NIH Toolbox

Technical Manual

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NIH Toolbox Technical Manual

Domain:

SENSATION

Subdomain:

VISION

Measure:

NIH Toolbox Visual Acuity Test

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This Technical Manual contains the following informational sections:

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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 Sensation 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 Sensation domain measure validation, see: Coldwell et al., Gustation Assessment Using the NIH Toolbox, *Neurology*, in press; Cook et al., Pain Assessment Using the NIH Toolbox, *Neurology*, in press; Dalton et al., Olfaction Assessment using the NIH Toolbox, *Neurology*, in press; Dunn et al., Somatosensation Assessment Using the NIH Toolbox, *Neurology*, in press; Paz et al., Development of a Vision-Targeted Health-Related Quality of Life Item Bank, *manuscript submitted for publication*; Rine et al., Vestibular Function Assessment Using the NIH Toolbox, *Neurology,* in press; Varma et al., Vision Assessment Using the NIH Toolbox, *Neurology*, in press; Zecker et al., Audition Assessment Using the NIH Toolbox, *Neurology*, in press. These manuscripts describe 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: SENSATION

Sensation refers to the biochemical and neurologic process of detecting incoming nerve impulses as nervous system activity. Sensory processes are vital to one's level of independence, in relationships with others, in academic and occupational endeavors, and for activities of daily living. Objective measures of Sensation can systematically examine and determine if participants have intact sensory functioning. There is also fundamental overlap of certain sensory processes with cognitive and motor functioning. Measurement of sensory health and function is important to epidemiologic and longitudinal studies whether or not Sensation is the primary focus of the study. Given the changes in sensory functioning across the lifespan, there is value in characterizing age-related sensory improvement and decline. The Sensation domain includes measures of:

AUDITION

Measured by:

      NIH Toolbox Words-in-Noise Test

      NIH Toolbox Hearing Threshold Test (Supplemental Measure)

      NIH Toolbox Hearing Handicap Inventory (Supplemental Measure)

OLFACTION

Measured by:

      NIH Toolbox Odor Identification Test

PAIN

Measured by:

      NIH Toolbox Pain Intensity Survey

      NIH Toolbox Pain Interference Survey

TASTE

Measured by:

      NIH Toolbox Taste Intensity Test

VESTIBULAR

Measured by:

      NIH Toolbox Dynamic Visual Acuity Test

      NIH Toolbox Standing Balance Test (contained within the NIH Toolbox Motor

      battery)

VISION

Measured by:

NIH Toolbox Visual Acuity Test

NIH Toolbox Vision-Related Quality of Life Survey (Supplemental Measure)

SENSATION Batteries

The NIH Toolbox Sensation Battery for ages 3-5 includes Visual Acuity, Dynamic Visual Acuity, and Odor Identification tests. For ages 6-11, the Words-in-Noise Test is added to the battery. For ages 12-17, the Taste Intensity Test is included with the other four; and for ages 18-85, the two Pain surveys are added. There are individual scores provided for each measure, as described below, but no composite scores.

Section 6:   Subdomain Definition

Subdomain: VISION

Vision is a complex sensation that provides us with a personal, conscious representation of our surrounding environment. Loss of vision or blindness may limit a person's ability to complete normal, daily activities and decrease overall quality of life. The key aspect of vision prioritized for testing in the NIH Toolbox is visual acuity. Visual acuity tests are used to measure impairments in visual resolution that can be caused by blurring of the retinal image, neural

processing disorders, or damage to neurons in the retina or other parts of the visual pathway.

In NIH Toolbox, Vision is measured by:

NIH Toolbox Visual Acuity Test

NIH Toolbox Vision-Related Quality of Life Survey (Supplemental Measure)

Section 7:   Measure Description

VISION Core Measure

The NIH Toolbox Visual Acuity Test directly measures participants' visual acuity, or distance vision. The participant is seated 12.5 feet away from a computer monitor at eye level, and letters (called "optotypes") are displayed one at a time on the screen for the participant to identify, using both eyes at the same time, with the participant wearing his/her normal corrective lenses for distance vision (glasses or contact lenses, if worn). As the participant successfully identifies optotypes of a given size, smaller ones appear on the screen, until the computer program ascertains the smallest-size optotype the participant can successfully see. Conversely, the program displays larger optotypes if the participant cannot see the letter size that is first displayed, until a size that he/she can accurately see is found. For participants ages 3-7, only the letters H, O, T, and V are used, and children may point to a laminated card showing the letters if they cannot verbalize or cannot recall the letter names. For participants ages 8 and above, the entire set of optotypes is used, following a common protocol used in professional vision testing. This test takes approximately three minutes to administer and is recommended for ages 3-85.

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

No notable Post-Validation/Post-Norming changes were made to the measure subsequent to those changes previously reported on during the measure's development and validation phases (Varma et al., Vision Assessment Using the NIH Toolbox, *Neurology*, in press).

Section 9: The Measure's Scoring Model

Measurement theory applied for scoring:

Classical Test Theory (CTT)

CTT scoring approach employed:

Standard static binocular visual acuity (in LogMAR units)

Measure length:

Fixed length, variable presentation (the computer software adjusts the size of the optotype presented to target an examinee's true visual acuity; not all items need to be administered, so credit is given for larger sizes not administered)

Response data:

Continuous (standard binocular visual acuity, scored in LogMAR units)

The MAR (minimum angle of resolution) is the reciprocal of the Snellen score notation. It equals the angle (in minutes of arc) at which the strokes of the letter subtend at the examinee's eye. LogMAR is MAR expressed in $\log_{10}$ form. A LogMAR score can be calculated from the raw number correct score using the following equation:

LogMAR score = 1.7 – (0.02*RAW).

Scores computed/available*:

LogMAR Score (range from -0.3 (best possible score) to 1.7 (worst possible score))

Static Visual Acuity Snellen Score (the Snellen equivalent for a LogMAR Score; range from 20/10 (highest acuity measured) to 20/800 (lowest acuity measured))

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)

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

Section 10:   Measure Norms

The following Tables and Figure present NIH Toolbox normative data associated with this measure. Note that, for the VA, only the letters H, O, T, and V are used for ages 3-7, while ages 8+ use the entire letter set. This may influence norming results.

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, $25^{th}/50^{th}/75^{th}$ 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 Visual Acuity Test by Age Group	Visual Acuity Test (logMAR)			Visual Acuity Unadjusted Scale Score			Visual Acuity Fully Adjusted Scale Score		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Age Group									
3	157	0.01	0.13	157	91.16	7.59	141	103.71	11.32
4	213	-0.07	0.08	213	97.25	7.77	198	100.99	9.54
5	204	-0.14	0.08	204	105.24	8.33	182	99.46	8.04
6	204	-0.19	0.06	204	112.97	8.44	184	98.51	6.62
7	249	-0.20	0.06	249	115.35	8.17	224	98.76	6.13
8	203	-0.09	0.10	203	99.05	7.41	194	100.76	8.50
9	205	-0.11	0.07	205	100.58	6.95	193	99.29	7.44
10	230	-0.09	0.09	230	99.88	7.57	213	100.38	8.19
11	205	-0.11	0.07	205	100.70	7.08	195	98.80	7.41
12	208	-0.11	0.07	208	100.21	6.90	200	99.02	7.43
13	210	-0.09	0.09	210	100.02	7.73	202	100.46	8.56
14	227	-0.10	0.07	227	100.11	7.00	219	99.08	7.25
15	215	-0.10	0.09	215	100.97	7.85	209	99.47	8.21
16	213	-0.12	0.08	213	101.93	7.70	203	98.99	7.81
17	212	-0.12	0.06	212	102.36	7.56	203	98.44	7.45
18 - 29	255	-0.12	0.23	255	101.87	23.28	246	99.46	24.27
30 - 39	294	-0.13	0.17	294	103.32	18.30	280	98.61	18.14
40 - 49	244	-0.11	0.22	244	100.72	20.66	230	98.94	21.48
50 - 59	181	-0.07	0.22	181	96.32	21.77	166	98.67	25.94
60 - 69	150	-0.03	0.21	150	91.55	17.31	142	99.03	24.31
70 - 85	233	0.08	0.23	233	84.28	13.88	205	102.20	25.27
All	4512	-0.09	0.15	4512	98.71	13.83	4229	99.35	14.26

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 3		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	33	40	73	42	42	84	75	82	157
	Mean	-0.01	0.04	0.01	0.00	0.00	0.00	-0.01	0.03	0.01
	Standard Deviation	0.13	0.19	0.17	0.11	0.06	0.09	0.12	0.14	0.13
	Minimum Observed	-0.24	-0.22	-0.24	-0.24	-0.30	-0.30	-0.24	-0.30	-0.30
	25th Percentile	-0.14	-0.14	-0.14	-0.12	-0.14	-0.12	-0.14	-0.14	-0.14
	50th Percentile (Median)	-0.04	-0.08	-0.04	-0.08	-0.02	-0.06	-0.04	-0.06	-0.04
	75th Percentile	0.04	0.10	0.08	0.10	0.14	0.10	0.08	0.10	0.10
	Maximum Observed	0.68	1.70	1.70	1.64	0.64	1.64	1.64	1.70	1.70

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 4		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	56	55	111	47	55	102	103	110	213
	Mean	-0.06	-0.07	-0.07	-0.06	-0.08	-0.07	-0.06	-0.07	-0.07
	Standard Deviation	0.13	0.07	0.10	0.05	0.04	0.04	0.10	0.06	0.08
	Minimum Observed	-0.30	-0.30	-0.30	-0.30	-0.28	-0.30	-0.30	-0.30	-0.30
	25th Percentile	-0.18	-0.14	-0.18	-0.18	-0.20	-0.18	-0.18	-0.16	-0.18
	50th Percentile (Median)	-0.12	-0.06	-0.12	-0.08	-0.12	-0.08	-0.12	-0.08	-0.10
	75th Percentile	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maximum Observed	0.64	0.22	0.64	0.26	0.24	0.26	0.64	0.24	0.64

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 5		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	59	59	118	42	44	86	101	103	204
	Mean	-0.13	-0.15	-0.14	-0.15	-0.10	-0.13	-0.14	-0.14	-0.14
	Standard Deviation	0.11	0.06	0.09	0.05	0.05	0.05	0.09	0.06	0.08
	Minimum Observed	-0.30	-0.30	-0.30	-0.30	-0.28	-0.30	-0.30	-0.30	-0.30
	25th Percentile	-0.24	-0.24	-0.24	-0.26	-0.20	-0.24	-0.24	-0.22	-0.24
	50th Percentile (Median)	-0.18	-0.14	-0.16	-0.18	-0.14	-0.16	-0.18	-0.14	-0.16
	75th Percentile	-0.10	-0.08	-0.10	-0.10	-0.02	-0.04	-0.10	-0.08	-0.10
	Maximum Observed	0.80	0.20	0.80	0.22	0.54	0.54	0.80	0.54	0.80

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 6		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	57	55	112	40	52	92	97	107	204
	Mean	-0.21	-0.18	-0.20	-0.18	-0.17	-0.17	-0.20	-0.18	-0.19
	Standard Deviation	0.07	0.08	0.08	0.04	0.04	0.04	0.06	0.07	0.06
	Minimum Observed	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30
	25th Percentile	-0.28	-0.26	-0.28	-0.28	-0.26	-0.26	-0.28	-0.26	-0.28
	50th Percentile (Median)	-0.22	-0.24	-0.22	-0.20	-0.22	-0.20	-0.22	-0.22	-0.22
	75th Percentile	-0.14	-0.16	-0.16	-0.12	-0.08	-0.12	-0.14	-0.14	-0.14
	Maximum Observed	0.26	0.46	0.46	0.02	0.24	0.24	0.26	0.46	0.46

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 7	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	83	76	159	43	47	90	126	123	249
Mean	-0.20	-0.20	-0.20	-0.22	-0.22	-0.22	-0.20	-0.20	-0.20
Standard Deviation	0.09	0.06	0.07	0.04	0.03	0.03	0.08	0.05	0.06
Minimum Observed	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30
25th Percentile	-0.28	-0.28	-0.28	-0.30	-0.28	-0.30	-0.28	-0.28	-0.28
50th Percentile (Median)	-0.24	-0.24	-0.24	-0.26	-0.26	-0.26	-0.24	-0.24	-0.24
75th Percentile	-0.20	-0.14	-0.18	-0.18	-0.18	-0.18	-0.20	-0.16	-0.18
Maximum Observed	0.42	0.10	0.42	0.12	0.20	0.20	0.42	0.20	0.42

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 8	English			Spanish			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	All
N	105	98	203	0	0	0	105	98	203
Mean	-0.10	-0.07	-0.09				-0.10	-0.07	-0.09
Standard Deviation	0.08	0.11	0.10				0.08	0.11	0.10
Minimum Observed	-0.26	-0.30	-0.30				-0.26	-0.30	-0.30
25th Percentile	-0.20	-0.18	-0.18				-0.20	-0.18	-0.18
50th Percentile (Median)	-0.12	-0.12	-0.12				-0.12	-0.12	-0.12
75th Percentile	-0.04	-0.06	-0.06				-0.04	-0.06	-0.06
Maximum Observed	0.44	1.42	1.42				0.44	1.42	1.42

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 9		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	103	102	205	0	0	0	103	102	205
	Mean	-0.11	-0.09	-0.11				-0.11	-0.09	-0.11
	Standard Deviation	0.07	0.08	0.07				0.07	0.08	0.07
	Minimum Observed	-0.26	-0.30	-0.30				-0.26	-0.30	-0.30
	25th Percentile	-0.20	-0.20	-0.20				-0.20	-0.20	-0.20
	50th Percentile (Median)	-0.14	-0.12	-0.14				-0.14	-0.12	-0.14
	75th Percentile	-0.08	-0.06	-0.08				-0.08	-0.06	-0.08
	Maximum Observed	0.36	0.74	0.74				0.36	0.74	0.74

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 10		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	115	115	230	0	0	0	115	115	230
	Mean	-0.08	-0.10	-0.09				-0.08	-0.10	-0.09
	Standard Deviation	0.10	0.06	0.09				0.10	0.06	0.09
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.22	-0.20	-0.20				-0.22	-0.20	-0.20
	50th Percentile (Median)	-0.12	-0.12	-0.12				-0.12	-0.12	-0.12
	75th Percentile	-0.04	-0.08	-0.04				-0.04	-0.08	-0.04
	Maximum Observed	0.92	0.54	0.92				0.92	0.54	0.92

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 11		English			Spanish			Total		
		Males	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**All**
	N	103	102	205	0	0	0	103	102	205
	Mean	-0.12	-0.09	-0.11				-0.12	-0.09	-0.11
	Standard Deviation	0.06	0.07	0.07				0.06	0.07	0.07
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.20	-0.18	-0.20				-0.20	-0.18	-0.20
	50th Percentile (Median)	-0.14	-0.10	-0.12				-0.14	-0.10	-0.12
	75th Percentile	-0.08	-0.04	-0.06				-0.08	-0.04	-0.06
	Maximum Observed	0.28	0.56	0.56				0.28	0.56	0.56

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 12		English			Spanish			Total		
		Males	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**All**
	N	97	111	208	0	0	0	97	111	208
	Mean	-0.11	-0.10	-0.11				-0.11	-0.10	-0.11
	Standard Deviation	0.08	0.06	0.07				0.08	0.06	0.07
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.20	-0.14	-0.18				-0.20	-0.14	-0.18
	50th Percentile (Median)	-0.12	-0.12	-0.12				-0.12	-0.12	-0.12
	75th Percentile	-0.08	-0.04	-0.08				-0.08	-0.04	-0.08
	Maximum Observed	0.40	0.42	0.42				0.40	0.42	0.42

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 13		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	111	99	210	0	0	0	111	99	210
	Mean	-0.09	-0.10	-0.09				-0.09	-0.10	-0.09
	Standard Deviation	0.11	0.06	0.09				0.11	0.06	0.09
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.20	-0.22	-0.20				-0.20	-0.22	-0.20
	50th Percentile (Median)	-0.12	-0.12	-0.12				-0.12	-0.12	-0.12
	75th Percentile	-0.06	-0.04	-0.04				-0.06	-0.04	-0.04
	Maximum Observed	1.18	0.62	1.18				1.18	0.62	1.18

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 14		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	109	118	227	0	0	0	109	118	227
	Mean	-0.10	-0.10	-0.10				-0.10	-0.10	-0.10
	Standard Deviation	0.09	0.05	0.07				0.09	0.05	0.07
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.20	-0.16	-0.20				-0.20	-0.16	-0.20
	50th Percentile (Median)	-0.14	-0.12	-0.12				-0.14	-0.12	-0.12
	75th Percentile	-0.04	-0.06	-0.06				-0.04	-0.06	-0.06
	Maximum Observed	0.42	0.34	0.42				0.42	0.34	0.42

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 15		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	106	109	215	0	0	0	106	109	215
	Mean	-0.10	-0.11	-0.10				-0.10	-0.11	-0.10
	Standard Deviation	0.10	0.07	0.09				0.10	0.07	0.09
	Minimum Observed	-0.30	-0.28	-0.30				-0.30	-0.28	-0.30
	25th Percentile	-0.20	-0.20	-0.20				-0.20	-0.20	-0.20
	50th Percentile (Median)	-0.12	-0.14	-0.12				-0.12	-0.14	-0.12
	75th Percentile	-0.04	-0.08	-0.08				-0.04	-0.08	-0.08
	Maximum Observed	0.64	0.40	0.64				0.64	0.40	0.64

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 16		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	107	106	213	0	0	0	107	106	213
	Mean	-0.12	-0.11	-0.12				-0.12	-0.11	-0.12
	Standard Deviation	0.09	0.06	0.08				0.09	0.06	0.08
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.22	-0.18	-0.20				-0.22	-0.18	-0.20
	50th Percentile (Median)	-0.14	-0.12	-0.14				-0.14	-0.12	-0.14
	75th Percentile	-0.06	-0.06	-0.06				-0.06	-0.06	-0.06
	Maximum Observed	0.98	0.30	0.98				0.98	0.30	0.98

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 17		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	104	108	212	0	0	0	104	108	212
	Mean	-0.13	-0.10	-0.12				-0.13	-0.10	-0.12
	Standard Deviation	0.07	0.05	0.06				0.07	0.05	0.06
	Minimum Observed	-0.30	-0.30	-0.30				-0.30	-0.30	-0.30
	25th Percentile	-0.22	-0.18	-0.20				-0.22	-0.18	-0.20
	50th Percentile (Median)	-0.14	-0.12	-0.12				-0.14	-0.12	-0.12
	75th Percentile	-0.08	-0.06	-0.08				-0.08	-0.06	-0.08
	Maximum Observed	0.48	0.40	0.48				0.48	0.40	0.48

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 18-29		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	57	108	165	19	71	90	76	179	255
	Mean	-0.13	-0.12	-0.12	-0.02	-0.08	-0.06	-0.12	-0.11	-0.12
	Standard Deviation	0.24	0.24	0.24	0.31	0.18	0.21	0.27	0.22	0.23
	Minimum Observed	-0.30	-0.30	-0.30	-0.26	-0.30	-0.30	-0.30	-0.30	-0.30
	25th Percentile	-0.18	-0.20	-0.20	-0.18	-0.20	-0.20	-0.18	-0.20	-0.20
	50th Percentile (Median)	-0.14	-0.14	-0.14	-0.10	-0.12	-0.10	-0.14	-0.14	-0.14
	75th Percentile	-0.10	-0.08	-0.10	0.00	-0.04	-0.02	-0.10	-0.08	-0.08
	Maximum Observed	0.30	0.38	0.38	0.54	0.56	0.56	0.54	0.56	0.56

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 30-39		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	51	147	198	21	75	96	72	222	294
	Mean	-0.14	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13
	Standard Deviation	0.26	0.17	0.19	0.16	0.09	0.11	0.23	0.15	0.17
	Minimum Observed	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30
	25th Percentile	-0.22	-0.20	-0.20	-0.22	-0.20	-0.20	-0.22	-0.20	-0.20
	50th Percentile (Median)	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
	75th Percentile	-0.12	-0.08	-0.08	-0.12	-0.08	-0.10	-0.12	-0.08	-0.08
	Maximum Observed	0.54	0.40	0.54	0.36	0.30	0.36	0.54	0.40	0.54

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 40-49		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	59	116	175	28	41	69	87	157	244
	Mean	-0.12	-0.11	-0.11	-0.09	-0.05	-0.07	-0.11	-0.11	-0.11
	Standard Deviation	0.28	0.18	0.22	0.19	0.25	0.23	0.26	0.20	0.22
	Minimum Observed	-0.26	-0.30	-0.30	-0.26	-0.24	-0.26	-0.26	-0.30	-0.30
	25th Percentile	-0.20	-0.18	-0.20	-0.18	-0.18	-0.18	-0.20	-0.18	-0.20
	50th Percentile (Median)	-0.14	-0.12	-0.12	-0.12	-0.10	-0.10	-0.14	-0.12	-0.12
	75th Percentile	-0.08	-0.08	-0.08	-0.02	-0.08	-0.06	-0.08	-0.08	-0.08
	Maximum Observed	0.48	0.40	0.48	0.52	1.64	1.64	0.52	1.64	1.64

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 50-59		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	53	81	134	23	24	47	76	105	181
	Mean	-0.08	-0.08	-0.08	-0.03	-0.10	-0.06	-0.07	-0.08	-0.07
	Standard Deviation	0.23	0.24	0.23	0.25	0.09	0.19	0.23	0.21	0.22
	Minimum Observed	-0.26	-0.30	-0.30	-0.24	-0.22	-0.24	-0.26	-0.30	-0.30
	25th Percentile	-0.14	-0.16	-0.14	-0.12	-0.14	-0.12	-0.14	-0.16	-0.14
	50th Percentile (Median)	-0.08	-0.10	-0.08	-0.10	-0.10	-0.10	-0.08	-0.10	-0.10
	75th Percentile	-0.04	-0.02	-0.04	0.00	-0.06	-0.06	-0.04	-0.02	-0.04
	Maximum Observed	0.16	0.48	0.48	0.70	0.16	0.70	0.70	0.48	0.70

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 60-69		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	44	67	111	16	23	39	60	90	150
	Mean	-0.05	-0.01	-0.03	0.02	0.00	0.01	-0.05	-0.01	-0.03
	Standard Deviation	0.22	0.22	0.22	0.19	0.12	0.15	0.22	0.20	0.21
	Minimum Observed	-0.24	-0.24	-0.24	-0.26	-0.22	-0.26	-0.26	-0.24	-0.26
	25th Percentile	-0.12	-0.08	-0.10	-0.08	-0.08	-0.08	-0.12	-0.08	-0.10
	50th Percentile (Median)	-0.08	-0.04	-0.04	0.00	-0.02	-0.02	-0.08	-0.04	-0.04
	75th Percentile	-0.02	0.06	0.04	0.10	0.08	0.10	0.04	0.06	0.04
	Maximum Observed	0.18	0.56	0.56	0.44	0.28	0.44	0.44	0.56	0.56

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – Age 70-85		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	94	99	193	25	15	40	119	114	233
	Mean	0.07	0.08	0.08	0.14	0.09	0.12	0.08	0.08	0.08
	Standard Deviation	0.24	0.24	0.24	0.25	0.07	0.20	0.24	0.22	0.23
	Minimum Observed	-0.22	-0.22	-0.22	-0.30	-0.06	-0.30	-0.30	-0.22	-0.30
	25th Percentile	-0.06	-0.06	-0.06	-0.02	-0.02	-0.02	-0.06	-0.06	-0.06
	50th Percentile (Median)	0.04	0.04	0.04	0.08	0.08	0.08	0.04	0.04	0.04
	75th Percentile	0.20	0.16	0.16	0.18	0.18	0.18	0.20	0.16	0.18
	Maximum Observed	0.54	0.94	0.94	1.68	0.30	1.68	1.68	0.94	1.68

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – NCS Sample of Mothers		English	Spanish	All
	N	76	33	109
	Mean	-0.12	-0.14	-0.12
	Standard Deviation	0.11	0.12	0.11
	Minimum Observed	-0.30	-0.30	-0.30
	25th Percentile	-0.18	-0.22	-0.20
	50th Percentile (Median)	-0.12	-0.14	-0.14
	75th Percentile	-0.08	-0.10	-0.08
	Maximum Observed	0.48	0.36	0.48

Table 2. NIH Toolbox Visual Acuity Test (logMAR) – NCS Sample of Pregnant Women		English	Spanish	All
	N	78	44	122
	Mean	-0.15	-0.03	-0.10
	Standard Deviation	0.08	0.31	0.20
	Minimum Observed	-0.30	-0.24	-0.30
	25th Percentile	-0.22	-0.18	-0.20
	50th Percentile (Median)	-0.14	-0.12	-0.14
	75th Percentile	-0.10	0.00	-0.08
	Maximum Observed	0.12	1.64	1.64

Figure 1
Least Squares Means

Mean Unadjusted Scale Score
With 95% Confidence Limits