
75th Percentile	-14.35	-13.47	-13.79				-14.35	-13.47	-13.79
Maximum Observed	-8.92	-4.33	-4.33				-8.92	-4.33	-4.33

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 5	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	26	34	60	0	0	0	26	34	60
Mean	-11.75	-12.06	-11.89				-11.75	-12.06	-11.89
Standard Deviation	3.52	2.65	3.03				3.52	2.65	3.03
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	-15.36	-15.33	-15.33				-15.36	-15.33	-15.33
50th Percentile (Median)	-14.35	-13.78	-13.79				-14.35	-13.78	-13.79
75th Percentile	-8.03	-9.75	-9.33				-8.03	-9.75	-9.33
Maximum Observed	-2.49	-1.01	-1.01				-2.49	-1.01	-1.01

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 6	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	45	52	97	0	0	0	45	52	97
Mean	-7.64	-6.51	-7.14				-7.64	-6.51	-7.14
Standard Deviation	2.81	1.84	2.36				2.81	1.84	2.36
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	-9.77	-8.59	-9.22				-9.77	-8.59	-9.22
50th Percentile (Median)	-7.29	-6.39	-7.05				-7.29	-6.39	-7.05
75th Percentile	-4.53	-4.34	-4.34				-4.53	-4.34	-4.34
Maximum Observed	-2.21	-0.99	-0.99				-2.21	-0.99	-0.99

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 7		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	67	61	128	0	0	0	67	61	128
	Mean	-4.71	-3.45	-4.24				-4.71	-3.45	-4.24
	Standard Deviation	2.47	1.55	2.11				2.47	1.55	2.11
	Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
	25th Percentile	-6.10	-5.32	-5.50				-6.10	-5.32	-5.50
	50th Percentile (Median)	-4.00	-2.88	-3.61				-4.00	-2.88	-3.61
	75th Percentile	-2.71	-1.46	-2.05				-2.71	-1.46	-2.05
	Maximum Observed	0.83	0.32	0.83				0.83	0.32	0.83

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 8		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	92	91	183	0	0	0	92	91	183
	Mean	-3.04	-2.35	-2.76				-3.04	-2.35	-2.76
	Standard Deviation	2.35	1.47	1.97				2.35	1.47	1.97
	Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
	25th Percentile	-3.61	-3.04	-3.58				-3.61	-3.04	-3.58
	50th Percentile (Median)	-2.30	-2.09	-2.25				-2.30	-2.09	-2.25
	75th Percentile	-1.00	-0.97	-1.00				-1.00	-0.97	-1.00
	Maximum Observed	3.25	2.63	3.25				3.25	2.63	3.25

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 9	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	83	83	166	0	0	0	83	83	166
Mean	-1.19	-0.68	-0.99				-1.19	-0.68	-0.99
Standard Deviation	1.82	0.88	1.43				1.82	0.88	1.43
Minimum Observed	-20.00	-4.97	-20.00				-20.00	-4.97	-20.00
25th Percentile	-2.01	-1.75	-1.93				-2.01	-1.75	-1.93
50th Percentile (Median)	-0.84	-0.83	-0.84				-0.84	-0.83	-0.84
75th Percentile	0.38	0.08	0.18				0.38	0.08	0.18
Maximum Observed	4.56	8.47	8.47				4.56	8.47	8.47

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 10	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	97	89	186	0	0	0	97	89	186
Mean	-1.11	-0.59	-0.92				-1.11	-0.59	-0.92
Standard Deviation	2.87	1.31	2.26				2.87	1.31	2.26
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	-1.61	-0.88	-1.42				-1.61	-0.88	-1.42
50th Percentile (Median)	-0.06	-0.39	-0.27				-0.06	-0.39	-0.27
75th Percentile	0.63	0.44	0.56				0.63	0.44	0.56
Maximum Observed	8.48	2.66	8.48				8.48	2.66	8.48

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 11	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	94	93	187	0	0	0	94	93	187
Mean	0.66	0.59	0.63				0.66	0.59	0.63
Standard Deviation	1.32	0.84	1.11				1.32	0.84	1.11
Minimum Observed	-20.00	-3.67	-20.00				-20.00	-3.67	-20.00
25th Percentile	-0.35	-0.40	-0.40				-0.35	-0.40	-0.40
50th Percentile (Median)	0.61	0.19	0.45				0.61	0.19	0.45
75th Percentile	1.84	1.63	1.68				1.84	1.63	1.68
Maximum Observed	6.40	5.65	6.40				6.40	5.65	6.40

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 12	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	86	90	176	0	0	0	86	90	176
Mean	0.41	1.44	0.85				0.41	1.44	0.85
Standard Deviation	2.13	0.83	1.62				2.13	0.83	1.62
Minimum Observed	-20.00	-3.15	-20.00				-20.00	-3.15	-20.00
25th Percentile	-0.39	0.34	-0.11				-0.39	0.34	-0.11
50th Percentile (Median)	0.72	1.54	0.93				0.72	1.54	0.93
75th Percentile	1.92	2.43	2.21				1.92	2.43	2.21
Maximum Observed	5.32	6.56	6.56				5.32	6.56	6.56

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 13	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	106	93	199	0	0	0	106	93	199
Mean	1.72	1.44	1.62				1.72	1.44	1.62
Standard Deviation	1.41	1.44	1.42				1.41	1.44	1.42
Minimum Observed	-5.65	-20.00	-20.00				-5.65	-20.00	-20.00
25th Percentile	0.77	0.59	0.70				0.77	0.59	0.70
50th Percentile (Median)	1.89	1.66	1.87				1.89	1.66	1.87
75th Percentile	2.92	2.73	2.92				2.92	2.73	2.92
Maximum Observed	9.31	5.62	9.31				9.31	5.62	9.31

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 14	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	97	92	189	0	0	0	97	92	189
Mean	2.55	2.16	2.40				2.55	2.16	2.40
Standard Deviation	1.50	1.09	1.31				1.50	1.09	1.31
Minimum Observed	-20.00	-10.37	-20.00				-20.00	-10.37	-20.00
25th Percentile	1.02	0.80	0.88				1.02	0.80	0.88
50th Percentile (Median)	2.41	2.23	2.40				2.41	2.23	2.40
75th Percentile	3.71	3.74	3.72				3.71	3.74	3.72
Maximum Observed	8.64	6.47	8.64				8.64	6.47	8.64

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 15		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	103	98	201	0	0	0	103	98	201
	Mean	2.57	2.24	2.43				2.57	2.24	2.43
	Standard Deviation	1.28	1.03	1.16				1.28	1.03	1.16
	Minimum Observed	-3.90	-2.59	-3.90				-3.90	-2.59	-3.90
	25th Percentile	1.30	0.98	1.10				1.30	0.98	1.10
	50th Percentile (Median)	2.37	2.34	2.37				2.37	2.34	2.37
	75th Percentile	3.66	3.53	3.64				3.66	3.53	3.64
	Maximum Observed	8.05	7.80	8.05				8.05	7.80	8.05

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 16		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	94	97	191	0	0	0	94	97	191
	Mean	3.24	2.86	3.08				3.24	2.86	3.08
	Standard Deviation	1.63	1.82	1.73				1.63	1.82	1.73
	Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
	25th Percentile	1.91	1.61	1.76				1.91	1.61	1.76
	50th Percentile (Median)	3.26	2.96	3.08				3.26	2.96	3.08
	75th Percentile	4.75	4.57	4.75				4.75	4.57	4.75
	Maximum Observed	8.68	8.62	8.68				8.68	8.62	8.68

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 17		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	102	105	207	0	0	0	102	105	207
	Mean	3.28	3.18	3.24				3.28	3.18	3.24
	Standard Deviation	1.42	1.38	1.40				1.42	1.38	1.40
	Minimum Observed	-2.60	-2.22	-2.60				-2.60	-2.22	-2.60
	25th Percentile	1.74	1.68	1.71				1.74	1.68	1.71
	50th Percentile (Median)	3.16	3.11	3.12				3.16	3.11	3.12
	75th Percentile	4.37	4.21	4.32				4.37	4.21	4.32
	Maximum Observed	9.54	20.00	20.00				9.54	20.00	20.00

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 18-29		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	55	104	159	0	0	0	55	104	159
	Mean	4.68	3.46	4.04				4.68	3.46	4.04
	Standard Deviation	5.89	7.20	6.87				5.89	7.20	6.87
	Minimum Observed	-0.58	-20.00	-20.00				-0.58	-20.00	-20.00
	25th Percentile	3.27	1.82	2.59				3.27	1.82	2.59
	50th Percentile (Median)	4.48	3.83	4.17				4.48	3.83	4.17
	75th Percentile	6.86	5.07	5.60				6.86	5.07	5.60
	Maximum Observed	9.00	20.00	20.00				9.00	20.00	20.00

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 30-39	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	46	141	187	0	0	0	46	141	187
Mean	4.16	4.25	4.22				4.16	4.25	4.22
Standard Deviation	6.78	5.11	5.55				6.78	5.11	5.55
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	2.74	2.74	2.74				2.74	2.74	2.74
50th Percentile (Median)	4.98	4.37	4.47				4.98	4.37	4.47
75th Percentile	6.15	5.94	5.99				6.15	5.94	5.99
Maximum Observed	8.41	10.06	10.06				8.41	10.06	10.06

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 40-49	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	54	92	146	0	0	0	54	92	146
Mean	4.79	4.37	4.56				4.79	4.37	4.56
Standard Deviation	6.29	7.34	6.96				6.29	7.34	6.96
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	3.24	2.92	3.22				3.24	2.92	3.22
50th Percentile (Median)	4.65	4.73	4.65				4.65	4.73	4.65
75th Percentile	6.85	6.54	6.68				6.85	6.54	6.68
Maximum Observed	10.06	10.06	10.06				10.06	10.06	10.06

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 50-59	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	48	70	118	0	0	0	48	70	118
Mean	3.62	2.79	3.24				3.62	2.79	3.24
Standard Deviation	13.09	12.45	12.69				13.09	12.45	12.69
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	3.02	1.93	2.72				3.02	1.93	2.72
50th Percentile (Median)	4.15	4.38	4.18				4.15	4.38	4.18
75th Percentile	6.28	6.19	6.28				6.28	6.19	6.28
Maximum Observed	9.16	9.56	9.56				9.16	9.56	9.56

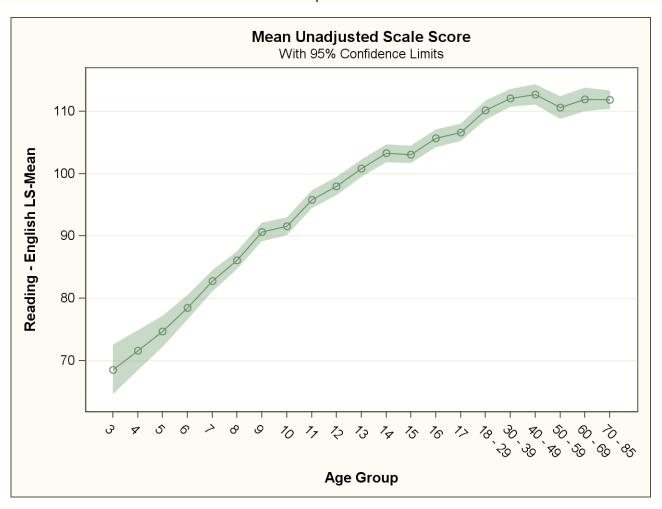| Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 60-69	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	44	62	106	0	0	0	44	62	106
Mean	4.21	3.88	4.05				4.21	3.88	4.05
Standard Deviation	11.25	9.41	10.17				11.25	9.41	10.17
Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
25th Percentile	2.85	3.05	2.97				2.85	3.05	2.97
50th Percentile (Median)	4.80	4.53	4.57				4.80	4.53	4.57
75th Percentile	6.91	6.68	6.83				6.91	6.68	6.83
Maximum Observed	9.36	8.89	9.36				9.36	8.89	9.36

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – Age 70-85		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	82	93	175	0	0	0	82	93	175
	Mean	4.55	3.64	4.16				4.55	3.64	4.16
	Standard Deviation	5.84	6.07	5.97				5.84	6.07	5.97
	Minimum Observed	-20.00	-20.00	-20.00				-20.00	-20.00	-20.00
	25th Percentile	2.07	2.47	2.38				2.07	2.47	2.38
	50th Percentile (Median)	5.17	4.09	5.03				5.17	4.09	5.03
	75th Percentile	7.17	6.44	6.98				7.17	6.44	6.98
	Maximum Observed	9.79	9.33	9.79				9.79	9.33	9.79

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – NCS Sample of Mothers		English	Spanish	All
	N	68	0	68
	Mean	3.20		3.20
	Standard Deviation	5.57		5.57
	Minimum Observed	-20.00		-20.00
	25th Percentile	2.11		2.11
	50th Percentile (Median)	4.07		4.07
	75th Percentile	5.56		5.56
	Maximum Observed	9.11		9.11

Table 2. NIH Toolbox Oral Reading Recognition Test-English (theta) – NCS Sample of Pregnant Women		English	Spanish	All
	N	77	0	77
	Mean	4.06		4.06
	Standard Deviation	3.60		3.60
	Minimum Observed	-20.00		-20.00
	25th Percentile	3.07		3.07
	50th Percentile (Median)	4.27		4.27
	75th Percentile	5.74		5.74
	Maximum Observed	9.17		9.17

Figure 1
Least Squares Means

Section 11:   Measure Norms-Spanish

The following Tables and Figure present NIH Toolbox normative data associated with this measure. Norms reported here should be interpreted cautiously, due to the limited subsample size.

Table 1.   Measure Raw/Computed Score, Unadjusted Scale Score, and Fully Adjusted Scale Score Summary (N, Mean, Standard Deviation) by Age Group (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85, All)

Table 2.   Measure Raw/Computed Score Statistics (N, Mean, Standard Deviation, Minimum/Maximum Observed, 25th/50th/75th Percentile) per Age Group (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85, All)

Figure 1.   Measure Mean Unadjusted Scale Scores across All Age Groups (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18-29, 30-39, 40-49, 50-59, 60-69, 70-85)

Table 1. NIH Toolbox Oral Reading Recognition Test-Spanish by Age Group	Oral Reading Recognition Test-Spanish (theta)			Reading - Spanish Unadjusted Scale Score			Reading - Spanish Fully Adjusted Scale Score		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Age Group									
3	2	-6.19	0.08	2	74.33	0.47	1	98.98	
4	1	-6.73		1	68.88		1	98.85	
5	13	-5.58	0.57	13	75.42	2.65	11	99.62	4.30
6	19	-4.07	0.93	19	80.71	3.48	17	99.92	5.97
7	48	-3.35	0.72	48	84.27	1.96	38	99.61	4.63
8	0			0			0		
9	0			0			0		
10	0			0			0		
11	0			0			0		
12	0			0			0		
13	0			0			0		
14	0			0			0		
15	0			0			0		
16	0			0			0		
17	0			0			0		
18 - 29	76	4.21	2.04	76	105.68	10.32	70	100.00	13.64
30 - 39	77	4.80	1.91	77	109.18	10.49	70	99.84	12.07
40 - 49	46	3.93	3.29	46	106.46	13.63	43	101.03	19.95
50 - 59	27	2.59	3.48	27	100.77	12.78	26	100.74	20.69
60 - 69	16	3.78	3.22	16	106.10	13.96	11	101.35	22.96
70 - 85	9	3.28	1.56	9	101.86	6.72	7	99.95	9.79
All	334	3.76	2.66	334	105.11	11.00	295	100.30	14.02

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 3		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	0	0	0	1	1	2	1	1	2
	Mean				-6.10	-6.41	-6.19	-6.10	-6.41	-6.19
	Standard Deviation						0.08			0.08
	Minimum Observed				-6.10	-6.41	-6.41	-6.10	-6.41	-6.41
	25th Percentile				-6.10	-6.41	-6.41	-6.10	-6.41	-6.41
	50th Percentile (Median)				-6.10	-6.41	-6.10	-6.10	-6.41	-6.10
	75th Percentile				-6.10	-6.41	-6.10	-6.10	-6.41	-6.10
	Maximum Observed				-6.10	-6.41	-6.10	-6.10	-6.41	-6.10

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 4		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	0	0	0	1	0	1	1	0	1
	Mean				-6.73		-6.73	-6.73		-6.73
	Standard Deviation									
	Minimum Observed				-6.73		-6.73	-6.73		-6.73
	25th Percentile				-6.73		-6.73	-6.73		-6.73
	50th Percentile (Median)				-6.73		-6.73	-6.73		-6.73
	75th Percentile				-6.73		-6.73	-6.73		-6.73
	Maximum Observed				-6.73		-6.73	-6.73		-6.73

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 5	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	0	0	0	6	7	13	6	7	13
Mean				-5.95	-5.04	-5.58	-5.95	-5.04	-5.58
Standard Deviation				0.46	0.65	0.57	0.46	0.65	0.57
Minimum Observed				-6.73	-6.91	-6.91	-6.73	-6.91	-6.91
25th Percentile				-6.73	-6.73	-6.73	-6.73	-6.73	-6.73
50th Percentile (Median)				-6.23	-5.44	-6.23	-6.23	-5.44	-6.23
75th Percentile				-5.64	-4.49	-5.30	-5.64	-4.49	-5.30
Maximum Observed				-4.00	-0.51	-0.51	-4.00	-0.51	-0.51

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 6	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	0	0	0	7	12	19	7	12	19
Mean				-4.18	-3.95	-4.07	-4.18	-3.95	-4.07
Standard Deviation				0.96	0.95	0.93	0.96	0.95	0.93
Minimum Observed				-6.91	-7.88	-7.88	-6.91	-7.88	-7.88
25th Percentile				-6.73	-5.96	-5.96	-6.73	-5.96	-5.96
50th Percentile (Median)				-4.74	-4.74	-4.74	-4.74	-4.74	-4.74
75th Percentile				-2.01	-3.37	-2.01	-2.01	-3.37	-2.01
Maximum Observed				-0.99	2.85	2.85	-0.99	2.85	2.85

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 7		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	0	0	0	18	30	48	18	30	48
	Mean				-3.36	-3.34	-3.35	-3.36	-3.34	-3.35
	Standard Deviation				0.81	0.68	0.72	0.81	0.68	0.72
	Minimum Observed				-6.23	-6.73	-6.73	-6.23	-6.73	-6.73
	25th Percentile				-4.99	-4.76	-4.99	-4.99	-4.76	-4.99
	50th Percentile (Median)				-3.70	-3.54	-3.64	-3.70	-3.54	-3.64
	75th Percentile				-1.99	-2.33	-1.99	-1.99	-2.33	-1.99
	Maximum Observed				1.10	2.65	2.65	1.10	2.65	2.65

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 18-29		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	0	0	0	16	60	76	16	60	76
	Mean				4.08	4.26	4.21	4.08	4.26	4.21
	Standard Deviation				2.14	2.03	2.04	2.14	2.03	2.04
	Minimum Observed				1.08	-1.04	-1.04	1.08	-1.04	-1.04
	25th Percentile				3.37	3.02	3.15	3.37	3.02	3.15
	50th Percentile (Median)				4.04	4.45	4.45	4.04	4.45	4.45
	75th Percentile				4.87	5.69	5.53	4.87	5.69	5.53
	Maximum Observed				8.18	8.88	8.88	8.18	8.88	8.88

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 30-39		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	0	0	0	18	59	77	18	59	77
	Mean				5.16	4.62	4.80	5.16	4.62	4.80
	Standard Deviation				2.15	1.83	1.91	2.15	1.83	1.91
	Minimum Observed				2.17	-3.39	-3.39	2.17	-3.39	-3.39
	25th Percentile				3.77	3.49	3.57	3.77	3.49	3.57
	50th Percentile (Median)				4.09	4.84	4.84	4.09	4.84	4.84
	75th Percentile				6.83	5.91	6.10	6.83	5.91	6.10
	Maximum Observed				8.88	8.88	8.88	8.88	8.88	8.88

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 40-49		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	0	0	0	16	30	46	16	30	46
	Mean				3.84	4.00	3.93	3.84	4.00	3.93
	Standard Deviation				4.65	2.36	3.29	4.65	2.36	3.29
	Minimum Observed				-3.89	-1.53	-3.89	-3.89	-1.53	-3.89
	25th Percentile				1.05	3.37	2.40	1.05	3.37	2.40
	50th Percentile (Median)				3.99	4.45	4.32	3.99	4.45	4.32
	75th Percentile				8.18	5.63	5.91	8.18	5.63	5.91
	Maximum Observed				8.88	8.18	8.88	8.88	8.18	8.88

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 50-59	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	0	0	0	10	17	27	10	17	27
Mean				1.31	3.81	2.59	1.31	3.81	2.59
Standard Deviation				4.36	2.38	3.48	4.36	2.38	3.48
Minimum Observed				-3.89	-2.53	-3.89	-3.89	-2.53	-3.89
25th Percentile				0.92	2.05	0.92	0.92	2.05	0.92
50th Percentile (Median)				0.93	4.19	2.45	0.93	4.19	2.45
75th Percentile				2.45	5.37	5.22	2.45	5.37	5.22
Maximum Observed				6.83	6.61	6.83	6.83	6.61	6.83

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 60-69	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	0	0	0	7	9	16	7	9	16
Mean				5.22	1.72	3.78	5.22	1.72	3.78
Standard Deviation				3.27	2.37	3.22	3.27	2.37	3.22
Minimum Observed				-0.60	-3.03	-3.03	-0.60	-3.03	-3.03
25th Percentile				3.65	-0.71	1.93	3.65	-0.71	1.93
50th Percentile (Median)				5.14	2.17	4.63	5.14	2.17	4.63
75th Percentile				7.40	4.10	5.63	7.40	4.10	5.63
Maximum Observed				8.88	5.33	8.88	8.88	5.33	8.88

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – Age 70-85	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	0	0	0	5	4	9	5	4	9
Mean				2.98	3.75	3.28	2.98	3.75	3.28
Standard Deviation				1.68	1.58	1.56	1.68	1.58	1.56
Minimum Observed				-0.71	0.69	-0.71	-0.71	0.69	-0.71
25th Percentile				2.20	0.69	2.20	2.20	0.69	2.20
50th Percentile (Median)				3.15	3.50	3.43	3.15	3.50	3.43
75th Percentile				3.43	6.61	4.45	3.43	6.61	4.45
Maximum Observed				5.69	6.61	6.61	5.69	6.61	6.61

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – NCS Sample of Mothers	English	Spanish	All
N	0	32	32
Mean		5.02	5.02
Standard Deviation		1.99	1.99
Minimum Observed		0.91	0.91
25th Percentile		3.58	3.58
50th Percentile (Median)		4.86	4.86
75th Percentile		6.21	6.21
Maximum Observed		8.88	8.88

Table 2. NIH Toolbox Oral Reading Recognition Test-Spanish (theta) – NCS Sample of Pregnant Women	English	Spanish	All
N	0	38	38
Mean		3.88	3.88
Standard Deviation		1.88	1.88
Minimum Observed		-0.32	-0.32
25th Percentile		2.71	2.71
50th Percentile (Median)		4.09	4.09
75th Percentile		5.34	5.34
Maximum Observed		8.18	8.18

Figure 1
Least Squares Means