NIH Toolbox

Technical Manual

Jerry Slotkin, PhD, Michael Kallen, PhD, James Griffith, PhD, Susan Magasi, PhD, John Salsman, PhD, Cindy Nowinski, MD, PhD, and Richard Gershon, PhD

September 27, 2012

NIH Toolbox Technical Manual

Domain:

SENSATION

Subdomain:

VESTIBULAR

Measure:

NIH Toolbox Dynamic Visual Acuity Test

Expert Contributors-VESTIBULAR

John Carey, MD (The Johns Hopkins University), Howard Hoffman, MA (National Institute on Deafness and Other Communication Disorders, NIH), Gary Jacobson, PhD (Vanderbilt University), Gregory Marchetti, PhD (Duquesne University), Mark Musolino, PhD (VitalClip), Mark Redfern, PhD (University of Pittsburgh), Rose Marie Rine, PhD (Marshall University), Michael Schubert, PhD (The Johns Hopkins University), Neil Shepard, PhD (Mayo Clinic), Jerry Slotkin, PhD (Northwestern University), Susan Whitney, PhD (University of Pittsburgh), Diane Wrisley, PhD (Lynchburg College)

Member Institutes, Centers, and Offices

National Center for Complementary and Alternative Medicine (NCCAM)

National Eye Institute (NEI)

National Institute of Biomedical Imaging and Bioengineering (NIBIB)

Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)

National Institute of Dental and Craniofacial Research (NIDCR)

National Institute of Environmental Health Sciences (NIEHS)

National Institute of General Medical Sciences (NIGMS)

National Institute of Mental Health (NIMH)

National Institute of Neurological Disorders and Stroke (NINDS)

National Institute of Nursing Research (NINR)

National Institute on Aging (NIA)

National Institute on Alcohol Abuse and Alcoholism (NIAAA)

National Institute on Deafness and Other Communication Disorders (NIDCD)

National Institute on Drug Abuse (NIDA)

Office of Behavioral and Social Sciences Research (OBSSR)

This project is funded in whole or in part with Federal funds from the Blueprint for Neuroscience Research and the Office of Behavioral and Social Sciences Research, National Institutes of Health, under Contract No. HHS-N-260-2006-00007-C, with additional support from the National Children's Study, under Contract No. HHS-N-267-2007-00027-C.

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

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: VESTIBULAR

The vestibular system transduces and processes angular and linear acceleration and deceleration of the head, enabling postural balance, locomotor control, and gaze stabilization, particularly during head movement. The vestibular system is an integral component of our sensory experience and sensory-motor function. NIH Toolbox measures functionally relevant gaze stability during head motion and postural control. In NIH Toolbox, Vestibular function is measured by:

NIH Toolbox Dynamic Visual Acuity Test

NIH Toolbox Standing Balance Test (contained within the NIH Toolbox Motor battery).

Section 7: Measure Description

VESTIBULAR Core Measure

The NIH Toolbox Dynamic Visual Acuity Test (DVA) is a measure of gaze stability during head movement, which helps identify individuals who may have a deficit of the vestibular system (which regulates internal balance). First, the NIH Toolbox Visual Acuity Test must be administered, followed by the DVA Test. Participants are again seated 12.5 feet from a computer monitor at eye level. For the DVA Test, participants wear lightweight headgear that contains a rate sensor and are asked to move the head back and forth, as if saying "no." Once the head is measured to be moving at greater than 180 degrees per second by the rate sensor, an optotype flashes on the monitor, and the participant is asked to identify it. As with the Visual Acuity Test, only the letters H, O, T, and V are used for ages 3-7, while ages 8+ use the entire letter set. Smaller optotypes are displayed as the participant correctly identifies letters, and larger ones are displayed if the participant cannot correctly identify the letter shown, until the computer has calculated the smallest size that the participant can see with the head moving. This is calculated separately for head rotation leftward and rightward from center (though the participant continues shaking the head both ways), and this performance is compared to the participant's visual acuity when the head was stationary (the NIH Toolbox Visual Acuity Test

score, sometimes referred to as “static” visual acuity in the context of the DVA test). The difference between “static” and dynamic visual acuity represents the vestibular contribution to gaze stability. The DVA Test takes approximately six minutes to administer and is recommended for ages 3-85.

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 (Rine et al., Vestibular Function Assessment Using the NIH Toolbox, *Neurology*, in press), the following changes have been made to this measure:

Test administration changes: The number of letters administered per line (optotype size) was reduced from five to two, to make administration time more manageable.

Section 9: The Measure’s Scoring Model

Measurement theory applied for scoring:

Classical Test Theory (CTT)

CTT scoring approach employed:

Dynamic 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 (dynamic 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*:

DVA Leftward Rotation Difference LogMAR Score (Visual Acuity Score minus DVA Leftward Rotation Score, converted to LogMAR units)

DVA Rightward Rotation Difference LogMAR Score (Visual Acuity Score minus DVA Rightward Rotation Score, converted to LogMAR units)

DVA Overall LogMAR (average of the DVA Leftward Rotation Difference LogMAR Score and DVA Rightward Rotation Difference LogMAR 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)

*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 DVA, 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 Dynamic Visual Acuity Test by Age Group	Dynamic Visual Acuity Test (logMAR difference score, average of left and right)			Dynamic Visual Acuity Unadjusted Scale Score			Dynamic Visual Acuity Fully Adjusted Scale Score		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Age Group									
3	54	0.22	0.13	54	91.93	9.22	44	100.37	10.60
4	152	0.18	0.12	152	95.87	8.53	142	101.35	9.49
5	169	0.12	0.10	169	99.62	7.85	150	99.77	8.33
6	177	0.11	0.09	177	100.36	8.23	157	99.84	8.51
7	230	0.08	0.08	230	103.10	7.16	207	99.42	7.15
8	188	0.15	0.10	188	96.11	7.55	179	99.66	8.04
9	195	0.12	0.10	195	99.01	8.14	183	99.78	8.39
10	216	0.12	0.09	216	99.28	7.54	200	99.53	7.63
11	193	0.13	0.10	193	98.88	7.83	184	99.99	8.23
12	200	0.09	0.10	200	102.42	8.50	192	99.77	8.34
13	199	0.09	0.10	199	102.65	7.95	191	100.00	7.96
14	215	0.11	0.10	215	100.71	7.90	207	99.93	7.82
15	208	0.10	0.08	208	101.04	7.27	203	99.07	7.27
16	201	0.07	0.10	201	103.92	8.30	192	99.65	7.97
17	202	0.09	0.08	202	101.58	7.53	194	99.10	7.42
18 - 29	242	0.08	0.33	242	103.53	25.27	237	99.72	24.31
30 - 39	275	0.09	0.25	275	101.81	21.45	262	99.71	21.13
40 - 49	224	0.10	0.28	224	101.11	24.05	211	99.47	24.58
50 - 59	170	0.18	0.40	170	94.79	28.66	157	101.13	32.45
60 - 69	126	0.21	0.38	126	92.58	27.44	120	100.77	32.19
70 - 85	156	0.23	0.26	156	90.67	18.65	140	100.48	22.59
All	3992	0.13	0.19	3992	99.12	15.37	3752	100.04	15.59

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 3		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	10	16	26	13	15	28	23	31	54
	Mean	0.25	0.13	0.19	0.32	0.34	0.33	0.27	0.17	0.22
	Standard Deviation	0.14	0.16	0.16	0.10	0.07	0.08	0.12	0.13	0.13
	Minimum Observed	-0.20	-0.28	-0.28	0.02	-0.11	-0.11	-0.20	-0.28	-0.28
	25th Percentile	0.14	0.01	0.05	0.09	0.11	0.11	0.14	0.01	0.06
	50th Percentile (Median)	0.21	0.06	0.14	0.32	0.34	0.34	0.22	0.13	0.15
	75th Percentile	0.34	0.17	0.31	0.43	0.48	0.48	0.35	0.29	0.34
	Maximum Observed	0.57	0.95	0.95	0.75	0.65	0.75	0.75	0.95	0.95

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 4		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	40	37	77	35	40	75	75	77	152
	Mean	0.21	0.16	0.19	0.12	0.09	0.11	0.19	0.15	0.18
	Standard Deviation	0.19	0.10	0.16	0.09	0.05	0.07	0.15	0.08	0.12
	Minimum Observed	-0.15	-0.12	-0.15	-0.20	-0.25	-0.25	-0.20	-0.25	-0.25
	25th Percentile	0.03	0.02	0.03	-0.05	0.01	-0.04	0.03	0.02	0.02
	50th Percentile (Median)	0.15	0.15	0.15	0.07	0.08	0.07	0.13	0.10	0.12
	75th Percentile	0.33	0.26	0.29	0.19	0.19	0.19	0.29	0.24	0.26
	Maximum Observed	1.26	0.60	1.26	1.04	0.76	1.04	1.26	0.76	1.26

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 5		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	49	45	94	36	39	75	85	84	169
	Mean	0.12	0.14	0.13	0.08	0.06	0.07	0.11	0.13	0.12
	Standard Deviation	0.12	0.12	0.12	0.07	0.04	0.06	0.10	0.10	0.10
	Minimum Observed	-0.30	-0.14	-0.30	-0.18	-0.39	-0.39	-0.30	-0.39	-0.39
	25th Percentile	0.02	0.05	0.02	-0.04	-0.01	-0.03	0.00	0.02	0.00
	50th Percentile (Median)	0.09	0.11	0.10	0.09	0.08	0.08	0.09	0.10	0.10
	75th Percentile	0.21	0.18	0.20	0.16	0.15	0.15	0.19	0.18	0.18
	Maximum Observed	0.71	1.08	1.08	0.51	0.27	0.51	0.71	1.08	1.08

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 6		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	51	46	97	37	43	80	88	89	177
	Mean	0.12	0.12	0.12	0.09	0.06	0.08	0.11	0.10	0.11
	Standard Deviation	0.12	0.12	0.12	0.06	0.05	0.06	0.10	0.09	0.09
	Minimum Observed	-0.13	-0.23	-0.23	-0.20	-0.32	-0.32	-0.20	-0.32	-0.32
	25th Percentile	-0.01	-0.02	-0.01	-0.01	-0.06	-0.04	-0.01	-0.04	-0.02
	50th Percentile (Median)	0.10	0.11	0.10	0.10	0.03	0.07	0.10	0.09	0.10
	75th Percentile	0.19	0.22	0.20	0.17	0.19	0.19	0.19	0.20	0.19
	Maximum Observed	0.58	0.73	0.73	0.56	0.48	0.56	0.58	0.73	0.73

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 7		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	74	72	146	41	43	84	115	115	230
	Mean	0.08	0.07	0.08	0.04	0.11	0.07	0.08	0.08	0.08
	Standard Deviation	0.11	0.08	0.10	0.07	0.04	0.06	0.09	0.07	0.08
	Minimum Observed	-0.22	-0.30	-0.30	-0.23	-0.13	-0.23	-0.23	-0.30	-0.30
	25th Percentile	-0.02	-0.03	-0.02	-0.08	0.03	-0.05	-0.02	0.01	-0.02
	50th Percentile (Median)	0.07	0.07	0.07	0.02	0.10	0.06	0.05	0.08	0.07
	75th Percentile	0.15	0.16	0.15	0.10	0.20	0.13	0.14	0.17	0.15
	Maximum Observed	0.80	0.92	0.92	0.86	0.41	0.86	0.86	0.92	0.92

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 8		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	99	89	188	0	0	0	99	89	188
	Mean	0.17	0.13	0.15				0.17	0.13	0.15
	Standard Deviation	0.10	0.09	0.10				0.10	0.09	0.10
	Minimum Observed	-0.27	-0.19	-0.27				-0.27	-0.19	-0.27
	25th Percentile	0.07	0.04	0.04				0.07	0.04	0.04
	50th Percentile (Median)	0.16	0.10	0.13				0.16	0.10	0.13
	75th Percentile	0.24	0.22	0.23				0.24	0.22	0.23
	Maximum Observed	0.92	0.84	0.92				0.92	0.84	0.92

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 9		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	100	95	195	0	0	0	100	95	195
	Mean	0.14	0.10	0.12				0.14	0.10	0.12
	Standard Deviation	0.11	0.09	0.10				0.11	0.09	0.10
	Minimum Observed	-0.27	-0.34	-0.34				-0.27	-0.34	-0.34
	25th Percentile	0.01	0.00	0.00				0.01	0.00	0.00
	50th Percentile (Median)	0.11	0.08	0.09				0.11	0.08	0.09
	75th Percentile	0.27	0.17	0.23				0.27	0.17	0.23
	Maximum Observed	0.85	0.99	0.99				0.85	0.99	0.99

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 10		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	109	107	216	0	0	0	109	107	216
	Mean	0.14	0.09	0.12				0.14	0.09	0.12
	Standard Deviation	0.09	0.08	0.09				0.09	0.08	0.09
	Minimum Observed	-0.21	-0.41	-0.41				-0.21	-0.41	-0.41
	25th Percentile	0.04	-0.03	0.01				0.04	-0.03	0.01
	50th Percentile (Median)	0.12	0.06	0.10				0.12	0.06	0.10
	75th Percentile	0.21	0.23	0.21				0.21	0.23	0.21
	Maximum Observed	0.69	0.53	0.69				0.69	0.53	0.69

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 11		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	96	97	193	0	0	0	96	97	193
	Mean	0.13	0.12	0.13				0.13	0.12	0.13
	Standard Deviation	0.10	0.09	0.10				0.10	0.09	0.10
	Minimum Observed	-0.12	-0.21	-0.21				-0.12	-0.21	-0.21
	25th Percentile	0.02	0.01	0.01				0.02	0.01	0.01
	50th Percentile (Median)	0.11	0.08	0.10				0.11	0.08	0.10
	75th Percentile	0.20	0.19	0.20				0.20	0.19	0.20
	Maximum Observed	0.72	0.85	0.85				0.72	0.85	0.85

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 12		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	93	107	200	0	0	0	93	107	200
	Mean	0.12	0.05	0.09				0.12	0.05	0.09
	Standard Deviation	0.11	0.08	0.10				0.11	0.08	0.10
	Minimum Observed	-0.25	-0.28	-0.28				-0.25	-0.28	-0.28
	25th Percentile	0.01	-0.06	-0.03				0.01	-0.06	-0.03
	50th Percentile (Median)	0.09	0.04	0.07				0.09	0.04	0.07
	75th Percentile	0.21	0.12	0.17				0.21	0.12	0.17
	Maximum Observed	0.95	0.52	0.95				0.95	0.52	0.95

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 13		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	104	95	199	0	0	0	104	95	199
	Mean	0.08	0.10	0.09				0.08	0.10	0.09
	Standard Deviation	0.11	0.08	0.10				0.11	0.08	0.10
	Minimum Observed	-0.36	-0.21	-0.36				-0.36	-0.21	-0.36
	25th Percentile	-0.03	-0.01	-0.03				-0.03	-0.01	-0.03
	50th Percentile (Median)	0.05	0.07	0.06				0.05	0.07	0.06
	75th Percentile	0.14	0.17	0.14				0.14	0.17	0.14
	Maximum Observed	1.03	0.85	1.03				1.03	0.85	1.03

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 14		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	104	111	215	0	0	0	104	111	215
	Mean	0.12	0.09	0.11				0.12	0.09	0.11
	Standard Deviation	0.10	0.09	0.10				0.10	0.09	0.10
	Minimum Observed	-0.20	-0.20	-0.20				-0.20	-0.20	-0.20
	25th Percentile	0.00	-0.02	-0.02				0.00	-0.02	-0.02
	50th Percentile (Median)	0.10	0.06	0.08				0.10	0.06	0.08
	75th Percentile	0.22	0.17	0.20				0.22	0.17	0.20
	Maximum Observed	0.88	1.27	1.27				0.88	1.27	1.27

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 15		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	102	106	208	0	0	0	102	106	208
	Mean	0.11	0.08	0.10				0.11	0.08	0.10
	Standard Deviation	0.08	0.08	0.08				0.08	0.08	0.08
	Minimum Observed	-0.19	-0.23	-0.23				-0.19	-0.23	-0.23
	25th Percentile	0.01	-0.02	0.00				0.01	-0.02	0.00
	50th Percentile (Median)	0.08	0.07	0.08				0.08	0.07	0.08
	75th Percentile	0.20	0.16	0.18				0.20	0.16	0.18
	Maximum Observed	0.41	0.74	0.74				0.41	0.74	0.74

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 16		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	99	102	201	0	0	0	99	102	201
	Mean	0.09	0.05	0.07				0.09	0.05	0.07
	Standard Deviation	0.12	0.08	0.10				0.12	0.08	0.10
	Minimum Observed	-0.36	-0.18	-0.36				-0.36	-0.18	-0.36
	25th Percentile	-0.01	-0.06	-0.03				-0.01	-0.06	-0.03
	50th Percentile (Median)	0.06	0.05	0.05				0.06	0.05	0.05
	75th Percentile	0.14	0.14	0.14				0.14	0.14	0.14
	Maximum Observed	1.17	0.80	1.17				1.17	0.80	1.17

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 17		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	98	104	202	0	0	0	98	104	202
	Mean	0.11	0.07	0.09				0.11	0.07	0.09
	Standard Deviation	0.10	0.07	0.08				0.10	0.07	0.08
	Minimum Observed	-0.17	-0.19	-0.19				-0.17	-0.19	-0.19
	25th Percentile	0.00	-0.01	-0.01				0.00	-0.01	-0.01
	50th Percentile (Median)	0.08	0.05	0.06				0.08	0.05	0.06
	75th Percentile	0.19	0.14	0.17				0.19	0.14	0.17
	Maximum Observed	1.21	0.72	1.21				1.21	0.72	1.21

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 18-29		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	56	102	158	17	67	84	73	169	242
	Mean	0.09	0.06	0.08	0.10	0.09	0.10	0.09	0.07	0.08
	Standard Deviation	0.45	0.36	0.39	0.15	0.17	0.16	0.40	0.30	0.33
	Minimum Observed	-0.22	-0.30	-0.30	-0.16	-0.19	-0.19	-0.22	-0.30	-0.30
	25th Percentile	-0.04	-0.02	-0.04	0.03	-0.01	0.00	-0.04	-0.01	-0.03
	50th Percentile (Median)	0.06	0.04	0.05	0.09	0.10	0.10	0.07	0.04	0.06
	75th Percentile	0.16	0.11	0.13	0.17	0.17	0.17	0.17	0.12	0.14
	Maximum Observed	0.86	1.47	1.47	0.27	0.71	0.71	0.86	1.47	1.47

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 30-39		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	47	137	184	20	71	91	67	208	275
	Mean	0.17	0.07	0.10	0.11	0.05	0.07	0.16	0.06	0.09
	Standard Deviation	0.36	0.24	0.28	0.21	0.13	0.15	0.32	0.21	0.25
	Minimum Observed	-0.19	-0.30	-0.30	-0.16	-0.22	-0.22	-0.19	-0.30	-0.30
	25th Percentile	0.05	-0.03	0.00	-0.03	-0.05	-0.04	0.05	-0.04	-0.01
	50th Percentile (Median)	0.14	0.04	0.08	0.04	0.03	0.04	0.14	0.04	0.07
	75th Percentile	0.22	0.15	0.17	0.19	0.14	0.17	0.21	0.15	0.17
	Maximum Observed	0.79	0.83	0.83	0.70	0.46	0.70	0.79	0.83	0.83

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 40-49		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	53	108	161	27	36	63	80	144	224
	Mean	0.08	0.10	0.09	0.18	0.12	0.15	0.09	0.10	0.10
	Standard Deviation	0.36	0.27	0.30	0.23	0.18	0.21	0.33	0.25	0.28
	Minimum Observed	-0.61	-0.15	-0.61	-0.09	-0.15	-0.15	-0.61	-0.15	-0.61
	25th Percentile	-0.02	0.00	-0.01	0.06	0.00	0.00	-0.02	0.00	-0.01
	50th Percentile (Median)	0.10	0.07	0.09	0.13	0.05	0.09	0.10	0.07	0.09
	75th Percentile	0.19	0.18	0.19	0.28	0.19	0.25	0.21	0.18	0.19
	Maximum Observed	0.46	1.00	1.00	0.77	0.75	0.77	0.77	1.00	1.00

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 50-59		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	50	76	126	22	22	44	72	98	170
	Mean	0.17	0.20	0.18	0.13	0.22	0.16	0.16	0.20	0.18
	Standard Deviation	0.35	0.47	0.43	0.27	0.31	0.29	0.33	0.44	0.40
	Minimum Observed	-0.06	-0.18	-0.18	-0.25	-0.12	-0.25	-0.25	-0.18	-0.25
	25th Percentile	0.06	0.03	0.04	-0.02	-0.03	-0.02	0.04	0.03	0.04
	50th Percentile (Median)	0.16	0.16	0.16	0.11	0.14	0.12	0.15	0.16	0.16
	75th Percentile	0.26	0.25	0.26	0.18	0.43	0.27	0.26	0.27	0.26
	Maximum Observed	0.78	1.05	1.05	0.56	0.89	0.89	0.78	1.05	1.05

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 60-69		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	40	56	96	13	17	30	53	73	126
	Mean	0.23	0.18	0.21	0.26	0.23	0.24	0.23	0.19	0.21
	Standard Deviation	0.44	0.41	0.42	0.28	0.17	0.22	0.40	0.36	0.38
	Minimum Observed	-0.13	-0.31	-0.31	-0.04	-0.15	-0.15	-0.13	-0.31	-0.31
	25th Percentile	0.08	0.04	0.06	0.12	0.11	0.12	0.08	0.04	0.07
	50th Percentile (Median)	0.24	0.15	0.19	0.16	0.17	0.16	0.23	0.15	0.19
	75th Percentile	0.31	0.24	0.29	0.28	0.32	0.32	0.31	0.24	0.29
	Maximum Observed	0.92	0.97	0.97	0.76	0.74	0.76	0.92	0.97	0.97

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – Age 70-85		English			Spanish			Total		
		Males	Females	Total	Males	Females	Total	Males	Females	All
	N	66	62	128	20	8	28	86	70	156
	Mean	0.28	0.15	0.23	0.27	0.30	0.28	0.28	0.15	0.23
	Standard Deviation	0.29	0.22	0.27	0.15	0.11	0.14	0.27	0.22	0.26
	Minimum Observed	-0.10	-0.39	-0.39	-0.09	0.05	-0.09	-0.10	-0.39	-0.39
	25th Percentile	0.11	0.03	0.09	0.15	0.17	0.15	0.11	0.03	0.09
	50th Percentile (Median)	0.27	0.16	0.21	0.27	0.36	0.27	0.27	0.16	0.21
	75th Percentile	0.40	0.29	0.32	0.40	0.37	0.38	0.40	0.29	0.32
	Maximum Observed	0.94	0.56	0.94	0.75	0.69	0.75	0.94	0.69	0.94

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – NCS Sample of Mothers		English	Spanish	All
	N	67	32	99
	Mean	0.08	0.07	0.08
	Standard Deviation	0.18	0.15	0.17
	Minimum Observed	-0.21	-0.18	-0.21
	25th Percentile	-0.04	-0.03	-0.04
	50th Percentile (Median)	0.06	0.02	0.05
	75th Percentile	0.17	0.19	0.17
	Maximum Observed	1.00	0.44	1.00

Table 2. NIH Toolbox Dynamic Visual Acuity Test (logMAR difference score, average of left and right) – NCS Sample of Pregnant Women		English	Spanish	All
	N	72	40	112
	Mean	0.04	0.05	0.04
	Standard Deviation	0.12	0.13	0.12
	Minimum Observed	-0.30	-0.19	-0.30
	25th Percentile	-0.01	-0.03	-0.02
	50th Percentile (Median)	0.04	0.05	0.04
	75th Percentile	0.11	0.13	0.12
	Maximum Observed	0.38	0.37	0.38

Figure 1
Least Squares Means