TOVA

Test of Variables of Attention®

PROFESSIONAL MANUAL

The TOVA Company
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T.O.V.A.® Professional Manual

Test Of Variables of Attention Continuous Performance Test

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1 Introduction to the T.O.V.A.

1.1 The History of the T.O.V.A.

The continuous performance test (CPT) is a paradigm first introduced by Rosvold, Mirsky, Sarason, Bransome & Beck in the mid-50's. Their CPT was a visual, language based, sequential A-X task in which the subject was asked to make a button press whenever they saw an "A" followed by "X" in a stream of characters presented one at a time. Since then, many CPTs have been created primarily for use in research projects, and a few have been made available commercially for researchers, schools, and clinicians.

The T.O.V.A. (Test of Variables of Attention) began life as a large rack of electronics controlling a tachistoscopic shutter and slide projector. This apparatus (nicknamed "Herman" by one of the children in an early study) was used in our earliest clinical research in 1966, focused on was then called "the Hyperkinetic Reaction of Childhood" (McMahon, Deem & Greenberg, 1970). This double blind, placebo controlled study examined the effects of three classes of medications (a psychostimulant, a tranquilizer, and a minor tranquilizer), and was one of the first to utilize a CPT as an outcome measure in research involving children.

This early CPT introduced some key features found in the T.O.V.A. The stimuli were non-alphanumeric, non-sequential, and randomly (but infrequently) presented. Even with an accuracy of only ±100 milliseconds ($\pm ms$), this early CPT showed the efficacy of a psychostimulant (dextroamphetamine) compared to a tranquilizer (chlorpromazine) in the treatment of hyperkinetic children. It is noteworthy that the classroom behavior rating scale used (the Conners' Parent-Teacher Questionnaire) was not useful in showing medication effects. This study also demonstrated the importance of measuring symptoms of inattention and hyperactivity separately, underscoring the need to develop appropriate tools to measure each set of symptoms.

Shortly after the release of the Apple II microcomputer in the late 70's, the current T.O.V.A. paradigm (infrequent followed by frequent stimulus conditions) and the electronic T.O.V.A. microswitch were developed. The new set-up was initially named the "MCA" (for"Minnesota Computer Assessment"). However, a potential copyright conflict was identified, and the MCA was renamed the "Test of Variables of Attention" or "T.O.V.A." During the 80's, the T.O.V.A. underwent wide-scale norming and was used in a number of clinical trials.

The DOS/PC version, programmed in the early 80's, continued the innovative use of two stimulus-frequency conditions and included tallies of anticipatory responses and commission errors as measures of validity. In those days, the data were sent directly to Lawrence Greenberg, MD for hand scoring and interpretation. The Macintosh version, programmed in the early 90's, and later DOS/PC versions were self-scoring, using an elaborate algorithm based on data from of some 10,000 clinical cases and numerous studies.

A distribution company, Universal Attention Disorders, Inc, was formed in 1990 with the hiring of full-time technical and interpretation support services and the formation T.O.V.A. Research Foundation.

In the early 1990s, the T.O.V.A. incorporated a second version, the auditory T.O.V.A. (formerly called the T.O.V.A.-A.). The T.O.V.A. continued to be upgraded with improved user friendliness, development of the School and Home Intervention Reports, expansion of the normative base to year-by-year, gender-based norms for children, and the addition of signal detection indices for comparison to an identified-ADHD sample.

Since 2000, the T.O.V.A. has continued to progress. The company changed its name in 2006 to The TOVA Company, and in 2007 released the T.O.V.A. 7.3. With the release of the T.O.V.A. 8 in 2011, the T.O.V.A. took a quantum leap forward. Testing became more accurate with the new T.O.V.A. 8 hardware, and the report added the Symptom Exaggeration Index, Attention Performance Index, and Ex-Gaussian distribution parameters. The External A/V test was introduced, which allows testing in your OS without rebooting, using the T.O.V.A. USB device to maintain accurate timing. In 2015, the data sets for the Symptom Exaggeration Index (SEI) were reanalyzed and renamed Performance Validity. Also in 2015, the Attention Performance

Index (API) became the Attention Comparison Score (ACS) to indicate a scale rather than index.

The current T.O.V.A. tests measure many more components of auditory and visual information processing than do earlier CPTs. These tests are laboratory-grade tools that provide precise, direct, and objective assessment of attention and self-regulation. While many clinicians rely on behavior rating scales, rater bias and inexperience are frequent contaminants of such measures. The T.O.V.A. test provides a tool to objectively measure critical aspects of attention and inhibitory control, which are a vital part of any broad assessment of attention disorders, including ADHD.

1.2 The T.O.V.A. Test

The Tests of Variables of Attention (T.O.V.A.) are individually administered computerized tests developed to assess attention and impulse control in normal and clinical populations. They are commonly used in conjunction with other clinical tools or diagnostic tests in neuropsychological or psychological evaluations. The T.O.V.A. was developed to measure attention and impulse control processes in four areas: response time variability, response time, impulse control (commission errors), and inattention (omission errors).

The visual T.O.V.A.'s stimuli are two easily discriminated geometric figures centered on the computer screen. A sample of the visual target and nontarget stimuli appears in Figure 1. The stimuli are squares; some widescreen LCD panel displays may distort the images into the form of rectangles. If this occurs, we recommend that the display resolution be modified in the computer's system control panel, or that an external monitor be used to display the stimuli.

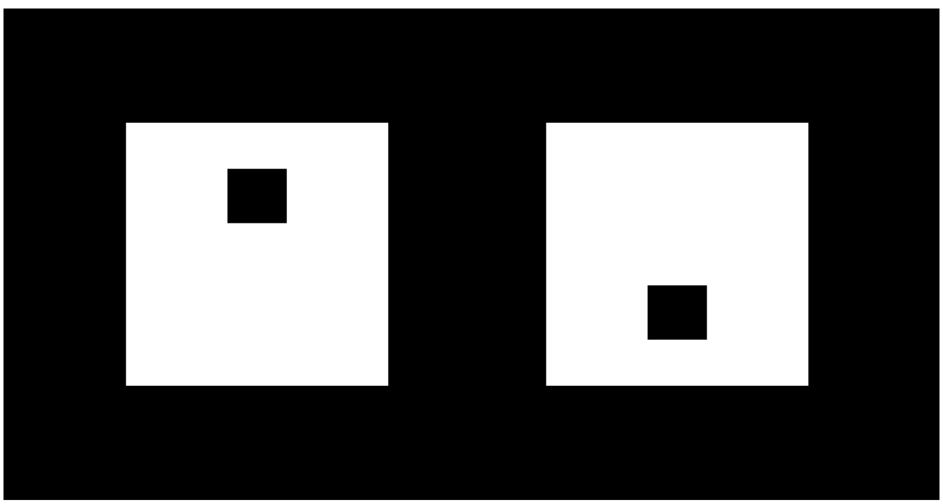

Figure 1: T.O.V.A. Stimuli: Target and Nontarget

The visual T.O.V.A. was normed using stimuli under the following conditions:

- A 12-inch (diagonally measured) monitor
- A stimulus size of roughly 3 inches (measured diagonally)
- An eye-to-monitor distance of roughly 24 - 36 inches, preferably closer to the latter
- Presentation of the stimuli at roughly eye level to the subject

These are the recommended conditions; however, monitor size, monitor resolution and distance from the subject's eyes may vary. For a typical distance from a typical display (sized 15 to 17 inches) it is recommended that the stimuli be sized to about three inches, measured diagonally. Because it may not be always possible to achieve this with precision, an acceptable range is around 15% - 30% of the monitor's size (measured diagonally), depending on the subject's distance to the monitor and the size of the screen (the greater the distance, the larger the desired stimulus). Target size is important for the following reasons:

- Stimuli that are too small (or too far away) can be visually fatiguing. Since the T.O.V.A. is a test of attention, not visual acuity, the subject must be able to readily discerning the target and nontarget stimuli for results to be valid.
- Stimuli that are too large (or too close) require large eye sweeps to discern targets from nontargets. Eye sweeping can slow response time and be visually fatiguing. The subject should be able to see the complete stimuli and screen all at once, without having to sweep their eyes to discern the target/nontarget.

Most computer configurations are well within these parameters. However, some screens may not have the capability to adjust the T.O.V.A.'s screen resolution to an appropriate size. To address situations such as this, the T.O.V.A. software has built-in scale adjustment settings. See **'Stimuli settings'** in the **T.O.V.A. 8 User's Manual** for details.

It is recommended that, if possible, the user select an option that most closely approximates the three inches diagonal measurement or 25%-of-screen rule.

Stimuli for the auditory T.O.V.A. test are two easily discriminated audible tones: the target is G above middle C (392.0 Hz) and the nontarget is middle C (261.6 Hz), played though external speakers connected to the computer.

In both versions of the T.O.V.A., a stimulus is presented for 100 ms at 2000 ms intervals. The target stimulus is presented in 22.5% (n = 72) of the trials during the first half of the test (stimulus infrequent condition) and 77.5% (n = 252) of the trials during the second half (stimulus frequent condition). The subject is instructed to respond to the target as quickly as possible. The varying target-nontarget ratio allows for the examination of the effects of differing response demands on response time variability, response time, inattention and impulsivity.

Specifically, quarters 1 and 2, representing the first half or stimulus infrequent condition, have 36 targets out of 162 stimuli per quarter (ratio of 1:3.5). Quarters 3 and 4, representing the second half or stimulus frequent condition, have 126 targets out of 162 stimuli per quarter (ratio of 3.5:1; see Table 1). The targets are presented in a fixed random sequence. The first half scores refer to the subject's performance across quarters 1 and 2 combined, and the second half refers to the combined scores for quarters 3 and 4. The total score reflects subject's performance over the entire test. The total test time is 21.6 minutes, which equates to 10.8 minutes per condition or half, and 5.4 minutes for each of the four quarters.

Table 1: Test Stimuli Breakdown

	Quarter				Half		Total
	1	2	3	4	1	2	
# Targets	36	36	126	126	72	252	324
# Nontargets	126	126	36	36	252	72	324

The T.O.V.A. software automatically records the subject's responses, nonresponses, and response times and then calculates raw scores, standard scores, and percentages. The T.O.V.A. Report provides standard scores for each variable by quarters, halves, and totals, and provides printable reports displaying the subject's results in narrative and graphic forms.

In addition to the primary attention variables, secondary indices provide information about the subject's performance in several ways: (a) anticipatory responses, (b) multiple responses, (c) post-commission response time and response time variability, (d) d' (d-prime), or discriminability, and (e) beta, or response style. A discriminate function measure comparing the current subject's performance to a known-ADHD group, the Attention Performance Index, is also provided.

1.2.1 T.O.V.A. Variables and Scoring

The following section provides explanatory information on each variable along with the formulas used to calculate the scores.

Response Time Variability (abbreviated "RTV") is a measure of the variability in the subject's response time for accurate responses; that is, the consistency of their speed of responding. The response time variability score is based on the standard deviation of the mean correct response times.

The response time variability formula is:

$$\text{Response Time Variability} = \sqrt{\frac{\Sigma(\text{Response Times - Mean Correct Response Time})^2}{\#\text{Correct Responses}}}$$

Response Time (abbreviated "RT') is the average time it takes the subject to respond correctly to a target. Specifically, it is the amount of time from when a target is first presented to when the microswitch is pressed by the subject. Response Time is the average of correct response times, in which the sum of all correct response times is divided by the number of correct target "hits" and is reported by quarter, half, and total.

The response time formula is:

$$\text{Response Time} = \frac{\Sigma\text{Correct Response Times}}{\#\text{Targets}}$$

Errors of Commission (abreviated "C" or "COM") occur when the subject fails to inhibit responding and incorrectly responds to a nontarget, that is, the subject presses the button after a nontarget is presented. The commission score is calculated as the number of incorrect responses to nontargets (false positives), divided by the number of nontargets presented. Commission errors are considered a measure of impulsivity or lack of inhibitory control. Commission errors are presented as a percentage of total possible errors.

The commission error formula is:

$$\text{Errors of Commission}(\%) = \frac{\#\text{Commissions}}{\#\text{Nontargets}} \times 100\%$$

Errors of Omission (abreviated "O" or "OM") occur when the subject does not respond to the designated target; that is, the subject fails to press the T.O.V.A. microswitch when a target is presented. Omission scores are calculated as the number of incorrect non-responses to targets (false negatives), divided by the number of total targets presented. Omission errors are considered a measure of inattention.

The omission error formula is:

$$\text{Errors of Omission}(\%) = \frac{\#\text{Omissions}}{\#\text{Targets}} \times 100\%$$

The **d' (D Prime)** score is a response discriminability score reflecting the ratio of hits to "false alarms". The measure is derived from Signal Detection Theory and has been shown to help distinguish non-impaired individuals from those diagnosed with attention disorders (Mussgay & Hertwig (1990). The score reflects the accuracy of target (signal) and nontarget (noise) discrimination and can be interpreted as a measure of "perceptual sensitivity." The calculation of D Prime is complex, and is detailed below.

Calculating D Prime (d')

1. Obtain the Omission and Commission percentage from the quarter, half, or total for which you wish to calculate D Prime (these can be found in the Results Table).
2. Calculate the Hit Rate and the False Alarm Rate:

$$\text{Hit Rate} = 1 - \frac{\text{Omission Percentage}}{100}$$

$$\text{False Alarm Rate} = \frac{\text{Commission Percentage}}{100}$$

   - If the Hit Rate is exactly 0, then set the Hit Rate equal to 0.00001
   - If the Hit Rate is exactly 1, then set the Hit Rate equal to 0.99999
   - If the False Alarm Rate is exactly 0, then set the False Alarm Rate equal to 0.00001
   - If the False Alarm Rate is exactly 1, then set the False Alarm Rate equal to 0.99999

3. Calculate the probabilities (called pHit Rate and pFalse Alarm Rate):

$$\text{pHit Rate} = 1 - (\text{Hit Rate})$$

$$\text{pFalse Alarm Rate} = 1 - (\text{False Alarm Rate})$$

   - If the pHit Rate > 0.5, then subtract the pHit Rate from 1 - i.e., the new pHit Rate = 1 - (old pHit Rate)
   - If the pFalse Alarm Rate > 0.5, then subtract the pFalse Alarm Rate from 1 - i.e., the new pFalse Alarm Rate = 1 - (old pFalse Alarm Rate)

4. Calculate the Z scores (called zHit Rate and zFalse Alarm Rate):

   If you have access to a spreadsheet or statistical program:

   - zHit Rate = InverseDistributionFunction(pHit Rate)
   - zFalse Alarm Rate = InverseDistributionFunction(pFalse Alarm Rate)
   - Skip directly to Part 5

   Otherwise (Ref 1),

$$\text{Let T} = \sqrt{\ln \frac{1}{\text{pHit Rate}^2}}$$

$$\text{zHit Rate} = T - \frac{2.515517 + 0.802853 \times T + 0.010328 \times T^2}{1 + 1.432788 \times T + 0.189269 \times T^2 + 0.001308 \times T^3}$$

$$\text{Let T} = \sqrt{\ln \frac{1}{\text{pFalse Alarm Rate}^2}}$$

$$\text{zFalse Alarm Rate} = T - \frac{2.515517 + 0.802853 \times T + 0.010328 \times T^2}{1 + 1.432788 \times T + 0.189269 \times T^2 + 0.001308 \times T^3}$$

- If the pHit Rate was ≤ 0.5 , multiply the zHit Rate by -1
- If the pFalse Alarm Rate was ≤ 0.5, multiply the zFalse Alarm Rate by -1

5. Calculate D Prime:

$$\text{D Prime} = \text{zFalse Alarm Rate - zHit Rate}$$

(Ref 1: Approximation to the Inverse Normal Distribution Function. The Handbook of Mathematical Functions, Abramowitz and Stegun, Section 26.2.23)

The **Attention Comparison Score** (abreviated “ACS”) is a comparison of the subject’s T.O.V.A. performance to an identified ADHD sample’s performance. The score tells how similar the performance is to the ADHD profile: an ACS score below zero is more like the ADHD sample, and an ACS at or above zero is more like the normative sample.

The ACS formula is:

$$\text{ACS} = \text{Response Time Z score (Half 1)} + \text{D' Z score (Half 2)} + \text{Variability Z score (Total)} + 1.80$$

Post-Commission Response Time is the measure of time (in milliseconds) that the subject took to respond to a target immediately after a commission had been recorded.

The formula used to derive the Post-Commission Response Time is as follows:

$$\text{Post Commission Response Time} = \frac{\Sigma\text{Post Commission Response Times}}{\#\text{Post Commission Responses}}$$

Anticipatory Responsesare recorded when the subject presses the microswitch within 150 ms of stimulus onset (target or nontarget) and represents the subject making a “guess” that the stimulus will be a target—in effect, a response after the stimulus was presented, but before the subject could have fully perceived and distinguished the stimulus (known whether the stimulus actually was a target or nontarget). The number of anticipatory responses is recorded for each quarter, half and total. Note that, because subjects who make frequent commission errors tend to respond more often overall, excessive Anticipatory Responses generally result in fewer omission errors, increased commission errors, shortened response time, and increased variability.

The formula used to calculate the Anticipatory percentage is as follows:

$$\text{Anticipatory}(\%) = \frac{\#\text{Anticipatory Responses}}{\#\text{Total Stimuli}} \times 100(\%)$$

Multiple Responses occur when a subject presses the microswitch more than once per stimulus presentation. The Multiple Responses score reflects the number of stimuli in the given period for which there were multiple button presses. Multiple Responses are unusual responses.

2 Test Materials and Use

2.1 Software

The T.O.V.A. software is installed on the computer's hard drive and requires Windows 7, 8, or 10, or Mac OS X 10.8.5 or higher. Test administration is performed in the T.O.V.A. Precision Test Environment (PTE) or in the T.O.V.A. USB device itself during External Audio/Video (EAV) testing, since modern operating systems are not appropriate for tasks requiring precise and consistent timing. These testing methods allow consistent and reliable timing down to ±1 ms.

2.2 Hardware

The T.O.V.A. hardware includes the T.O.V.A. USB device and the T.O.V.A. microswitch—containing a built-in photodiode for display calibration, and the cables required to connect the device to the PC for either PTE or EAV testing. Use of the T.O.V.A. microswitch removes the timing and ergonomic variability that are present with the range and variety of input devices that used in typical Windows computer configurations.

The T.O.V.A. runs on most modern PCs. The test is administered via the computer's display (visual test) and speakers (auditory test).

- x86-64 processor running at 1 GHz or better
- 2 GB of memory available
- Minimum of 1 GB hard drive space
- USB Type A port (or Type C with an adapter)
- Screen size must be 10 inches or more.
- **PTE testing** requires a VESA video mode of 1024 x 768 x 16-bit.
- On Mac systems, **PTE testing** also requires a CD-ROM drive
- **External A/V testing** requires an external display (with a standard VGA connection) and external speakers.

2.3 Sample Populations

The Visual T.O.V.A. has been normed on children and adults, ages 4 to 80+ years. The full 21.6-minute Visual test was normed on children and adults 6 to 80+ years. The 4-and 5-year-old normative samples were gathered using a shorter version, consisting of the infrequent stimulus from Quarter 1 and the frequent stimulus condition from Quarter 3.

The 21.6-minute Auditory T.O.V.A. was normed on children and adults 6-29 years.

All norms are stratified by age and gender. Ages are calculated by rounding to the nearest birthday within six months. Adult normative date are provided in decade groupings (i.e., 20-29 years).

See section 4 on page 10 for Visual and Auditory normative data.

2.4 Professional Requirements

Please see **T.O.V.A. Intended Use** in the **T.O.V.A. Clinical Manual**.

2.5 Test Administration

Please see **Administering the T.O.V.A. Test** in the **User's Manual**.

3 Accurate, Precise Timing

Accurate measurement of the subject's response speed and variability of response speed is crucial for a CPT to be useful. On any compatible computer system, T.O.V.A. timing errors are controlled to within ±1 millisecond (ms), an unparalleled level of precision for these key parameters. This precision is attained through a number of technical innovations.

The first of these is the T.O.V.A. microswitch, a standard, precision input device. The inconsistent rate at which polling of standard input devices occurs means that no mouse or keyboard can be used for testing with any accuracy.

The second challenge to be overcome were the timing issues presented by complex, multitasking operating systems. Because of the variable number of background tasks, no CPT program running in a modern OS (Windows/Mac/Linux) can deliver timing precision.

Earlier versions of the T.O.V.A. 7 took advantage of Windows 95 and 98's ability to reboot to DOS, where the T.O.V.A. test could run uninterrupted. The T.O.V.A. 7.3 used a similar method of circumventing Windows, rebooting to a "Precision Test Environment" (PTE) for testing and then returning, automatically, to your operating system. The T.O.V.A. 8 brings a new PTE, this time based on a real-time flavor of Linux.

The T.O.V.A. 8 also introduces a second testing method. Instead of circumventing the operating system, The TOVA Company developed a USB device that could circumvent the PC entirely. The user's monitor and speakers plug into the T.O.V.A. USB device, thus creating an independent testing system that, during testing, relies on the PC only for power. Because this requires an external monitor and speakers (for auditory testing), we call it External Audio/Video (EAV) testing.

In addition to other hardware and software delays, we discovered one more timing issue: monitor refresh rates. Older CRT monitors had consistent refresh rates, but modern LCD displays do not. LCDs very widely from one another, and sometimes do not behave consistently at all.

To maintain timing accuracy, we need to compensate for this variability, and we do this through display calibration. Our T.O.V.A. 8 microswitch is equipped with a photodiode that, during calibration, measures the refresh rate of your display, whether it be a separate CRT or LCD display or the screen built into your laptop. Since we then know, with ±1 millisecond precision, how quickly the image will appear on the screen, we can record subjects' response times accurately. If the display simply cannot be calibrated, we know that the refresh rate is too variable, and we should not use that screen for testing.

None of these technologies are available in any other commercially available CPT.

4 Normative Data

4.1 Overview

This chapter presents the information concerning the normative data. The chapter is divided into normative information for each test, visual and auditory. The actual normative data are found in the Appendices. The data are given in table format across variables, stratified by age and gender.

4.2 Normative Data for the Visual T.O.V.A.

4.2.1 For child subjects

The subjects in the original normative data (Greenberg & Waldman, 1993) came from randomly selected classrooms in grades 1, 3, 5, 7 and 9. The schools were suburban public schools in or near Minneapolis, Minnesota. The ages of the children in this sample ranged from 6 to 16 years (see Table 2) and were primarily Caucasian (99%, 1% other). Subjects were excluded if they met any of the following criteria: a deviant classroom behavior rating defined by a score of greater than 2 standard deviations below average on the Conners Parent-Teacher Questionnaire, Abbreviated form; current use of psychoactive medication; or if they were receiving Special Education services. All testing was done in the mornings to control for possible diurnal effects.

Table 2: Age and Gender Distribution by Sample

Group	Original Sample	Additional Sample	Total Sample
Age 4 - 5			
Males	NA	36	36
Females	NA	36	36
Age 6 - 7			
Males	99	0	99
Females	100	1	101
Age 8 - 9			
Males	90	0	90
Females	99	0	99
Age 10 - 11			
Males	90	0	90
Females	82	0	82
Age 12 - 13			
Males	53	51	104
Females	59	59	118
Age 14 - 15			
Males	41	74	115
Females	56	50	106
Age 16 - 17			
Males	NA	40	40
Females	NA	47	47
Age 18 - 19			
Males	NA	57	57
Females	NA	120	120

Table 3: Age and Gender Distribution of Adult Sample

Group	Sample Size
Age 20 -29	
Male	19
Female	30
Age 30 - 39	
Male	4
Female	22
Age 40 -49	
Male	14
Female	19
Age 50 - 59	
Male	8
Female	16
Age 60 - 69	
Male	12
Female	24
Age 70 - 79	
Male	12
Female	39
Age 80+	
Male	8
Female	23

Additional normative data was later collected from 571 subjects. This sample consisted of 73 children, ages 4 to 5, and 498 subjects, ages 12 to 19 years (Greenberg & Crosby, 1992; also shown in Table 2). This sample consisted of children from an early-education screening project, public grade schools (in randomly selected classrooms), and a public high school. The early-education and grade-school children were from suburban public schools. The high school was located in a rural Minnesota community, and those subjects were primarily Caucasian (99%, 1% other). Exclusion rules were the same as those described above for the original normative sample. The 4 and 5 year old subjects were administered a shorter version of T.O.V.A., consisting of only one quarter for each condition (stimulus infrequent and stimulus frequent), quarters #1 and #3. All testing was done in the mornings to control for possible diurnal effects.

4.2.2 For adult subjects

The original T.O.V.A. adult normative sample consisted of 250 subjects, age 20 and older. The sample consisted primarily of persons of Caucasian ethnicity (99%, 1% other), and it was comprised of undergraduate students enrolled in three Minnesota liberal arts colleges and persons residing in nearby communities. Subjects were excluded from the study based upon current use of psychoactive medication, history of CNS disorder, or history of CNS injury (see Table 3 for demographic information of sample).

4.2.3 Normative Data for Test Variables

Greenberg & Waldman (1993) noted mean score differences for gender across age-groups for percentage of omission errors, percentage of commission errors, and mean response time. Males showed a higher percentage of omission errors than females ($F(1,771) = 13.42$, $p < .001$). Males also displayed more commission errors than females ($F(1,771) = 65.61$, $p < .001$). The curvilinear decrease with age in percentage of commission errors differed significantly between the two halves. The interactions of both linear ($F(1{,}771) = 15.80$, $p < .001$) and quadratic ($F(1{,}771) = 27.48$, $p < .001$) components of age with test half were significant. While the decrease in commission errors with age in the first half was flat with linear and curvilinear components virtually absent, in the second half the curvilinear decrease was much more dramatic. In addition, the significant differences for males to have more commission errors than females was greater in the second than the first half ($F(1{,}771) = 57.45$, $p < .001$).

Females showed a slower mean Response Time ($F(1{,}771) = 21.18$) $p < .001$), especially in younger ages, and a steeper linear decrease with age than males (slope = -.35 for females and -.29 for males; $F(1{,}770) = 9.70$, $p < .001$). Response time variability decreased curvilinearly with age ($F(1{,}771) = 174.41$, $p < .001$ for the linear trend); ($F(1{,}771) = 84.75$, $p < .001$ for the quadratic trend). Response time variability was greater ($F(1{,}771) = 68.74$, $p < .001$), and the age decrease was steeper and more curvilinear ($F(1{,}771) = 31.53$, $p < .001$ for the linear trend); ($F(1{,}771) = 18.67$, $p < .001$ for the quadratic trend), in the second half than in the first half (Greenberg & Waldman, 1993). Effects on response time variability also differed by quarter. Response time variability was greater ($F(1{,}773) = 82.96$, $p < .001$), and the linear decrease with age was steeper (slope = .33) for quarters 2 and 4 and -.28 for quarters 1 and 3; ($F(1, 773) = 32.90$, $p < .001$ for the linear trend), in quarters 2 and 4 than in quarters 1 and 3. No gender differences were found for response time variability (Greenberg & Waldman, 1993).

The means and standard deviations for percentage of omission errors, percentage of commission errors, response time, response time variability, and d prime across age groups by gender are provided in Appendices C and D. These tables represent the pool of the original sample, N = 775, (Greenberg & Waldman, 1993) and additional sample, N = 821, (Greenberg & Crosby, 1992A) for a total sample size of 1596 for ages ranging from 4 to 80 years (1346 children, 250 adults).

4.3 Normative Data for Auditory T.O.V.A.

4.3.1 For child subjects

The subjects for the normative sample (N = 2551) were recruited from elementary and high schools in three metropolitan Minneapolis suburban public schools and were predominately Caucasian (99%, 1% other). Age and gender distribution are shown in Table 4. Subjects were excluded from the sample if they met any of the following: a deviant classroom behavior rating defined by a score of greater than 2 standard deviations above the mean on the Conners Parent-Teacher Questionnaire, Abbreviated form; current use of psychoactive medication; or receiving Special Education services. Ages of the sample ranged from 6 - 19 years. As with the visual T.O.V.A., all testing was done in the mornings to minimize diurnal effects.

It is important to note that the auditory stimulus version of the test has been normed on children aged 6 - 19 years. Our preliminary testing of the auditory version with 4 and 5 years olds indicated that this auditory task was too difficult for the children at this age, even when using the shorter (i.e., quarters 1 and 3 only) version.

4.3.2 For adult subjects

Limited additional normative data is available for the adult sample in Table 5. Testing adult subjects is to be considered experimental for the auditory version. The normative study will be made available upon completion.

Table 4: Age and Gender Distribution by Sample

Group	Total Sample		Group	Total Sample
Age 6			Age 13	
Males	85		Males	98
Females	90		Females	91
Age 7			Age 14	
Males	92		Males	100
Females	82		Females	101
Age 8			Age 15	
Males	97		Males	98
Females	108		Females	90
Age 9			Age 16	
Males	104		Males	94
Females	100		Females	87
Age 10			Age 17	
Males	106		Males	99
Females	107		Females	107
Age 11			Age 18	
Males	96		Males	101
Females	104		Females	101
Age 12			Age 19	
Males	87		Males	22
Females	94		Females	10

Table 5: Age and Gender Distribution of Adult Sample

Group	Sample Size
Age 20 +	
Male	54
Female	75

4.3.3 Normative Data for Test Variables

To maintain consistency between visual and auditory tests, two-year age groups were used (i.e., 6 to 7, 8 to 9, etc.). Age and gender differences for each variable were examined.

Similar to the visual stimulus test, significant main effects were found for age for all six performance indices. Further testing indicated that for commission, response time, and response time variability, all three contrasts were significant: quarter 1 vs. quarter 2 ($p < .01$ for commissions, $p < .001$ for response time and response time variability); quarter 3 vs. quarter 4 ($p < .001$ for all three variables); and quarter 1 and 2 vs. quarters 3 and 4 ($p < .001$ all three variables). A different set of contrasts was found to be significant for omission errors: quarter 1 vs. quarter 2: quarters 1 and 2 vs. quarters 3 and 4 ($p < .001$ for both contrasts). For d' (d prime), the following two comparisons were significant: quarters 3 vs. quarter 4; quarters 1 and 2 vs. quarters 3 and 4 ($p < .001$). Significant age effects were observed for omissions, commissions, response time, response time variability ($p < .001$ for each).

Results of analysis for effects of gender found that males had: (1) significantly higher commission errors ($p < .001$); and (2) shorter response times [i.e., lower mean response time scores] ($p < .001$). No main effects for gender were noted for omissions, response time variability and d prime.

Gender by quarter interactions were noted for commissions ($p < .001$), response time ($p < .001$), response time variability ($p < .01$) and d prime ($p < .01$).

The means and standard deviations for percent of omission errors, percent of commission errors, response time, response time variability and d' across age groups by gender are provided in the Appendices.

5 Reliability

5.1 Internal Reliability

Internal Reliability Chronbach alpha, split half and Kuder-Richardson reliability coefficients, traditionally reported as measures of a test's consistency, are not appropriate for timed tasks such as the T.O.V.A. (Anastasi, 1988). To calculate reliability coefficients for the test, Pearson product coefficients (r) were computed for all variables across both conditions. Pearson correlation coefficients (r) were computed for all variables across the two conditions, as shown in Tables 6 - 16. As can be seen in the tables, the two time epochs represent consistent measures within each condition.

Table 6: Within Condition 1 Reliability Coefficients

Variable	Q1 : Q2	Q3 : Q4
Omission	.72	.70
Commission	.79	.82
Response Time (ms)	.93	.93
RT Variability (ms)	.70	.86
D Prime	.52	.72

5.1.1 Condition 1 (Stimulus Infrequent)

The reliability coefficients for the stimulus infrequent condition (quarters 1 and 2) support that the variables are consistent within each variable over the condition, yet distinct between each variable.

Table 7: Within Condition 1 Omission Reliability Coefficients

Condition 1	Omission Reliability
Q1 : Q2	.72
Q1 : H1	.92
Q1 : Total	.79
Q2 : H1	.93
Q2 : Total	.85
H1 : Total	.88

Table 8: Within Condition 1 Commission Reliability Coefficients

Condition 1	Commission Reliability
Q1 : Q2	.79
Q1 : H1	.95
Q1 : Total	.88
Q2 : H1	.93
Q2 : Total	.80
H1 : Total	.71

Between-variable coefficients support the contention that the variables capture different components of variance. The relationship between percentage of omission and percentage of commission coefficients, while

Table 9: Within Condition 1 Response Time Reliability Coefficients

Condition 1	Response Time (ms) Reliability
Q1 : Q2	.93
Q1 : H1	.98
Q1 : Total	.90
Q2 : H1	.98
Q2 : Total	.91
H1 : Total	.89

Table 10: Within Condition 1 Response Time Variability Reliability Coefficients

Condition 1	Response Time (ms) Variability Reliability
Q1 : Q2	.70
Q1 : H1	.89
Q1 : Total	.80
Q2 : H1	.94
Q2 : Total	.84
H1 : Total	.92

statistically significant ($p < .01$), are not generally robust. The relationship between percentage of omissions to the other variables fails to demonstrate a robust level of commonness.

Percentage of commissions to response time comparisons failed to find statistical significance for all variable relationships (see Table ?? in the Appendices). Those that did find statistical significance were not robust with ranges from .05 to .12. Commission to response time variability relationships, while statistically significant ($p < .001$), supported a limited relationship between the two variables.

Response time and response time variability relationships were statistically significant ($p < .001$), and the data supported the relationship between the two variables, as one would predict. For the two variables, the within-quarter relationships are generally stronger than the between-quarter relationships.

5.1.2 Condition 2 (Stimulus Frequent)

Condition 2 data followed that of condition 1. Within-variable coefficients were generally stronger than those between variables.

The coefficient for percentage of commission errors between quarters 3 and 4, $\underline{r} = .82$, indicates a consistent relationship.

Between-variable reliability coefficients followed suit with those of condition 1. The between-variable coefficients are not as robust as the within-variable ones. Again, the variables across the condition are measuring a small degree of commonness. The exception is where one would expect, between response time and response time variability. These two variables showed the expected closeness of task measure with coefficients ranging from .70, response time quarter 3 to variability quarter 4, to .80, response time total to variability half 2.

Table 11: Within Condition 1 D Prime Reliability Coefficients

Condition 1	D Prime Reliability
Q1 : Q2	.52
Q1 : H1	.81
Q1 : Total	.56
Q2 : H1	.82
Q2 : Total	.55
H1 : Total	.72

Table 12: Within Condition 2 Omission Reliability Coefficients

Condition 2	Omission Reliability
Q3 : Q4	.70
Q4 : H2	.92
Q3 : Total	.79
Q4 : H2	.93
Q4 : Total	.85
H2 : Total	.88

5.1.3 Standard Errors of Measurement

Standard errors of measurement (SE_M) were calculated for the standard scores based upon the above reliability coefficients. A pooled (weighted average) standard deviation was calculated to determine the quarter-to-quarter combined standard deviation. This pooled (weighted average) standard deviation was used in the calculation of the SE_M for each variable. Only those comparisons which would logically be made for the test data were calculated. SE_M for within condition within variable comparison were calculated; between condition were not calculated due to the nature of the test. Table 17, below, provides the pooled (weighted average) standard deviation and SE_M.

5.1.4 Internal Consistency

Llorente, Voigt, Jensen, Fraley, Heird & Rennie (2008) re-examined the internal consistency of the T.O.V.A. within an increased sample size of 63 ADHD children. The ages of the children ranged from 6 to 12. The study participants were strictly diagnosed to meet the DSM-IV diagnostic criteria or ADHD. Llorente, et al. used a diagnostic rule insisting that each participant in the study had to meet at least 5 out of the 6 diagnostic criteria for the Inattention criteria dealing with inattention within the DSM-IV ADHD criterion. A no medication baseline T.O.V.A. was given to all children and the baseline test data was used to determine the internal consistency of the T.O.V.A.

Table 18 provides the mean raw error totals and raw time in milliseconds for each quarter. Table 19 provides the internal consistency coefficients (Pearson product-moment correlation coefficients). The number of subjects found within the table differs from the total number of participants in that some subject data was invalid, per the study's authors.

The Llorente, et al. (2008) study reports robust internal consistency for the T.O.V.A. The coefficients were slightly less than we report with this manual, however, the sampling for each study differed. Our reported internal consistencies (see above) were based on the normative data taken from healthy sample

Table 13: Within Condition 2 Commission Reliability Coefficients

Condition 2	Commission Reliability
Q3 : Q4	.82
Q3 : H2	.94
Q3 : Total	.90
Q4 : H2	.96
Q4 : Total	.89
H2 : Total	.93

Table 14: Within Condition 2 Response Time (RT) Reliability Coefficients

Condition 2	RT (ms) Reliability
Q3 : Q4	.93
Q3 : H2	.98
Q3 : Total	.98
Q4: H2	.98
Q4 : Total	.97
H2 : Total	.99

(i.e., non-ADHD) children. The Llorente et al. coefficients are based on children strictly diagnosed as ADHD. The authors note that the use of a strictly homogeneous cohort base most likely had a negative effect on the magnitude of the correlations observed. Nonetheless, the range of the internal consistency coefficients reported is robust. The data support the internal consistency of the TOVA within normative and ADHD clinical samples.

5.1.5 Test/Retest Reliability

In addition to examining internal consistency of the T.O.V.A., Llorente, Amado, Voigt, Berretta, Fraley, Jensen & Heird (2001) evaluated temporal stability and reproducibility of individual test scores. The study utilized 49 strictly diagnosed Attention Deficit Hyperactive Disorder (ADHD) children. The mean age of the cohorts was 9.5 years with a standard deviation of 1.5 years. Age range of the participants was from 6 to 12 years. The children were evaluated three times over four months.

Pearson product moment correlations (r_{xy}) were calculated across three time intervals for errors of omission, errors of commission, response time and response time variability. The coefficients are in Table 21. The coefficients indicate moderate test-retest correlation across several test periods. While the coefficients may be moderate, they are not unexpected in that the participants were children diagnosed with ADHD, rather than normal controls. Variability is expected within the ADHD group scores with less variability expected in normal control groups. To understand this further, the study authors then examined the repeatability of individual test scores within this same ADHD sample.

Llorente et al. (2001) used a Bland-Altman procedure to determine the limits of score agreement between the individual scores of each scale (omission, commission, response time and response time variability) between each of the visits (V_1-V_2, V_1-V_3, and V_2-V_3). Differences between the test scores from each of the two visits were used to evaluate the limits of agreement.

The data from the Bland-Altman procedure are provided in Table 22. The result of their analysis does indicate that the errors scores (omission and commission) had increased differences between test administra-

Table 15: Within Condition 2 Response Time Variability Reliability Coefficients

Condition 2	RT Variability Reliability
Q3 : Q4	.87
Q3 : H2	.95
Q3 : Total	.95
Q4 : H2	.97
Q4 : Total	.96
H2 : Total	.99

Table 16: Within Condition 2 D Prime Reliability Coefficients

Condition 2	RT Variability Reliability
Q3 : Q4	.87
Q3 : H2	.95
Q3 : Total	.95
Q4 : H2	.97
Q4 : Total	.96
H2 : Total	.99

tions. The response time and response time variability scores displayed less bias associated with increased differences, thus exhibiting greater reproducibility of individual scores. Llorente et al. conclude that the analysis yielded less agreement than observed for the entire sample (test-retest reliability coefficients). The variability found within the reproducibility analysis is most likely due to the nature of variability of attention and concentration found in ADHD itself. The authors also add that the T.O.V.A. test scores should be interpreted in context of a subject's history, neuropsychological test profile as well as neurobehavioral characteristics. This position is consistent with that proposed in the first edition of this manual.

To further understand the test-retest reliability Leark, Wallace & Fitzgerald (2004) investigated the matter using two different time intervals: 90 minutes and 1 week. The two intervals were selected for several reasons. Greenberg, Kindschi, Dupuy & Corman (1996) had recommended using the T.O.V.A. to monitor medication. The second time frame was chosen as it reflected what may occur in a typical clinical setting.

Study 1: 90-minute Test-Retest Interval

31 children, ages ranging from 6 through 14.2 years (overall M = 10.00 years, SD = 2.66 years) were administered the T.O.V.A. and then underwent a second administration at 90-minutes. Participants for the study were excluded if there was any history of central nervous system impairment, loss of consciousness, psychiatric disorder, or use of prescribed medication or over-the-counter medication affecting attention.

A two-tailed Pearson product moment correlation was utilized to determine the relationship between first and second administrations. The analysis yielded significant positive correlations overall T.O.V.A. scores (Table 23).

The correlation coefficients were then used to calculate the standard error of measurement (SE_M) for each T.O.V.A. score. The SE_M values are also located in Table 23.

To determine if there were practice effects, a series of paired Student t-tests were conducted over each of the four scores. Statistically significant mean score differences were found for the commission and response time scores. The commission scores were about 12 points higher on the second administration. The response time scores were slightly lower for the second administration. Each of the commission scores were within

Table 17: Table of Weighted Standard Deviation and SEm for Variable Over Condition

Variable	Q 1 : Q 2		Q 3 : Q 4	
	SD	SE_M	SD	SE_M
Omission	5.34	2.80	5.16	2.72
Commission	2.71	1.25	16.44	8.66
Response Time (ms)	109.11	29.23	104.35	54.99
Variability	38.75	21.33	62.34	32.85
D Prime	1.37	1.20	1.73	0.91

Table 18: Summary Statistics (Means and Standard Deviations[SD]) for Errors of Omission(OMM), Errors of Commission (COM), Response Time (RT) and Response Time Variability (RTV) at Baseline

	OMM Mean (SD)	COM Mean (SD)	RT Mean (SD)	RTV Mean (SD)
Q1	2.3 (3.7)	3.9 (6.8)	579.6 (126)	165. (64.4)
Q2	4.4 (6.2)	4.1 (7.1)	638.2 (174.3)	170. (65.6)
Q3	14.9 (24.9)	8.7 (5.5)	533. (144)	204.5 (83.8)
Q4	18.7 (28.7)	10.3 (6.1)	547.3 (175.5)	236. (112)

From: Llorente, A.M., Voight, R, Jensen, C.L., Fraley, J.K., Heird, W.C. & Rennie, K.M. (2008). The Test of Variables of Attention (TOVA): Internal Consistency (Q1 vs. Q2 and Q3 vs. Q4)) in Children with Attention Deficit/Hyperactivity Disorder (ADHD). Child Neuropsychology, 14. 314-322.

the normal limits range but do reflect actual differences obtained. The differences obtained on the response time are slight (about 4 points) yet reached statistical significance. The significant difference noted on the response time score is most likely related to the group variance within the second administration itself, as the SD is larger. Nonetheless, test users are encouraged to use caution when using the T.O.V.A. in 90-minute test intervals often reported in clinical settings.

The data indicate satisfactory test-retest reliability for the 90-minute interval. The use of at least one SE_M difference is highly recommended when comparing T.O.V.A. test scores for medication purposes. This will help account for test score fluctuations that may reflect random error rather than medication change. The use of at least two SE_M scores will provide even a more stable predictor of test scores when using the medication titration method.

Study 2: 1-week interval

For this study 33 children (20 males, 13 females) were administered the T.O.V.A. at one week intervals (+ 2 days). The ages of the sample ranged from 6 to 14.5 years (M = 10.10 years, SD = 2.59). The grade range was from first through eighth grade (M = 4.33 grade level, SD = 2.5). The participants had to have normal or corrected vision, as well as the time for the testing session. The testing was conducted at the child's school (Southern California private and public schools). Participants for the study were excluded if there was any history of central nervous system impairment, loss of consciousness, psychiatric disorder, or use of prescribed medication or over-the-counter medication affecting attention. All tests were administered following standardized procedures. Each participant was administered the T.O.V.A. once then re-administered the test approximately seven days later at the same time of the day as the first administration.

A two-tailed Pearson product moment correlation was utilized to determine the relationship between the test variables over the two time intervals. The results of the analysis indicate positive and significant correlations between the two administrations across all four of the T.O.V.A. scores (Table 24). As with the 90-minute interval study, the correlations were then used to determine the standard error of measurement (SE_M) for each of the scores.

Table 19: Internal Consistency (Q1 vs. Q2 and Q3 vs. Q4) Correlations for Errors of Omission, Errors of Commission, Response Time, and Response Time Variability

Errors of Omission *n=57*

	Q1	Q2	Q3	Q4
Q1	1.00			
Q2	.74	1.00		
Q3	.52	.69	1.00	
Q4	.55	.70	.94	1.00

Errors of Commission *n=58*

	Q1	Q2	Q3	Q4
Q1	1.00			
Q2	.53	1.00		
Q3	.32	.44	1.00	
Q4	.12	.22	.76	1.00

Response Time *n=58*

	Q1	Q2	Q3	Q4
Q1	1.00			
Q2	.77	1.00		
Q3	.63	.80	1.00	
Q4	.55	.71	.69	1.00

Response Time Variability

	Q1	Q2	Q3	Q4
Q1	1.00			
Q2	.55	1.00		
Q3	.55	.60	1.00	
Q4	.49	.63	.58	1.00

From: Llorente, A.M., Voight, R, Jensen, C.L., Fraley, J.K., Heird, W.C. & Rennie, K.M. (2008). The Test of Variables of Attention (TOVA): Internal Consistency(Q1 vs. Q2 and Q3 vs. Q4)) in Children with Attention Deficit/Hyperactivity Disorder (ADHD). Child Neuropsychology, 14. 314-322.

Practice effects were also examined using the same paired Student t-test method. As with the 90-minute interval study, statistically significant mean score differences were found for the commission mean scores. Similar to the 90-minute interval study, the commission score increased by about a 12 point margin. Non-significant mean score differences were found for the three remaining scores. Response time mean scores did not differ significantly as was found for the 90-minute interval.

The data from the study does indicate that the T.O.V.A. has highly stable test-retest reliability at one-week intervals with the healthy school aged children. The data from the Leark, Wallace & Fitzgerald study reflect more stable measures of reliability over the shorter time intervals. This finding is not unusual as Anastasi & Urbina (1997) have reported that test-retest coefficients are typically more stable over shorter time periods than those reported within the Llorente et al. study.

5.2 Reliability Data for the Auditory T.O.V.A. Test

5.2.1 Reliability

Like the visual version, the auditory version is a timed test. This makes traditional reliability coefficients, such as Chronbach alpha or split half, inappropriate (Anastasi, 1988). To calculate reliability coefficients for

Table 20: Total Number of Correct Target Responses (errors of omission and commission) internal consistency correlations for T.O.V.A. at Visit 3 (16 weeks [average] into study)

Test segment	(n)	(r_{xy})
Half 1 vs. Half 2	49	0.93**
Half 1 vs. Total	49	0.96**
Half 2 vs. Total	49	0.99**

** significant at .001 (two-tailed test)

From: Llorente, A. M., Amado, A.J., Voigt, R.G., Berretta, M.C., Fraley, J.K., Jensen, C.L. & Heird, W.C. (2001). Internal consistency, temporal stability, and reproducibility of the Test of Variables of Attention in children with attention-deficit hyperactive disorder. Archives of Clinical Neuropsychology, 16, 535-546.

Table 21: Test-Retest Reliability For Raw Scores Across Visits 1, 2 and 3

	Visit 1	Visit 2	Visit 3
Errors of Omission			
Visit 1	1.00		
Visit 2	0.51**	1.00	
Visit 3	0.61**	0.58**	1.00
Errors of Commission			
Visit 1	1.00		
Visit 2	0.71**	1.00	
Visit 3	0.58**	0.69**	1.00
Response Time			
Visit 1	1.00		
Visit 2	0.73**	1.00	
Visit 3	0.70**	0.82**	1.00
Response Time Variability			
Visit 1	1.00		
Visit 2	0.75**	1.00	
Visit 3	0.66**	0.72**	1.00

** Significant at the .0.1 level (two-tailed test).

From: Llorente, A. M., Amado, A.J., Voigt, R.G., Berretta, M.C., Fraley, J.K., Jensen, C.L. & Heird, W.C. (2001). Internal consistency, temporal stability, and reproducibility of the Test of Variables of Attention in children with attention-deficit hyperactive disorder. Archives of Clinical Neuropsychology, 16, 535-546.

the test, Pearson product coefficients (r) were computed for all variables across both conditions. Tables 25 - 35 provide the Pearson product coefficients (r) for all variables across the two conditions, stimulus infrequent (quarters 1 and 2) and stimulus frequent (quarters 3 and 4). Since the table presents a large amount of data, two additional tables were prepared to divide the information by the two conditions. These additional tables present within condition correlations. Tables are presented for the stimulus infrequent condition (quarters 1 and 2), and for the stimulus frequent condition (quarters 3 and 4). Complete tables including between conditions are in the Appendices.

5.2.2 Condition 1 (Stimulus Infrequent)

The Condition 1 percentage of omission errors coefficient value for quarters 1 and 2 was r = .8082. The value indicates that the test measures percentage of omission errors between the two quarters over the condition consistently.

The percentage of commission errors coefficient value comparing quarter 1 and 2 was r = .87. Like omission errors, commission errors across the two quarters for this test condition are measured with consistency.

Table 22: Bland-Altman Procedure to Determine Test-Retest Reliability

	Lower	Mean difference	Upper
Errors of omission			
Visit 1 - Visit 2	-97.3	-1.57	94.2
Visit 1 - Visit 3	-112.5	-13.6	85.2
Visit 2 - Visit 3	-110.6	-12.4	85.8
Errors of commission			
Visit 1 - Visit 2	-21.3	5.91	33.1
Visit 1 - Visit 3	-26.1	8.57	43.3
Visit 2 - Visit 3	-23.1	5.17	33.4
Response Time			
Visit 1 - Visit 2	-209.2	-27.7	153.8
Visit 1 - Visit 3	-245.4	-43.3	158.7
Visit 2 - Visit 3	-196.1	-24.5	147.2
Response Time Variability Visit 1 - Visit 2	-93.3	3.70	100.7
Visit 1 - Visit 3	-135	-9.04	116.9
Visit 2 - Visit 3	-135.4	-15.6	104.1

Llorente, A. M., Amado, A.J., Voigt, R.G., Berretta, M.C., Fraley, J.K., Jensen, C.L. & Heird, W.C. (2001). Internal consistency, temporal stability, and reproducibility of the Test of Variables of Attention in children with attention-deficit hyperactive disorder. Archives of Clinical Neuropsychology, 16, 535-546.

Table 23: Scores for the 90-Minute Interval (N = 31)

T.O.V.A. Score	First Time M	First Time SD	Second Time M	Second Time SD	r	SE_M
Omission	95.95	15.40	96.95	14.68	.70	8.22
Commission	95.29	14.32	107.12*	11.54	.78	7.03
Response Time	96.66	15.43	92.36*	20.07	.84	6.00
Response Time Variability	99.94	16.43	101.48	20.12	.87	5.41

* $p < .05$

From: Leark, R. A., Wallace, D.R. & Fitzgerald, R (2004). Test-Retest Reliability and Standard Errors of Measurement for the Test of Variables of Attention (T.O.V.A.) with healthy school aged children. Assessment, 4, 285-289.

The Response time (mean response time) coefficient comparing quarter 1 and 2 was $\underline{r}$ = .91. The two quarters show a high degree of consistency across the two time epochs.

The Response time (RT) Variability coefficient value for quarter 1 and 2 was $\underline{r}$ = .75. The variability of mean response time is fairly consistent across the two time epochs over the same condition.

5.2.3 Condition 2 (Stimulus Frequent)

Within condition reliability coefficients for condition 2 found percentage of omission errors between quarters 3 and 4, $\underline{r}$ = .94. Like condition 1, the two time periods are measuring the same task consistently.

Percentage of commission errors between quarters 3 and 4 to reliability coefficient, $\underline{r}$ = .83. The two quarters measure with consistency.

Mean response time for quarters 3 and 4, $\underline{r}$ = .88. The two time epochs are consistent in their measurement of mean response time.

Table 24: Scores For The 1-Week Interval (N = 33)

T.O.V.A. Score	First Time M	First Time SD	Second Time M	Second Time SD	r	SE_M
Omission	90.39	21.85	91.42	21.86	.86	5.61
Commission	92.39	19.95	105.88	15.37	.74	7.65
Response Time	94.63	15.55	90.85	21.05	.79	6.87
Response Time Variability	97.70	18.32	98.64	20.94	.87	5.41

* $p < .01$

From: Leark, R. A., Wallace, D.R. & Fitzgerald, R (2004). Test-Retest Reliability and Standard Errors of Measurement for the Test of Variables of Attention (T.O.V.A.) with healthy school aged children. Assessment, 4, 285-289.

Table 25: Within Condition 1 Reliability Coefficients(Auditory)

Variable	Q 1: Q 2	Q 3: Q 4
Omission	.81	.94
Commission	.87	.83
Response Time (ms)	.91	.88
RT Variability	.75	.87
D Prime	.63	.74

5.2.4 Standard Errors of Measurement

Standard errors of measurement (SE_M) were calculated for the standard scores based upon the above reliability coefficients. A pooled (weighted average) standard deviation was calculated to determine the quarter to quarter combined standard deviation. This pooled weighted standard deviation was used in the calculation of the SE_M for each variable. SE_M for within condition comparisons were calculated, between condition were not calculated due to the nature of the test. Only those comparisons which would logically be made for the test data were calculated. SE_M for within condition within variable comparison were calculated. Between conditions were not calculated due to the nature of the test. Table 36 provides the pooled weighted standard deviations and SE_M for the auditory version data.

Table 26: Within Condition 1 Omission Reliability Coefficients(Auditory)

Condition 1	Omission Reliability
Q1 : Q2	.81
Q1 : H1	.94
Q1 : Total	.73
Q2 : H1	.96
Q2 : Total	.79
H1 : Total	.99

Table 27: Within Condition 1 Commission Reliability Coefficients(Auditory)

Condition 1	Commission Reliability
Q1 : Q2	.87
Q1 : H1	.96
Q1 : Total	.86
Q2 : H1	.97
Q2 : Total	.88
H1 : Total	.90

Table 28: Within Condition 1 Response Time (ms) Reliability Coefficients(Auditory)

Condition 1	RT Reliability
Q1 : Q2	.91
Q1 : H1	.98
Q1 : Total	.85
Q2 : H1	.98
Q2 : Total	.88
H1 : Total	.88

Table 29: Within Condition 1 RT Variability Reliability Coefficients(Auditory)

Condition 1	RT Variability Reliability
Q1 : Q2	.75
Q1 : H1	.91
Q1 : Total	.80
Q2 : H1	.95
Q2 : Total	.83
H1 : Total	.87

Table 30: Within Condition 1 D Prime Reliability Coefficients(Auditory)

Condition 1	D Prime Reliability
Q1 : Q2	.63
Q1 : H1	.87
Q1 : Total	.67
Q2 : H1	.87
Q2 : Total	.68
H1 : Total	.75

Table 31: Within Condition 2 Omission Reliability Coefficients(Auditory)

Condition 2	D Prime Reliability
Q3 : Q4	.95
Q3 : H2	.98
Q3 : Total	.98
Q4 : H2	.98
Q4 : Total	.98
H2 : Total	.99

Table 32: Within Condition 2 Commission Reliability Coefficients(Auditory)

Condition 2	Commission Reliability
Q3 : Q4	.83
Q3 : H2	.95
Q3 : Total	.78
Q4 : H2	.96
Q4 : Total	.71
H2 : Total	.77

Table 33: Within Condition 2 Response Time (ms) Reliability Coefficients(Auditory)

Condition 2	RT Reliability
Q3 : Q4	.88
Q3 : H2	.98
Q3 : Total	.97
Q4 : H2	.95
Q4 : Total	.94
H2 : Total	.99

Table 34: Within Condition 2 RT Variability Reliability Coefficients(Auditory)

Condition 2	RT Variability Reliability
Q3 : Q4	.87
Q3 : H2	.96
Q3 : Total	.95
Q4 : H2	.95
Q4 : Total	.94
H2 : Total	.99

Table 35: Within Condition 2 D Prime Reliability Coefficients(Auditory)

Condition 2	D Prime Reliability
Q3 : Q4	.74
Q3 : H2	.89
Q3 : Total	.87
Q4 : H2	.92
Q4 : Total	.89
H2 : Total	.97

Table 36: Table of Weighted Standard Deviation and SEm for Variable Over Condition(Auditory)

Variable	Q 1 : Q 2		Q 3 : Q 4	
	SD	SE_M	SD	SE_M
Omission	5.34	2.34	5.16	1.31
Commission	2.54	0.93	16.44	6.78
Response Time (ms)	107.11	31.83	104.35	36.30
Variability	85.03	42.62	62.34	22.87
D Prime	1.73	1.05	1.73	0.88

6 Validity

6.1 Overview

Validity refers to a test's ability to adequately measure what it purports to measure and how well it does in measuring it. The T.O.V.A. was designed to measure variables that have been found to be important to differentiating ADHD subjects from normals.

6.2 Validity Data for the T.O.V.A. (visual)

Criterion validity: Criterion validity refers to the extent to which a measurement corresponds to an accurate measure of in interest, also known as the criterion. One example of criterion related validity was a study by Greenberg & Waldman (1993). They investigated ADHD, UADD (Undifferentiated ADD, DSM-III-R), Conduct Disorder (CD) and non-disordered control (NC) subjects performance on the visual stimulus version of the test. They analyzed group performance differences across the variables of in five different ways: 1.) group performance differences; 2.) group performance controlling for gender and age; 3.) group performance as a function of age; 4.) group performance differences as a function of test condition; and 5.) group performance differences as a function of test quarter.

On the first analysis, for measures of in attention, they found that the ADHD and ADD groups made more omission errors (t (896) = 4.10, p $\leq$ .001) and showed greater response time variability (t (896), p $\leq$ .001) than the CD and NC groups. The ADHD group made more omission errors (t (896) = 2.38, p $\leq$. 018) and showed greater response time variability (t (896) -3.97, p $\leq$ .001) than the UADD group No significant differences were found between CD and NC groups.

Differences between the ADHD and CD groups were found on measures of impulsivity. ADHD subjects made more commission errors (t (896) = 3.97, p $\leq$ .001) and more anticipatory responses (t (896) =3.65, p $\leq$ .001) than the UADD and NC groups. The UADD group made more commission errors than the NC (t (896) = 2.51, p $\leq$ .012). No significant differences were found on the anticipatory response variable. Response Time differences were noted with the ADHD group having significantly higher mean response times than the NC (p $\leq$ .001). The CD had higher mean response times than the NC (p $\leq$ .019), as well.

When controlling for age and gender, Greenberg and Waldman (1993) found that the ADHD and UADD groups made more omission errors (t (894) = 3.51, p $\leq$.001) and showed greater response time variability (t (894) = 6.07, p $\leq$ .007) than the CD and NC groups. The ADHD group showed greater response time variability than the UADD group (t (894) = 2.76, p $\leq$ .006). The CD group showed greater response time variability than the NC (t (894) = 4.92, p $\leq$ .001) but no differences were noted for omission errors. The group differences for inattention were similar after partialing out the effects of age and gender with the exception that CD groups showed greater response time variability to NC and only a trend for group differences was noted for omission errors for the ADHD and UADD groups. When controlling for age and gender, ADHD and CD groups made more commission errors (t (894) = 3.69, $\leq$ .001) and anticipatory responses (t (894), p $\leq$ .001) than the UADD and NC groups. UADD made more commission errors than the NC (t (894) = 2.48, $\leq$ .013), but no differences were found for anticipatory responses. Response time group differences were found with the CD group having higher mean response times (all p < .001). ADHD and UADD groups had higher mean response times than the NC (p $\leq$ .001).

When looking at the function of age, the differences between ADHD and UADD groups and the CD and NC groups in the number of omission errors varied as a function of age (t (894) = 3.92, p $\leq$ .001). The differences were larger in younger than in older children. Differences between ADHD and CD and the UADD and NC differences for anticipatory responses varied as a function of age (t (894) 1 = 1.97, p $\leq$ .001). More anticipatory responses were found in older than younger children. Mean response time differences were not found to very by age.

Test condition differences (stimulus infrequent, first half; stimulus frequent, second half) were examined. After controlling for age and gender, Greenberg and Waldman (1992c) found the indices of attention, impulsivity and mean response time different according to the differential response demands of the test. ADHD and UADD groups' greater omission errors (t (804) = 2.96, p ≤ .003) and response time variability (t (894) = 2.90, p = .004) relative to the CD and NC groups was more pronounced during the second half (stimulus frequent). The difference between the ADHD and UADD groups in the number of omission errors (t (894) = 1.98, p = .048) and the response time variability (t (894) = 2.30, p = 0.22) were also greater in the later half. None of the patient group differences in commission errors or mean response time difference significantly by condition.

To further examine effects of condition, group differences were analyzed by quarter, after controlling for age and gender. ADHD and UADD group differences were found for response time variability (t (894) = 2.92, p = 004). Greater response time variability was found in the second and forth quarters than in the first and third quarters. The Greenberg & Waldman (1992c) study concluded that ADHD and UADD groups were more inattentive, whereas the ADHD and CD groups were more impulsive, consistent with the DSM-IIIR conceptualization of the disorders. The ADHD group was more impulsive than the UADD group, and the UADD group was more impulsive than the NC group. Condition differences suggest that the response demands of the stimulus frequent condition tended to exacerbate inattention in those participants who already had problems in that domain. Figures 2 to 7 display these group differences.

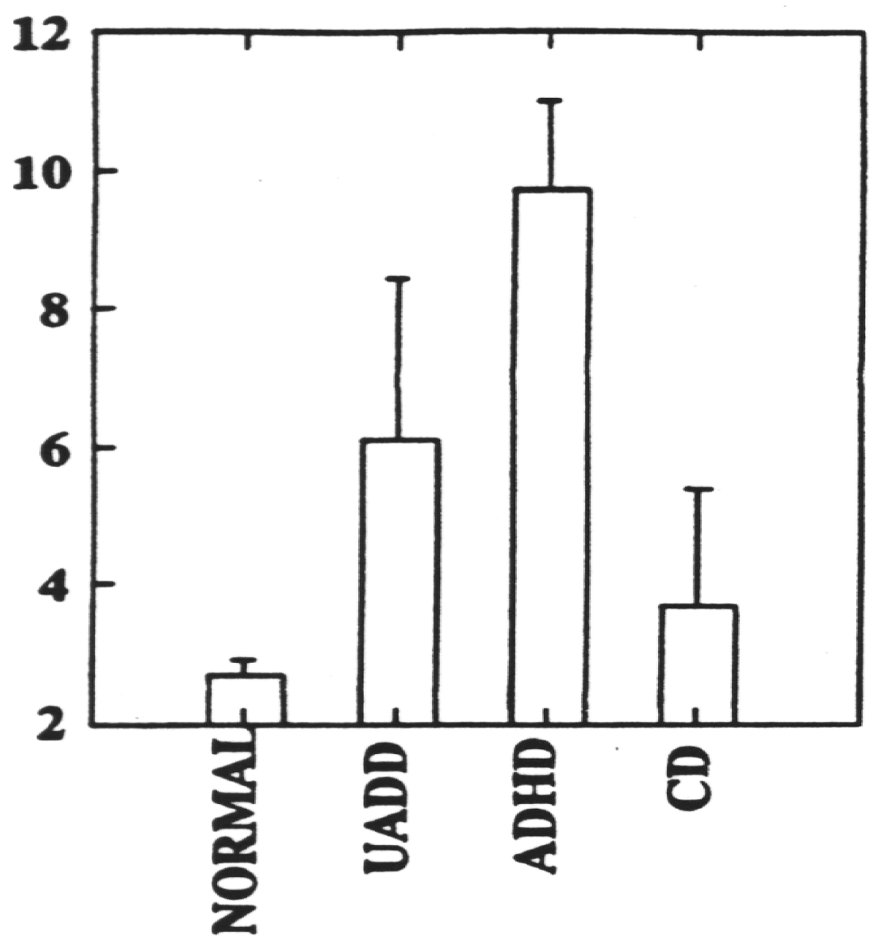

Figure 2: Group Differences by Total Omissions

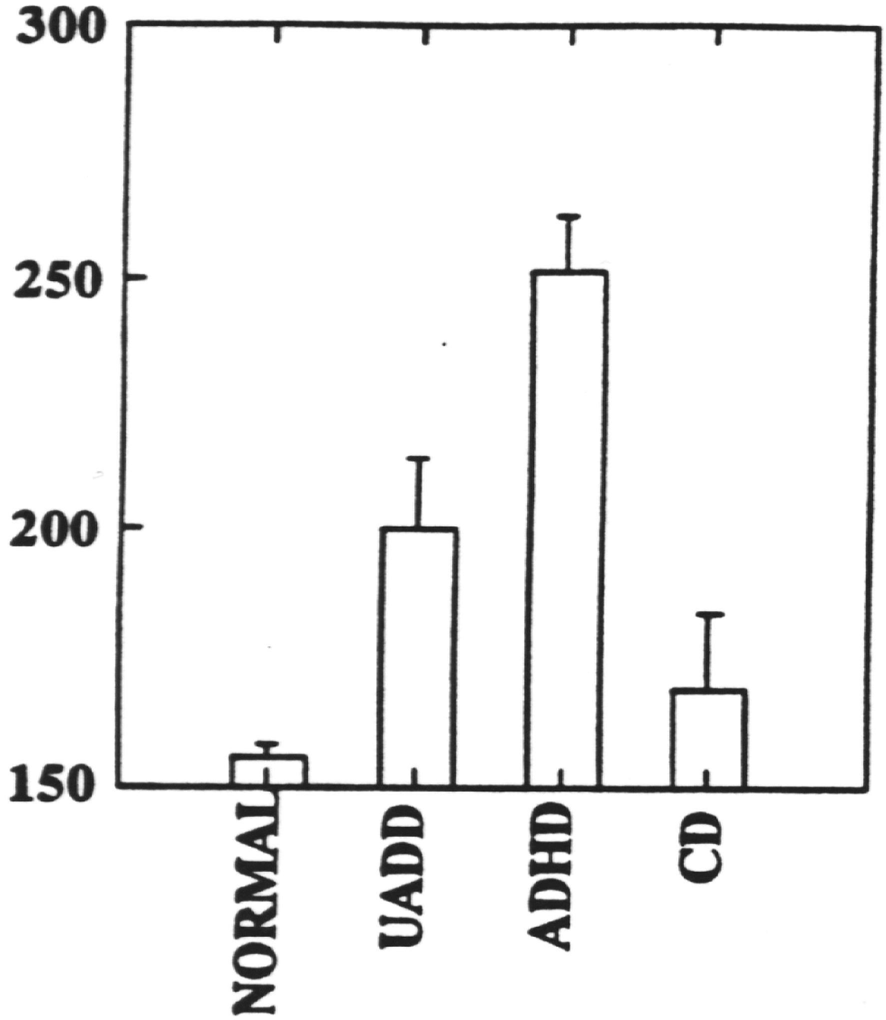

Figure 3: Group Differences in Total Response Time Variability (ms)

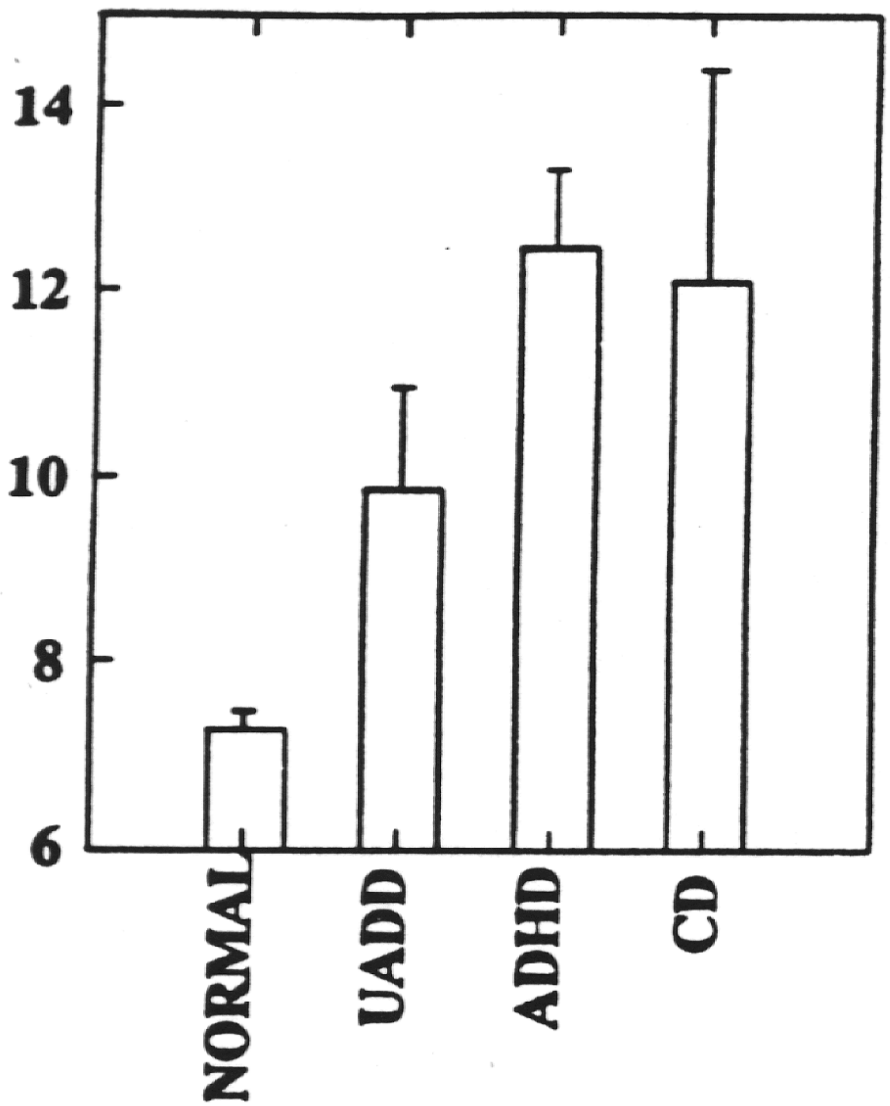

Figure 4: Group Differences in Commission Errors Total Commission Errors (%)

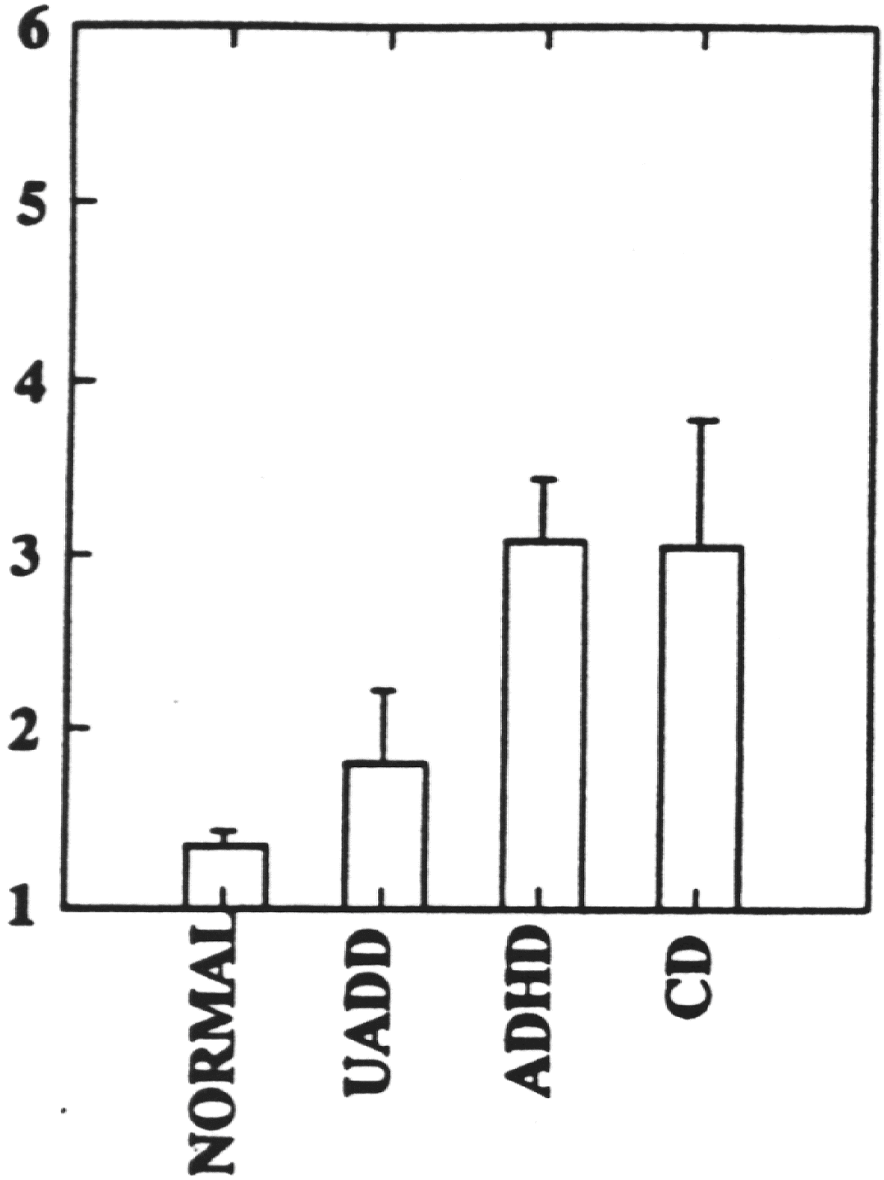

Figure 5: Groups Differences in Total Anticipatory Responses (%)

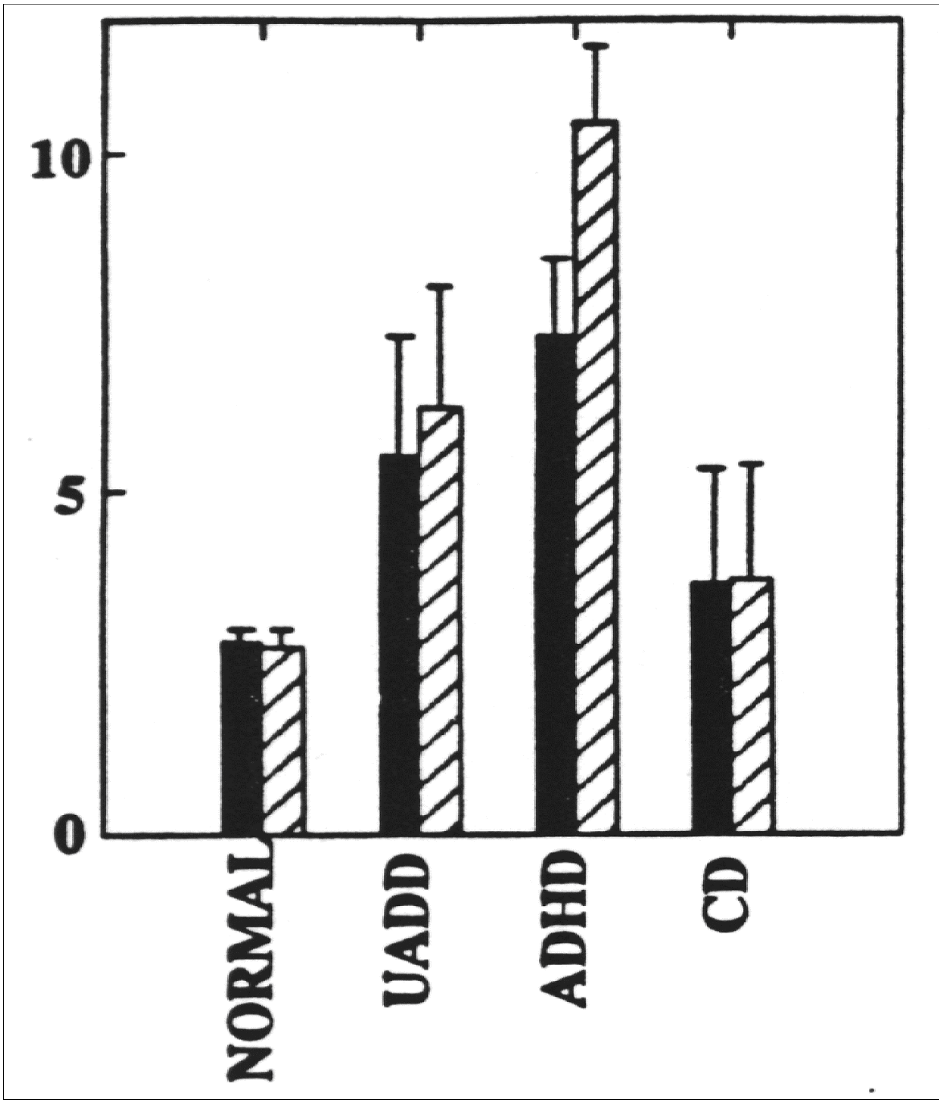

Figure 6: Group Differences in Omission Errors by Half

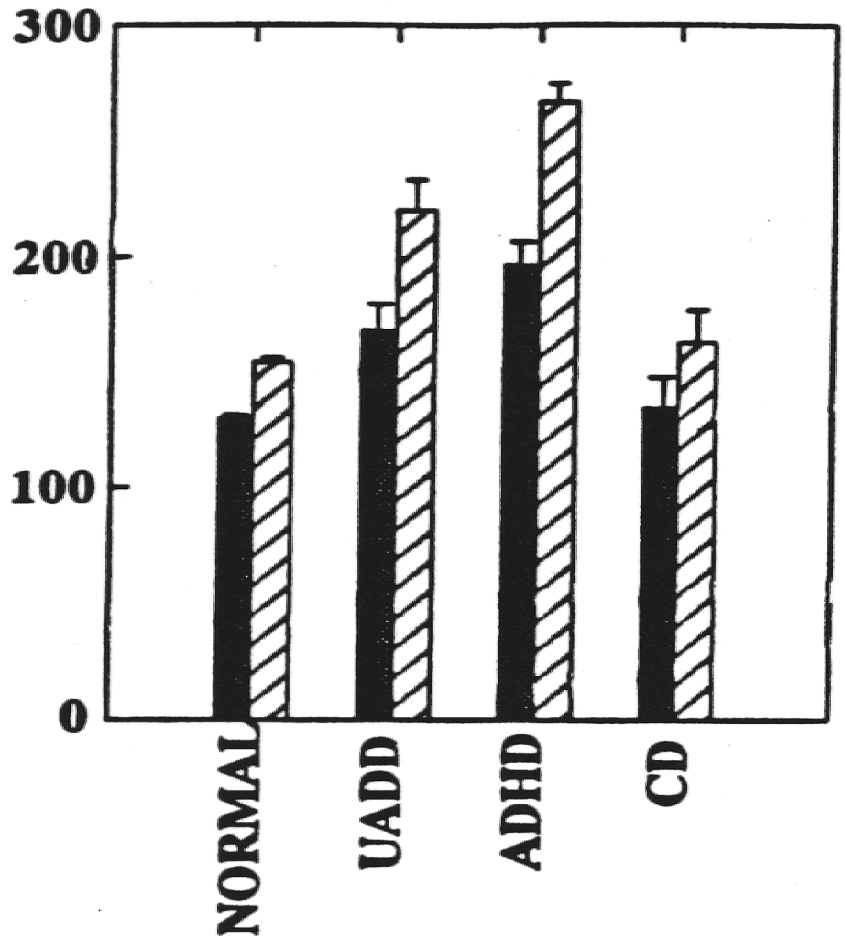

Figure 7: Group Differences in Response Time Variability By Half

Forbes (1998) reported that his sample of 117 children with ADHD/ADD differed significantly on omission errors, response time, response time variability and number of multiple responses [F (5,140) = 5.60, p <. 001) compared to a comparison group. The comparison group was comprised of age-matched children with oppositional defiant disorder, conduct disorder, adjustment disorders and learning disorders (n = 29). For this study, Forbes used z scores (standardized scores) in the calculations. Table 37 provides the data from this study.

Semrud-Clikeman & Wical (1999) evaluated attentional difficulties in children with complex partial seizures (CPS), children with ADHD, children with combined CPS and ADHD and normal controls. Each received the T.O.V.A. and those with ADHD also received the T.O.V.A. post medication. The baseline 3 (group) by 4 (T.O.V.A. scores) ANOVA yielded significant main effects for the T.O.V.A. [F (3, 82) = 6.906, p ≤ .001]. Post-hoc analysis indicated that the CPS/ADHD group performed the lowest (poor performance). The CPS and ADHD groups also performed poorer than normal control participants across all omission, commission, response time and response time variability (p ≤ .01). Post medication analysis revealed that the CPS/ADHD group improved following methylphenidate dosage (from -3.5 standard deviations to -1.5 standard deviations). The ADHD group mean T.O.V.A. scores were reported as normalized (no specific scores were reported within the article).

The study by Mautner, Thakkar, Kluwe & Leark (2002) also provided support for criterion related validity. Their study investigated the both the relationship of ADHD among children with neurofibromatosis type I (nf1) and the treatment of those children. The four groups included those with nf1, nf1 with ADHD, ADHD

Table 37: Mean z scores on the T.O.V.A.

TOVA	ADHD/ADD (n=117)		Other (n=29)		F(df =1,144)
Score	M	SD	M	SD	
Omission	.74	3.50	.01	.35	7.10*
Commission	1.03	2.34	.28	1.08	2.83
Response Time	1.37	1.29	.41	1.30	12.71**
Response Time Variability	2.58	2.31	.58	.99	20.67**
# Multiple Responses	1895	27.89	4.59	6.38	7.54*

* p <.01 **p < .001

From: Forbes, G.B. (1998). Clinical utility of the Test of Variables of Attention (TOVA) in the diagnosis of Attention Deficit Hyperactivity Disorder. Journal of Clinical Psychology, 54(4), 461-476.

Table 38: T.O.V.A. Mean Scores

T.O.V.A.	Nf1-ADHD		Nf1 no ADHD		ADHD		Normal	
Score	M	SD	M	SD	M	SD	M	SD
Omission	97.10	17.12	104.04	5.96	77343	23.09	104.29	5.47
Commission	68.50	25.19	104.73	8.04	98.21	9.30	104.14	7.98
RT	76.65	20.92	104.54	7.90	79.00	13.69	105.79	8.89
RTV	80.25	20.92	105.08	6.31	73.29	29.87	109.36	11.06

RT = Response Time, RTV = Response Time Variability.

From: Mautner, V.F., Thakkar, S., Kluwe, L. & Leark, R.A. (2002). Treatment of ADHD in neurofibromatosis type 1. Developmental Medicine & Child Neurology, 44 (3) 164-170.

without nf1, and normal control participants. The T.O.V.A. scores were poorer in the nf1 with ADHD and ADHD groups than the nf1 no ADHD and normal controls (Table 38).

Sensitivity & Specificity: Sensitivity refers to the test's ability to correctly identify true ADHD cases, while, specificity refers to the test's ability to correctly identify normal individuals. The higher a test's sensitivity, the greater the ability to function as a diagnostic or screening tool as it would detect those likely to have ADHD. The higher the test's specificity, the less likely it would be for the test to incorrectly classify a normal as not normal. In other words, a high specificity would decrease false positives. There is a balance between sensitivity and specificity, when one value increases, the other decreases. The cost of errors in either direction (missing ADHD cases due to lower sensitivity, or, conversely, over-diagnosing ADHD due to low specificity) must be carefully weighed.

To study this for the T.O.V.A., Greenberg & Crosby (1992B) examined 73 subjects (62 males, 11 females), all diagnosed by senior faculty level university psychiatrists or psychologists independent of the study. The subjects were screened for co-existing psychiatric problems such as depression, conduct disorder or oppositional defiant disorder through the use of history, interview, psychological testing (not including the T.O.V.A.) and teacher rating scales (CPTQ-A and ACTeRs). Only those with a diagnosis of ADHD alone were included in the study. The diagnosis was made independent of test performance. The subjects had all been referred to the Clinic for Attention Deficit Disorders at the University of Minnesota. The subjects' scores for each of the five measures were converted to standard scores (z score) based upon normative data for age and gender. A one-way MANOVA was then used to compare z scores for the ADHD sample to the normative sample, and univariate tests of significance were also performed. For this study, two alternate approaches to classification were used, discriminant analysis and equal weighting of standardized scores using summed standardized scores. For both approaches, a random sample of one-half of the ADHD and the normative samples were selected. Analysis performed yielded 2 distinct cut-off points to achieve "false positive" rates of 10% (0.90 specificity) and 20% (0.80 specificity). The identical cutoff points were then applied to the remaining sample and sensitivity indices recomputed.

Initial discriminant analysis, with prior probabilities set to sample size, found that anticipatory responses failed to contribute significantly to the regression equation, due largely to a substantial correlation ($\underline{r}$ = .55) to errors of commission. Thus, a subsequent analysis with the four variables (errors of omission, errors of commission, response time and response time variability) was done. The discriminant analysis of the first randomly selected sample (384 normals, 36 ADHD) revealed that the four variables were significantly able to predict group membership (canonical correlation = .56; Wilks' lambda = .68; $p < .001$). All four variables were significantly correlated to the discriminant function with values ranging from .42 (errors of commission) to .98 (response time variability). The .80 specificity cutoff point for the first sample was .34, and those scoring above this value were considered target cases. The resulting sensitivity based on this cutoff was .69. The .90 specificity cutoff point for this sample was .79 with a corresponding sensitivity of .67.

Discriminant function scores were then computed for the remaining sample using the regression weights from the first analysis. The cutoff points, determined from the first analysis, were applied to this sample. The .80 specificity (cutoff = .34) produced a sensitivity of .73 and specificity of .73; the .90 specificity (cutoff = .79) yielded a sensitivity of .68 and specificity of .85. Figure 8 demonstrates the sensitivity and specificity analysis graphically.

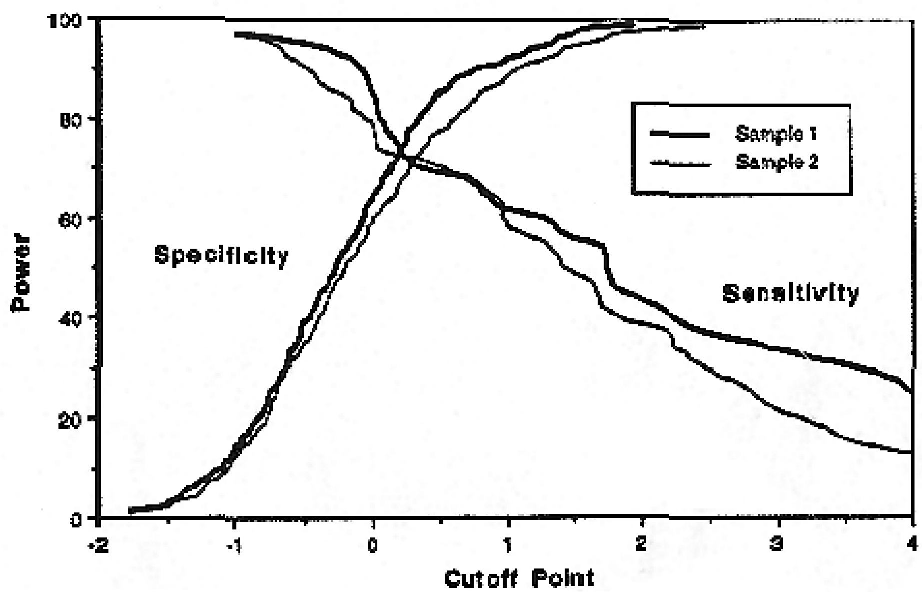

Figure 8: Sensitivity and Specificity: Discriminant Analysis. From Specificity And Sensitivity Of The Test Of Variables Of Attention (Greenberg & Crosby, 1992C)

For the second model of classification, equal weighting scores were computed for the first sample (384 normals, 36 AHDH). These was done by summing standardized scores ($\underline{z}$) for each of the four variables. Cutoff points for 0.80 and 0.90 specificity were determined, yielding cutoff points of 1.94 and 3.42, respectively. A sensitivity rate of .76 was achieved for the 0.80 cutoff, and, .60 for the 0.90 cutoff.

The second sample equal weighting classification analysis was done using the established cutoff points. The 0.80 specificity cutoff yielded an overall sensitivity of .72 and specificity of .85; the 0.90 specificity yielded overall sensitivity of .61 and specificity of .94. Figure 9 demonstrates the standardized scores of the sensitivity and specificity graphically.

Table 39: Comparison of Classification Methods

Method	1st Sample Sensitivity	Specificity*	2nd Sample Sensitivity	Specificity
Discriminant Analysis Equal Weighting	.69	.80	.73	.73
	.67	.90	.68	.85
	.76	.80	.72	.85
	.60	.90	.61	.94

*Specificity rates for Sample 1 chosen a priori. Specificity And Sensitivity Of The Test Of Variables Of Attention (Greenberg & Crosby, 1992C)

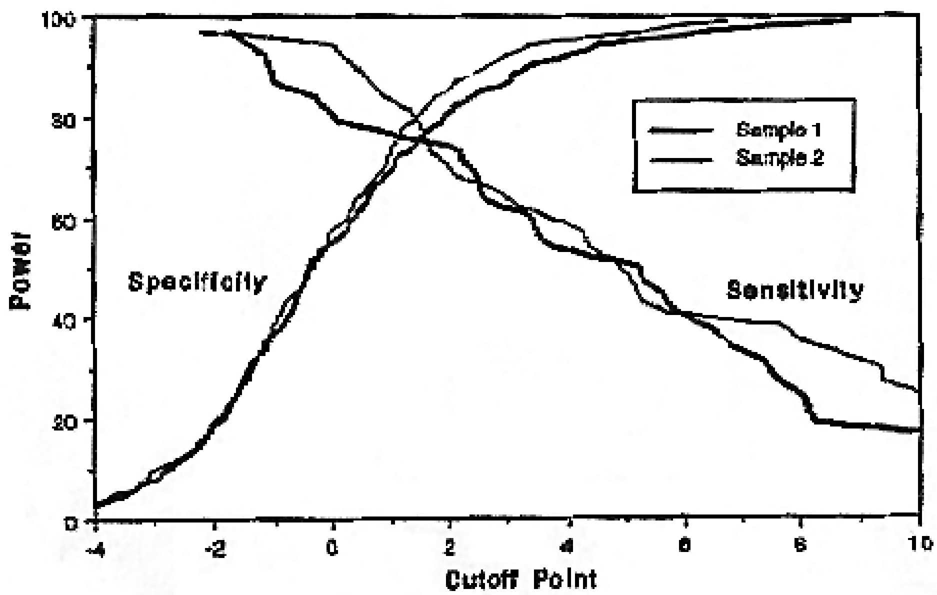

Figure 9: Sensitivity and Specificity: Summed Standardized Scores*

*Specificity And Sensitivity Of The Test Of Variables Of Attention (Greenberg & Crosby, 1992C)

Comparison of the two approaches is presented in Table 39. The sensitivity for the initial sample is higher for the discriminant analysis at the 0.90 specificity level. Somewhat surprisingly, the sensitivity for the equal weighting approach is higher at the 0.80 specificity level. The findings suggest that both weighted scoring via discriminant analysis and equal weighting via summed standardized scores produced respectable and similar levels of sensitivity and specificity.

Greenberg & Crosby (1992C) recommend a cutoff point of 1.94 for nonclinical screening settings (such as schools or work places). This resulted in a sensitivity of .72 and specificity of .85 (based upon sample two), yielding a minimum of false positives (28%). Rating scales could further reduce this "false positive" rate. For clinical settings, a cutoff of 3.42 is recommended. This resulted in sensitivity of .61 and specificity of .94 with a minimal number of "false positives" (6%). The higher rate of false negatives (39%) would be reduced by clinical history, rating scales and other psychological tests.

A second study, (Greenberg & Crosby, 1992C) examined sensitivity and specificity in 105 children (86 males, 19 females; ages 6 to 15) with carefully diagnosed ADHD (diagnosis made by senior faculty level university psychiatrists or psychologists independent of the study). These subjects were also reported in the Greenberg & Crosby (1992A) study. The normative sample was comprised of 954 age similar children (471 males, 483 females).

The first series of analysis was carried out using Receiver Operator Characteristic (ROC) Analysis (Murphy, Berwick, Weinstein, Borus, Budman, & Klerman, 1987). ROC analysis can be used to calculate the overall predictive performances of a score by assessing the score's diagnostic accuracy (true positives vs false negatives) over a continuum of scores. For this study, the scores for the omission errors, commission errors, mean response time, response time variability (variability), d prime and beta for first half, second half and total were converted to z scores (to control for effects of age and gender). Then a ROC analysis was conducted on each of the three scores for each variable to identify the scores that yielded the highest overall predictive performance. Next, a ROC analysis was conducted on combinations of "highly predictive" scores. These combinations represented theoretical elements of attention that are most strongly implicated in ADHD. The following combination score proved to have superior overall predictive performance: Mean Response Time (1st half) + D Prime (2nd half) + Variability (total).

Thus, the formula used to calculate the ADHD Score is:

ADHD Score = Response Time z score (half 1) + D' z score (half 2) + Variability z score (total)

The last step of the procedure involved creating a series of contingency tables so that the sensitivity and specificity associated with each value of the combination score could be evaluated. Through examination of the tables, a cutoff score was identified that resulted in the highest overall test performance (equal diagnostic sensitivity and specificity). The cutoff score that was chosen yielded a sensitivity of .80 (i.e., false negatives @ 20%) and a specificity of .80 (i.e., false positives @ 20%).

The ROC analysis differs from the discriminant function analysis in that the latter produces prediction equations with item weights that often vary from sample to sample. The ROC analysis creates an analysis both theoretically based and yet able to be cross validated across diverse groups of individuals. Thus, ROC, the more conservative measure, is the more appropriate analysis since CPT norm samples are not representative of the general population.

Comparison of the two studies (discriminate function and ROC), yields overall discrimination abilities at minimum of .80 sensitivity and .80 specificity for the test across both analyses.

In another study, Teichner, Ito, Glod, & Barber (1996) examined the movement abnormalities in seated children with ADHD while engaged in a derivative of the T.O.V.A. Movement patterns of 18 boys with ADHD (9.3 + 2.4 yrs) and 11 normal controls (8.6 + 1.8 yrs) were recorded using an infrared motion analysis system that tracked the position of four markers 50 times per second to a resolution of 0.04 mm. Their results found that boys with ADHD moved their head 2.3 times more often than normal children ($p < .002$); moved 3.4 times as far ($p < .01$); covered a 3.8 fold greater area ($p < .001$); and had a more linear and less complex movement pattern ($p < .00004$). ADHD boys responded more slowly (response time) and had higher response time variability scores than the controls.

Bernstein, Carroll, Crosy, Perwien, Go, and Benowitz (1994) examined the acute effects of caffeine on learning, performance and anxiety in normal prepubertal children. 21 children were examined in a double-blind, placebo-controlled crossover design, studied during four sessions, each 1 week apart, under four conditions: baseline; placebo; 2.5mg/kg caffeine; and 5.0 mg/kg caffeine. Using randomized order of placebo and two dosages of caffeine, the children were tested in tests of attention, manual dexterity, short-term memory and processing speed. The T.O.V.A. was found to be sensitive to caffeine dosage on two of the four test variables. Table 40 presents this information.

Greenberg & Waldman (1993) investigated ADHD, UADD (Undifferentiated ADD, DSM III-R), CD (Conduct Disordered), and nondisordered control (NC) subjects performance on the visual stimulus version of the test. The researchers analyzed group performance differences across the variables in five different ways: group performance differences; group performance controlling for gender and age; group performance as function of age; group performance differences as a function of test condition; and group performance differences as

Table 40: Caffeine Effects in Children*

	Placebo		2.5mg/k Caffeine		5.0 mg/k Caffeine		ANOVA			Random Regression		P
	X	SD	X	SD	X	SD	F	df		Est. Caf		
OmisErr	7.9	17.8	4.0	13.5	1.5	3.2	2.86	2,38	.070	-	1.55	.005
ComErr	1.7	2.7	1.3	1.9	1.7	2.9	0.56	2,38	.577	0.02	-	.866
RT	498.3	130.7	490.4	93.2	478.3	106.8	0.32	2,38	.726	-	2.67	.619
V-RT	159	61.4	135	52.6	121.2	46.4	8.33	2,38	.001	-	8.48	<.01

* from: Bernstein, Carroll, Crosby, Perwien, Go, & Benowitz (1994). "Caffeine Effects on Learning, Performance, And Anxiety in Normal Aged School Children". Journal of the American Academy Child Adolescent Psychiatry, 33:3, March/April.

a function of test quarter.

On the first analysis, for measures of inattention, they found that the ADHD and ADD groups made more omission errors (t (896) = 4.10, p < .001), and showed a greater response time variability (t (896) = 594, p < .001) than the CD and NC groups. The ADHD group made more omission errors (t (896) = 2.38, p < .018) and showed greater response time variability (t (896) = 3.62, p < .001) than the UADD group. No significant differences were found between the CD and NC groups.

Differences between the ADHD and CD groups were found on measures of impulsivity. ADHD subjects made more commission errors (t (896) = 3.97, p < .001) and more anticipatory responses (t (896) = 3 .65, p < .001) than the UADD and NC groups. The UADD group made more commission errors than the NC (t (896) = 2.51, p < .012). No significant differences were found on the anticipatory response variable.

Response time differences were noted with the ADHD group having significantly higher mean response times than the NC (p < .001). The CD had higher mean response times than the NC (p < .018), as well.

When controlling for age and gender, Greenberg and Waldman (1993), again, found that again, the ADHD and UADD groups made more omission errors (t (894) = 3.51, p < .001) and showed greater response time variability (t (894) = 6.07, p < .001) than the CD and NC groups. The ADHD showed greater response time variability than the UADD group (t (894) = 2.76, p < .006). The CD group showed greater response time variability than the NC (t (894) = 4.92, p < .001) but no differences were noted for omission errors. The group differences for inattention were similar after partialing out the effects of age and gender with the exception that CD group showed greater response time variability to NC and only a trend for group differences was noted for omission errors for the ADHD and UADD groups.

Again, when controlling for age and gender, ADHD and CD groups made more commission errors (t (894) = 3.69, p < .001) and anticipatory responses (t (894) = 3.19, p < .001) than the UADD and NC groups. UADD made more commission errors than the NC (t (894) = 2.48, p < .013), but no differences were found for anticipatory responses. Response time group differences were found with the CD group having higher mean response times (all p < .001). ADHD and UADD groups had higher mean response times than NC (p < .001).

When looking at the function of age, the differences between ADHD and UADD groups and the CD and NC groups in the number of omission errors varied as a function of age (t (894) = 3.92, p < .001). The differences were larger in younger than in older children. Differences between ADHD and CD and the UADD and NC differences for anticipatory responses varied as a function of age (t (894) = 1.97, p < .001). More anticipatory responses were found in older than in younger children. Mean response time group differences were not found to vary by age.

Test condition differences (stimulus infrequent, first half; stimulus frequent, second half) were examined. After controlling for age and gender, Greenberg & Waldman (1992C), found the indices of attention, impulsivity and mean response time differed according to the differential response demands of the test. ADHD

Table 41: Visual Factor Data

Variable	Factor 1	Factor 2	Factor 3	Variable	Factor 1	Factor 2	Factor 3	Variable	Factor 1	Factor 2	Factor 3
Var. Total	.915			RT Q1	.748			Com Q3		-.707	
Var Half2	.892			D Half2	-.735			Com Half2		-.699	
Var Q4	.869			D Q4	-.719			RT Jhalf2	.664		
Var Q3	.860			RT Total	.709			RT Q4	.635		
Var Half1	.842			D Half1	-.965			Com Q4		-.635	
Var Q2	.798			D Q1	-.669			Com Q1		-.587	
RT Q2	.791			RT Q3	.666			Om Total		.721	
RT Half1	.783			D Q2	-.661			Om Half1		.717	
D Total	-.761			D Q3	-.653			Om Q3		.702	
Var Q1	.759			Com Total		-.750		Om Half2		.690	
								Om Q1		.673	

and UADD groups' greater omission errors (t (894) = 2.96, p = .003) and response time variability (t (894) = 2.90, p = .004) relative to the CD and NC groups was more pronounced during the second half, stimulus frequent. The difference between the ADHD and UADD groups in the number of omission errors (t (894) = 1.98,)p = .048) and the response time variability (t (894) = 2.30), p = 0.22) were also greater in the later half. None of the patient group differences in commission errors or mean response time differed significantly by condition.

To further examine effects of condition, group differences were analyzed by quarter, after controlling for age and gender. ADHD and UADD group differences were found for response time variability (t (894) = 2.92, p = .004). Greater response time variability was found in the second and fourth quarters than in the first and third quarters. ADHD and UADD groups and CD and NC group differences were found for response time variability differed by test half and quarter (t (894) = 2.97, p = 0.14).

Greenberg & Waldman (1992C) concluded that the ADHD and UADD groups were more inattentive, whereas the ADHD and CD groups were more impulsive, consistent with the DSM III-R conceptualization of the disorders. The ADHD group was more impulsive than the UADD group, and the UADD was more impulsive than the NC group. Condition differences suggest that the response demands of the stimulus frequent condition tended to exacerbate inattention in those patients who already have problems in that domain. Figures 2 to 7 display these group differences.

Factor Data: Data for the percentage of omission errors, percentage of commission errors, mean response time, response time variability and d prime over both conditions were entered into a principle components varimax rotation factor analysis (N=1468). Three significant factors emerged: Factor 1.) response time (mean response time, response time variability) and d prime (hit to miss ratio); Factor 2.) percentage of commission errors; and Factor 3.) percentage of omission errors. Visual factor loadings for each are presented in Table 41.

The factor data supports the contention that the test is measuring distinct variables: response time, impulsivity and inattention.

Discriminant Analysis: In a separate analysis from the data reported above, Forbes (1998) reported the T.O.V.A. correctly classified 80% of the ADHD group and 72% of the other group. This result was obtained by using criteria on any one or more T.O.V.A. scores exceeding 1.5 standard deviations below expectation. This data is similar to that reported within the sensitivity and specificity section (see above).

Another study of the discriminant abilities of the T.O.V.A. was reported by Leark, Dixon, Allen & Llorente (2002) used 44 ADHD children and 44 aged matched subjects randomly selected from the T.O.V.A. normative sample. Their analysis used raw test data to classify subjects using group (ADHD, normative) as the criteria. This analysis yielded an overall 84.1% original group classification rate. The normal group was correctly classified 93.2% of the time. The ADHD group was correctly classified at 75% (Table **??**).

Table 42: Classification Results

	Predicted Group Membership			
	Normal		ADHD	
Original Group	Percent	Count	Percent	Count
Normal	93.2	41	6.8	3
ADHD	25	11	75	33

From: Leark, R.A., Dixon, D. Allen, M. & Llorente, A. (2002). Cross-validation of the diagnostic hit rates and performance differences between ADHD and normative groups of children on the Test of Variables of Attention. Poster paper presented at the 20th Annual Meeting of the National Academy of Neuropsychology, Orlando, FL.

These studies along with the sensitivity and specificity data indicate that the T.O.V.A. to be highly predictive in correctly classifying those with attention problems. As with all tests, we do not encourage the use of the T.O.V.A. to be used alone in the clinical diagnosis of ADHD. History, interviews, behavior rating scales are all essential components of an ADHD workup.

Relationship of T.O.V.A. (visual) to measures of intelligence: In an earlier edition of the T.O.V.A. Clinical Guide (Greenberg, Kindschi, Dupuy & Corman, 1996) as well as in workshops, Greenberg, et al. had suggested that scores to the T.O.V.A. were related to measures of intelligence. The nature of these suggestions came at the clinical experience of the author (Greenberg). These also made rational sense towards test interpretation strategies especially in light of interpreting test scores related to medication titration. However, these suggestions were just that, suggestions and did not have statistical support for them. Since then, several studies have been reported which indicate that the T.O.V.A. test scores are not influenced by the intelligence of the examinee.

For example, Chae (1999) compared T.O.V.A. (visual) test scores to the performance of 44 children referred for ADHD symptoms on the Wechsler Intelligence Scale for Children, 3rd revision (WISC-III). The children were not on medication during any of the testing. The results of his analysis are reported in Table 43. Non-significant correlations were shown between the total scores for the T.O.V.A. commission, response time and response time variability and the WISC-III Full Scale IQ (FSIQ), Verbal IQ (VIQ) and Performance IQ (PIQ). A negative correlation was found between the omission score and the PIQ and FSIQ. A negative but non-significant correlation was also shown between omission score and the VIQ.

The trend towards negative correlation between omission score and PIQ performance was further analyzed using the subtests that comprise the PIQ. This analysis yielded a significant negative correlation between total omission score and Picture Arrangement (-.502, $p < .01$) and Object Assembly (-.540, $p < .01$). No other significant correlations were found between PIQ subtests and T.O.V.A. performance. The same trend toward negative correlation was noted on the correlation between VIQ subtests and omission total scores. The only significant correlation between total T.O.V.A. scores and VIQ subtests was found between omission and the Information subtest (-.462, $p < .01$). The data from Chae's study indicates that the T.O.V.A. scores are related only slightly to intellectual processing. In particular, for these ADHD participants as their omission scores increased (poorer sustained attention) the performance on the WISC-III declined.

Using college aged participants, Weyandt, Mitzlaff & Thomas (2002) compared age-matched controls to referrals to a college ADHD clinic. Each was administered the T.O.V.A. and the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Their analysis (Table 44) yielded non-significant correlation coefficients between T.O.V.A. scores and WAIS-F FSIQ. Further, an additional analysis yielded non-significant correlation coefficients between the T.O.V.A. scores and the WAIS-R factor derived summary scores: Verbal Comprehension (VC), Perceptual Organization (PO) and Freedom from Distractibility (FD). Weyandt, Mitzlaff & Thomas concluded that intelligence is unrelated to performance on continuous performance tests.

Fake Bad Test Bias: Leark, Dixon, Hoffman & Huynh (2001) investigated how intentionally faking bad would

Table 43: Correlation Data Between WISC-III and T.O.V.A.

WISC-III	Omission	Commission	RT	RTV
FSIQ	-.440*	-.006	-.161	-.249
PIQ	-.458*	-.507	-.141	-.161
VIQ	-.202	-.003	-.221	-.274
PC	.113	.156	.154	.170
PA	-.502**	-.082	-.073	-.252
BD	-.198	.031	-.208	-.216
OA	-.540**	-.074	-.279	-.315
CD	.125	.141	.171	.182
SS	.009	.207	.126	.077
INF	-.462*	-.150	-.121	-.284
SIM	-.313	-.024	-.138	-.137
ARI	-.265	.011	-.170	-.206
VOC	-.205	.041	-.017	-.120
COM	-.126	.107	.058	.000
DS	-.078	.047	-.256	-.131

* p <.05, ** p < .01. RT = Response Time, RTV = Response Time Variability, PC = Picture Completion, PA = Picture Arrangement, BD = Block Design, OA = Object Assembly, CD = Coding, SS = Symbol Search, INF = Information SIM = Similarities, ARI = Arithmetic, VOC = Vocabulary, COM = Comprehension, DS = Digit Span.

From: Chae, P. K. (1999) Correlation study between WISC-III scores and TOVA performance. Psychology in the Schools, 36(3), 179-175.

Table 44: Correlation Coefficients Between T.O.V.A. Scores and WAIS-R

T.O.V.A. Score	FSIQ	VC	PO	FD
Omission	-.075	-.055	-.156	-.001
Commission	.130	.152	.022	.050
RT	.059	.023	-.121	.016
RTV	.023	-.030	-.121	.068

Note: All correlation coefficients were non-significant. RT = Response Time, RTV = Response Time Variability, FSIQ = Full Scale IQ, VC = Verbal Comprehension, PO = Perceptional Organization, FD = Freedom from Distractibility.

From: Weyandt, L.L., Mitzlaff, L. & Thomas, L. (2002). The relationship between intelligence and performance on the Test of Variables of Attention (TOVA). Journal of Learning Disabilities, 35(2), 114-120.

Table 45: Table of Raw Score Means for Normal Condition (NC) and Fake Bad (FB) Instructions

		Omission		Commission		RT		RTV		D Prime	
		NC	FB	NC	FB	NC	FB	NC	FB	NC	FB
Q1	M	8.49	22.66*	1.92	11.24t	441.78	530.00	111.44	201.55**	6.67	3.82**
	SD	22.27	26.51	4.59	18.92	175.32	190.08	114.20	134.68	2.73	2.97
Q2	M	9.26	26.32*	1.56	10.06t	444.22	602.11**	114.91	223.24**	6.74	3.53**
	SD	23.76	29.74	4.02	17.59	179.52	238.56	139.57	107.82	2.54	2.69
Q3	M	6.35	24.77*	12.86	26.24t	370.56	491.50	106.78	215.71**	4.73	2.14**
	SD	19.72	27.84	12.09	18.82	125.21	236.05	106.78	133.69	1.97	1.90
Q4	M	6.57	25.52*	11.46	24.61t	361.28	471.38**	105.16	207.12**	4.81	2.16**
	SD	18.33	26.3	11.03	16.6	126.98	188.79	100.62	119.38	2.13	1.91
H1	M	8.87	24.49*	1.74	10.68t	442.22	566.67	113.16	220.38**	6.30	3.44**
	SD	22.89	27.47	4.26	18.21	174.97	212.82	119.33	119.68	2.50	2.63
H2	M	6.46	25.14*	12.11	25.37t	365.17	481.89**	108.18	217.14**	4.47	2.00**
	SD	19.84	26.94	10.89	16.09	122.63	210.62	101.91	123.52	1.78	1.75
Total	M	6.99	25.00*	3.99	13.77t	381.00	500.39**	115.50	227.11**	4.89	2.46**
	SD	19.63	26.83	5.18	16.91	127.85	205.37	105.12	118.13	1.81	1.84

RT = Response Time, RTV = Response Time Variability, * Paired Mann-Whitney U test, p <.003 Bonferroni corrected, ** Paired Student's t test, p <.03 Bonferroni corrected, t Paired Mann-Whitney U test, p <.02 Bonferroni corrected.

From: Leark, R.A., Dixon, D., Hoffman, T., & Huynh, D. (2001). Fake bad test response bias effects on the Test of Variables of Attention. Archives of Clinical Neuropsychology, 17, 335-342.

affect T.O.V.A. test performance. Two groups of age-matched college control participants were used with counter-balanced test order. One group was administered the T.O.V.A. under standard administration, followed by a second administration with standardized instructions to subtly fake bad. The other group took the initial administration with the instruction to subtly fake bad, then the standard administration of the test. The analysis of test-order yielded non-significant findings indicating that the instruction to fake bad provided the difference. Given there were non-significant effects for test-order, the two groups were then combined into fake bad (FB) and normal conditions (NC). Group mean score differences were analyzed using student t-tests for all four of the T.O.V.A. scores over each quarter, half and the total score. The analysis yielded significant mean score differences between the two groups with the FB group having excessively higher scores nearly across all quarters, halves and total score (Table 45). The study affirmed that the test is subject to intentional fake bad test bias. Professionals are encouraged to evaluate for malingered or intentional fake bad response bias when excessively high scores are obtained on the test.

6.3 Validity Data for the Auditory T.O.V.A. Test

Factor Data: As was done with the visual version of the test, the percentage of omission errors, percentage of commission errors, mean response time, response time variability and d prime across both conditions by quarter, halves and totals were entered into a principal components factor analysis with a varimax rotation (N=2,551). The factor analysis yielded five loadings accounting for 86% of the variance. These five factors were: Factor 1) response time (mean response time and response time variability); Factor 2) percentage of commission errors stimulus frequent condition (quarters 3 & 4, 2nd half) and D Prime; and, Factor 3) percentage of omissions stimulus frequent condition (quarter 3, quarter 4 & second half; Factor 4) percentage of commission errors stimulus infrequent (quarters 1 & 2, 1st half); and, Factor 5) percentage of omission errors stimulus infrequent condition (quarter 1, quarter 2 and first half). Table 46 illustrates factor data for the Auditory T.O.V.A. test.

Table 46: Auditory Factor Data for the Auditory T.O.V.A. Test

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
RT Total	.937				D' Q4		-.800			
RT Half 2	.915				D' Total		-.782			
RT Q4	.895				D' Q3		-.779			
RT Q3	.894				Com Q3		.751			
RTQ2	.844				Om Half 2			.852		
RT Half 1	.842				Om Q3			.843		
RT Q1	.796				Om Total			.839		
Var Total	.727				Om Q4			.834		
Var Half 2	.702				Com Half 1				.955	
Var Q3	.682				Com Q2				.927	
Var Q4	.677				Com Q1				.918	
Var H1	.672				Com Total				.813	
Var Q2	.633				Om Half 1					.653
Var Q1	.605				Om Q1					.629
D' Half 2		-.835			Om Q2					.615
Com Half 2		.814			D' Half1					-.597
Com Q4		.802								

Table 47: Comparison of the Visual and Auditory T.O.V.A. Tests(Adjusted Mean plus/minus 1 SD)*

Variable	Visual (N=1331)	Auditory (N=2551)	F Value, Significance
Omission	2.06±5.49	3.99±10.92	F(1,3878) = 41.89, p <.001
Commission	5.73±5.11	2.41±5.23	F(1,3878) = 419.66, p <.001
Response Time	445.00±117.93	586.28 ±139.31	F(1,3878) = 1601.14, P <.001
Variability	137.67±62.78	183.46±79.85	F(1,3878) = 556.94, P <.001
D Prime	4.79±1.45	5.29±1.86	F(1,3878) = 105.58, P <.001

*Results of analyses of covariance controlling for age and gender.

In comparison to visual test version, the auditory version factor data partial out commission errors across the two conditions. Stimulus frequent percentage of commission errors emerged separate from stimulus infrequent percentage of commission errors. This separation was not found for percentage of omission errors across the conditions.

6.4 Construct Validity

An analysis of covariance (ANCOVA) controlling for age and gender was performed to compare total variable scores between tests (see Table 47). A higher mean of percentage of omission errors was found with the auditory test, having twice as high of omission errors than visual (3.99 ±10.92; 2.06 ±5.49). Mean percentage of commission errors were higher for the visual test (5.73 ±5.11; 2.41 ±5.23). Mean response times were faster for the visual test (445.00 ms ±117.93; 586.28 ms ±139.31). Response time variability was greater for the auditory than the visual (183.46 ±79.85; 137.61 ±62.78). All mean score between test differences were significant ($p < .001$).

To understand the uniqueness of the Auditory T.O.V.A. test, Dixon & Leark (1999) compared the performances of 30 college aged participants on the Auditory T.O.V.A. test and two measures from the Halstead Reitan Neuropsychological Battery (HRNB). The HRNB has two measures purported to measure sustained attention. These are the Seashore Rhythm Test (SRT) and the Speech Sounds Perception Test (SSPT). The SRT requires the participant to differentiate between pairs of rhythmic beats over thirty trials. There are

Table 48: Correlation Coefficients Between Seashore Rhythm Test (SRT) and Auditory T.O.V.A. Omission Scores

Omission Score	SRT
Q1	.42*
Q2	.43*
Q3	.44*
Q4	.27ns
H1	.42*
H2	.38*
Total	.48*

* p = .05, ns = non-significant correlation.

From: Dixon, D. & Leark, R.A. (1999). Construct Validation of the Test of Variables of Attention - Auditory: Comparison to Reitan's Model of Attention. Poster presentation at the American Association for the Advancement of Sciences 168th Annual Conference. Anaheim, CA January.

no breaks within the test and the stimuli are presented at a fairly rapid pace. The instructions require the individual to identify if the pairs are the same or different. The SSPT is comprised of sixty spoken vowel consonant nonsensical word blends, all of which are variations of the "ee" sound. The stimuli are played over a cassette tape with volume adjustment to user's preference. Reitan maintains (1985) that the test requires the maintenance of sustained attention through the 60 items. Given that the Auditory T.O.V.A. test, SSPT and SRT require differing presentation of stimuli, only the Omission scores were used. Speed of processing is not a variable of either the SRT or the SSPT. Thus, response time and response time variability were not used for this study. A correlation analysis was done which yielded significant correlations between omission scores and SRT. However, the Omission Quarter 4 scores were not significantly correlated with SRT. None of the commission scores reached statistically significant correlation with the SRT. The SSPT was not significantly correlated the neither the omission nor commission scores of the Auditory T.O.V.A. test, (Table 48). Dixon & Leark noted that the correlation between the omission scores of the Auditory T.O.V.A. test and the SRT made rational sense in that both instruments require immediate and sustained attention to task. The failure to find a statistically significant correlation between the SSPT and the Auditory T.O.V.A. test also makes rational sense in that the two tasks present stimuli in non-related methods. The correlation between the SRT and Auditory T.O.V.A. test supports the sustained attention construct of the omission score.

6.5 Discriminant Function

Validity Studies: Leark, Dixon, Allen & Llorente (2000) reported cross validation data on diagnostic hit rates between ADHD and normal control subjects. In their study, 44 children (mean age = 8.77 years, SD = 0.42O diagnosed with ADHD were compared to aged matched control subjects (mean age = 8.64 years, SD = 0.49) randomly selected from the T.O.V.A. norm base. Mann-Whitney U tests were conducted to compare mean group ranks for the raw Omission and Commission scales. Statistically significant differences were found between the ADHD and control groups (p ¡ .001) with the ADHD group having higher mean rank raw scores (i.e., poorer test performance). Student t-tests were conducted on the raw response time (RT) and the raw response time variability (RTV). Statistically significant mean score differences were found between the ADHD and control subject groups (p ¡ .05). The ADHD group had slower response speed and also had greater variability of response time than did the normal control group. To assess for the ability of the T.O.V.A. to classify subjects into correct diagnostic groupings, a discriminant function analysis was performed using the raw Total test score (Omission Total, Commission Total, Response Time Total and Response Time Variability Total). This yielded an overall correct original group classification rate of 84.1%. The normal control group was 41 of 44 correctly classified (93.2%) and 3 of 44 incorrectly classified (6.8%). The ADHD sample classification yielded 33 of 44 correctly identified (75%) and 11 of 44 incorrectly classified (25%). The classification data is slightly less than reported above, however, the Leark, Dixon, Allen & Llorente study used raw performance scores while the other studies reported above utilized z score conversions. Given that the Leark et al. study used age matched samples, z score conversion was not as essential as it was in the earlier reported studies.

Table 49: Means & Standard Deviations by Diagnostic Group

	Normal Mean (SD)	ADHD Mean (SD)
Total Omission Errors	1.77 (2.63)	26.68 (36.94**)
Total Commission Errors	9.91 (7.84)	25.27 (16.01**)
Total Response Time (ms)	488.61 (93.47)	555.41 (115.91*)
Total RT Variability (ms)	167.66 (40.93)	207.86 (55.59*)

*p < .05 **p < .001

From: Leark, R.A., Dixon, D., Allen, M. Llorente, A.M. (2000) Cross Validation of Diagnostic Hit Rates & Performance Differences between ADHD and Normative Groups of Children on the Test of Variable of Attention. Poster paper presentation at the 20th Annual Meeting of the National Academy of Neuropsychology. Orlando, FL.

Table 50: Classification Results

	Predicted Group Membership			
	Normal		ADHD	
Original Group	Percent	Count	Percent	Count
Normal	93.2%	41	6.8%	3
ADHD	25.0%	11	75. %	33

From: Leark, R.A., Dixon, D., Allen, M. Llorente, A.M. (2000) Cross Validation of Diagnostic Hit Rates & Performance Differences between ADHD and Normative Groups of Children on the Test of Variable of Attention. Poster paper presentation at the 20th Annual Meeting of the National Academy of Neuropsychology. Orlando, FL.

6.5.1 Culturally Based Data and Special Population Data

Cultural Based Data: There have been studies reporting on the use of the T.O.V.A. in non-English speaking cultural groups. These studies compared T.O.V.A. test score differences between ADHD and normal control groups. For example, Wada, Yamashita, Matsuishi, Ohtani & Kato (2000) found the T.O.V.A. to be useful in the diagnosis of Japanese male children with ADHD. Wada, et al. compared a group of 17 Japanese male children (age range 6 to 12) to aged-matched normal Japanese male children. The authors reported that the group of Japanese male children with ADHD had statistically significant differences across the four TOVA scales (Table 51). Wada et al. were careful to use raw scores to compute their analysis noting that the standard score model used within the software itself is based upon the normative sample collected within the United States.

Xueni & Yufeng (2000) reported the results of their investigation into the applicability of the T.O.V.A. on ADHD children in China. 56 ADHD children and 16 normal controls were tested using the visual T.O.V.A. Baseline testing was used and the authors reported significant differences between the Chinese children with ADHD and the Chinese normal controls across all T.O.V.A. scores. Xueni & Yufeng reported a sensitivity of diagnosis was 85.71% and specificity of 87.5%. The authors concluded that the T.O.V.A. has application in China and encouraged is use in research and clinical practice.

Table 51: T.O.V.A. Results in ADHD and control group

	First Half		Second Half	
	Q1	Q2	Q3	Q4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Omission errors:				
ADHD	7.67 (8.90)	18.15 (23.72)	10.81 (13.09)	11.065 (12.78)
Control	0.58 (2.54**)	0.43 (1.04**)	0.87 (2.01**)	1.37 (3.12**)
Commission errors:				
ADHD	6.53 (12.79)	3.81 (5.99)	33.41 (19.11)	36.34 (21.79)
Control	0.96 (1.04**)	0.79 (1.63*)	3.41 (9.85**)	19.48 (12.00**)
Response Time (ms):				
ADHD	589.94 (184.52)	631.35 (210.93)	523.76 (181.91)	526.94 (176.48)
Control	451.13 (86.48**)	488.15 (12.86**)	416.47 (79.92**)	428.31 (101.98**)
RT Variability (ms):				
ADHD	172.35 (70.50)	183.00 (78.80)	221.41 (103.29)	236.82 (114.35)
Control	96.00 (34.43**)	98.31 (39.77**)	109.31 (49.11**)	132.26 (55.83**)

ADHD n = 17 Control n = 19
*p < .05 **p < .01

From: Wada, N., Yamashita, Y., Matsuishi,T., Ohtani, Y. & Kato, H. (2000) The Test of Variables of Attention (TOVA) is useful in the diagnosis of Japanese male children with attention deficit hyperactivity disorder. Brain & Development, 22, 378-382.

6.5.2 Special Populations

Deaf Subjects: Evaluation of deaf children or adults is fraught with language, cultural and procedural difficulties (Parasnis, Samar & Berent, 2003). These authors point out that test materials and instructions are generally not available in a signed of bilingual format, nor are deaf population norms readily available for most assessment tools. There is some evidence that deafness leads the visual attention system to re-organize itself in order to adapt to optimize visual alerting (Bavelier, Tomann, Hutton, Mitchell, Corina, Liu & Neville, 2000; Parasnis & Samar, 1985). These researchers point out that heightened sensitivity to novel visual events in the deaf individual's periphery becomes an important factor that individual's ability to process information. To further understand this and how this adaption impacts performance on the visual T.O.V.A., Parasnis, Samar & Berent examined 44 prelingually deaf and 38 normal-hearing college students with no known history of ADHD. In addition to the T.O.V.A., the participants also were given an adult rating scale for attention deficits, a nonverbal measure of intelligence and the Symbol Digit Modalities Test. Their data (see Table 52) indicates that no statistically significant differences were found between the deaf and hearing groups for Omissions, Response Time and Response Time Variability. However, the deaf group showed significant evidence of greater impulsivity than the hearing subjects. The deaf group had twice the number of commission errors and was nearly three times higher in their number of anticipatory responses compared to the hearing group. The deaf group had a significant reduction in the rate of correct responses in the Total and for both halves. Further, the deaf group d' was significantly lower than for the hearing group. The reduced d' raises a cautionary flag is it suggests the deaf may have a reduce attention to the T.O.V.A. stimuli. The authors conclude that caution is advised when assessing deaf children. This caution is both for behavior rating scales as well as the visual T.O.V.A.

Gifted Children: The T.O.V.A. was standardized using participants with normal range intelligence. Weyandt, Mitzlaff & Thomas (2002) reported that in their college aged sample of normal range IQ students there were no significant correlations between the T.O.V.A. and WAIS-R Full Scale, Verbal an Performance IQ scores. No significant correlations were found for the WAIS-R Freedom from Distractibility Score either.

Table 52: Means (and Standard Deviations) for T.O.V.A. across Hearing Status Groups

	Omission	Commission	RT	RTV	d'	Correct Responses	Anticipatory Responses
Total:							
Deaf	3.55 (17.13)	12.21 (10.03)	314.93 (57.66)	74.30 (33.65)	4.20 (0.68)	286.87 (40.37)	28.32 (42.63)
Hearing	2.21 (8.55)	5.50** (5.04)	329.41 (62.22)	71.77 (18.73)	4.51 (0.48)	307.21** (19.30)	10.79** (16.21)
Half 1:							
Deaf	0.30 (0.80)	1.05 (1.25)	340.30 (56.82)	58.12 (15.18)	4.67 (0.24)	70.16 (2.51)	1.16 (4.11)
Hearing	0.12 (0.41)	0.32** (0.32)	354.72 (72.39)	58.94 (72.39)	4.71 (0.15)	71.53** (083.)	0.09 (0.09)
Half 2:							
Deaf	3.26 (17.14)	11.16 (9.38)	307.21 (63.07)	74.15 (38.31)	3.56 (1.04)	216.71 (38.61)	27.16 (40.04)
Hearing	2.09 (8.57)	5.18** (4.80)	321.64 (62.58)	70.56 (20.48)	3.72 (0.79)	235.68** (19.03)	10.71** (16.22)

Deaf n = 44 Hearing n = 38
**p < 0.01

From: Parasnis, I,, Samar, V. J., & Berent, G.P. (2003). Deaf Adults without Attention Deficit Hyperactivity Disorder Display Reduced Perceptual Sensitivity on Elevated Impulsivity on the Test of Variables of Attention. Journal of Speech, Language & Hearing Research, Vol. 46, 1166-1183.

However, Chae (1999) reported significant negative correlation between the T.O.V.A. Omission and WISC-III Performance and Full Scale IQ scores (-.458 and -.440, respectively) in a cohort of40 children aged 6 to 17 years. Chae concludes that normal range intelligence seems unrelated to tasks measured by the T.O.V.A.

However, there are at least two studies, which indicate that individuals with higher IQ scores respond differently to the T.O.V.A. than do the subjects within the normative range of intelligence. Chae, Kim & Noh (2003) reported on their study of differences between a sample of gifted (n = 106) and non-gifted (n = 71) children. ANCOVA was used to compare the differences between the gifted and non-gifted children with age and gender used as covariates (consistent with T.O.V.A. normative data). The results of the ANCOVA (Table 53) indicate that there were significant differences between the two groups for Omission errors, Response Time Variability, sensitivity (d') and for the ADHD score. Gifted children performed better than non-gifted children in attending target stimuli, showing consistent response patterns to targets and discriminating target from nontarget. No significant difference was found for Response Time (NOTE: the authors did not provide for any table of mean scores for the T.O.V.A. within the article). Chae, Kim & Noh did report significant negative correlations between KEDI-WISC (a Korean version of the WISC) for FIQ, VIQ and PIQ intelligence measures and TOVA Omission, Commission, Response Time Variability, d', and ADHD scores (Table 54), none for Response Time. Chae, Kim & Noh's data indicates that intelligence is related to T.O.V.A. performance in gifted children, whereas, intelligence seems less related to T.O.V.A. performance for normal range IQ. The study also indicates that use of the T.O.V.A. outside of the standardization assumptions should be done with caution.

Rosengren (2004) examined whether children who met the criteria for giftedness would perform differently on the visual T.O.V.A. than subjects in the respective normative sample. The sample consisted of 90

Table 53: Comparison of T.O.V.A. Performance between Gifted and Non-gifted with Age and Gender Controlled

Variance	Sum of Squares	DF	Mean Square	F
Omission	1313.83	1	1313.83	45.54***
Commission	51080.00	1	51080.00	4.11*
Response Time	21607.43	1	21607.43	2.71
RT Variability	29824.03	1	29824.03	19.32***
d'	59.54	1	59.54	67.56***
ADHD score	85.74	1	85.74	12.89**

*p < .05 **p < .01 ***p < .001

From: Chae, P.K., Kim, J.H., & Noh, K.S. (2003) Diagnosis of ADHD Among Gifted Children in Relation to KEDI-WISC and T.O.V.A. Performance. Gifted Child Quarterly, Vol. 47, 3, 192-201.

Table 54: Partial Correlations between IQ and T.O.V.A. Performances with Age and Gender Controlled

	Omission	Commission	RT	RTV	d'	ADHD
Full IQ	−0.52***	−0.17*	−0.12	−0.30***	0.50***	0.27***
Verbal IQ	−0.48***	−0.13	−0.11	−0.25**	0.41***	0.20*
Performance IQ	−0.46***	−0.19*	−0.12	−0.32***	0..52***	0.33***

*p < .05 **p < .01 ***p < .001

From: Chae, P.K., Kim, J.H., & Noh, K.S. (2003) Diagnosis of ADHD Among Gifted Children in Relation to KEDI-WISC and T.O.V.A. Performance. Gifted Child Quarterly, Vol. 47, 3, 192-201.

children, 59 male, 32 female between five and eleven year of age (mean = 9.3 years, SD = 1.4). The criterion for eligibility for participation was an IQ score of a minimum of 120. The results from Rosegren's initial analysis yielded significant differences between raw performance measures for Omission, Response Time and Response Time Variability, but not for Commission or d' (Table 53). The magnitude of the effect size for these differences was medium for Omission and large for the remaining three scales. An analysis for gender differences also held for the same finding, gifted males and gifted females performed significantly different than the normative data. Gifted males and gifted females both performed significantly different on Omission, Response Time, Response Time Variability and d'. To determine if age impacted performance by these gifted children, Rosegren separated the subjects into two groups, ages 6 to 8 and ages 9 to 11. The analysis of differences between raw T.O.V.A. performances by age group yielded significant differences between the two groups. The analysis yielded significant age – related findings with the younger subjects performing s slower, less consistent, more impulsive and less attentive than the older children. It should be noted that Rosegren's findings here are similar to the T.O.V.A. normative base. Younger children perform differently than older children, hence the age-based norm scoring by the T.O.V.A. However, Rosegren further examined his data and found that when compared to the same T.O.V.A. normative age grouping, the gifted children performed significantly different from the T.O.V.A. norms. Specifically, the finding that the younger gifted children performed differently than the older children remained consistent. Further, the younger children were significantly different than age matched norm data. Thus, higher IQ does impact T.O.V.A. performance for younger children but not so for older children (Table 54).

Rosengren's (2004) findings along with those from Chae, Kim & Noh (2003) raise a cautionary flag for use of the T.O.V.A. with individuals with higher than normal IQ

Valid Effort and Motivation: The validity of responses to the items on any psychological or neuropsychological test is anchored to appropriate levels of effort to attend to the task at hand. With this in mind, several studies have demonstrated the effects of poor effort or intentional test response bias on T.O.V.A. scores. Leark, Dixon, Hoffman & Huynh (2002) investigated the effects of simulated faking (bad) on the T.O.V.A.

36 volunteer college students were randomly placed into two groups. One group received the T.O.V.A. with normal instructions (NC), and then was instructed to simulate a subtly bad T.O.V.A. performance (FB). The other group received the same simulated subtly bad T.O.V.A. performance, then was administered the T.O.V.A. with standard instruction. Test order was found to be non-significant. The two groups were then merged to determine the effects of purposeful simulated fake bad performance. An analysis for group mean between the NC and FB instructions found significant differences across all of the T.O.V.A. scores for the four quarters, each half and the Total (Table 55) The FB group had excessive amounts of omission and commission errors, a greater response time mean (i.e., slower to respond) and had greater variance around their mean response times. The authors encouraged caution towards interpreting as valid any T.O.V.A. performance with an excessive number of either Omission or Commission errors, or extremely variant scores on Response Time and Response Time Variability.

Henry (2005) also examined poor effort on the T.O.V.A. Henry used 50 adult subjects with reported mild head injury who were involved in personal injury litigation along with two subjects who were referred for evaluation of a disability status. Each was administered with neuropsychological evaluation which included the T.O.V.A. In addition to the neuropsychological examination, symptom validity testing (SVT) was conducted on each subject. The SVTs administered included the Test of Memory Malingered (TOMM), Word Memory Test (WMT) or the Computerized Assessment of Response Bias (CARB). A retrospective data analysis allowed the subjects to be classified into two groups, a probable malingering group (PM) or a not malingering group (NM). The subjects were placed into the PM group on the basis of scoring below published cutoff scores for the TOMM, WMT or the CARB. The analysis indicated the PM group to performed significantly worse than the NM group on the T.O.V.A. (Table 56). Given this difference, Henry then performed a series of classification analyses to determine the classification threshold wherein an individual whose predicted probability exceeds the threshold is truly classified as malingering. Henry determined that using a classification of three or more errors on the Omission scale as malingering, the corresponding predicted hit rate is 0.26. Application of this criterion produced then an overall hit rate of 84.6% and correctly classifies 88.5% of the malingerers (i.e., sensitivity) and 80.8% on the non-malingerers (i.e., specificity).

Hughes, Leark, Henry, Robertson & Greenberg (2008) provided a further analysis of the Leark (2002) and Henry (2005) data and created a different model of interpretative rules. Hughes, et al., formulated a symptom validity rule based upon the individual's response time. In this model, Commission Error Response Time (CERT), Correct Response Response Time (CRRT) and Post-Commission Error Response Time (PCERT) were used to develop hit rates of likely invalid performance. The model, CERT<CRRT<PCERT, is based upon the relationship (i.e., CERT<CRRT;CERT<PCERT; CRRT<PCERT) each increases the likelihood of invalid responding. Hughes, et al. reported that when using these rules (CERT<CRRT; CERT<CERT; and CRRT<PCERT) to discern valid/invalid performance 95% of the Leark (2002) fake bad data set had at least 2 error violations. None of the "good" data had any rule violations. However, when the symptom validity rules were used in a data set of children and adolescent subjects, the rule model did not show any clear relationship. Thus, while very helpful in determining effort validity/invalidity in adults, the model is not appropriate for children or adolescences. This rule system was then further developed and incorporated in the T.O.V.A. rule algorithms and is the basis for the Symptom Exaggeration Index currently used with the T.O.V.A. reporting software.

Table 55: Table of Means for Normal and Fake Bad Instructions

	Omission[a]		Commission[b]		RT[c]		RTV[c]		d'	
	NC	FB	NC	FB	NC	FB	NC	FB	NC	FB
Q1:										
χ	8.49	22.66*	1.92	11.24***	441.78	530.00	111.44	201.55	6.67	3.82**
SD	22.27	26.51	4.59	18.92	175.32	190.08	114.20	134.68	2.73	2.97
Q2:										
χ	9.26	26.32*	1.56	10.06***	444.22	602.11**	114.91	223.24	6.74	3.53**
SD	23.76	29.74	4.02	17.59	179.52	238.56	139.57	107.82	2.54	2.69
Q3:										
χ	6.35	24.77*	12.86	26.24***	370.56	491.50	106.78	215.71**	4.43	2.14**
SD	19.72	27.84	12.09	18.82	125.21	236.05	106.78	133.69	1.97	1.90
Q3:										
χ	6.57	25.52*	11.46	24.61***	361.28	471.39**	105.16	207.12**	4.81	2.16**
SD	18.33	26.30	11.03	16.86	126.98	188.79	100.62	119.38	2.13	1.91
H1:										
χ	8.81	24.49*	1.74	10.68***	442.22	566.67	113.16	220.38**	6.3	3.44**
SD	22.89	27.47	4.26	18.21	174.97	212.82	119.33	119.67	2.50	2.63
H2:										
χ	6.46	25.14*	12.11	25.37***	365.17	481.89**	108.18	217.14**	4.47	2.00**
SD	18.94	26.94	10.89	16.09	122.63	210.62	101.91	125.52	1.78	1.75
T:										
χ	6.99	25.00*	3.99	13.77***	381.00	500.39**	115.50	227.11**	4.89	2.46**
SD	19.63	26.83	5.28	16.91	127.85	205.37	105.12	118.13	1.81	1.84

NC = Normal Instruction FB = Fake Bad Instruction
[a] Percentage of omission errors made
[b] Percentage of commission errors made
[c] Time in millisecond
* Paired Mann-Whitney U test, p < .003, Bonferroni corrected
** Paired Student's t-test, p < .03, Bonferroni corrected
*** Paired Mann-Whitney U test, p < .02, Bonferroni corrected

From: Leark, R.A., Dixon, D., Hoffman, T., & Huynh, D. (2002). Fake Bad Test Response Bias Effects on the Test of Variables of Attention. Archives of Clinical Neuropsychology, 17, 35.342.

Table 56: Univariate Test of Mean Differences

	Mean	SD	t (df)	p	D
Omission:					
PM	54.50	71.95	3.75	0.001	0.73
NM	1.62	2.97	(25)		
Commissions:					
PM	20.77	39.30	1.69	0.10	0.34
NM	7.58	6.74	(27)		
Response Time:					
PM	602.62	249.03	3.87	<0.001	0.83
NM	397.12	105.46	(34)		
Response Time Variability:					
PM	230.42	94.14	5.76	<0.001	1.28
NM	109.92	50.17	(38)		

n = 26

From: Henry, G.K. (2005). Probable Malingering and Performance on the Test of Variables of Attention. The Clinical Neuropsychologist, 19, 121-129.

7 Interpretation

Please see **Interpreting T.O.V.A. Reports** in the **Clinical Manual**.

8 CSV Export

8.1 Introduction

The T.O.V.A. version 8.0 and later is able to export session data as a “comma-separated variable” (usually abbreviated CSV) file. CSV files are like spreadsheet files, and can be opened by all well-known spreadsheet programs such as Excel, SPSS, or OpenOffice. Statistical processing tools like MATLAB, R, and Python should also have no problems opening CSV files.

The first row of a CSV file is the “header” row, which contains an alphanumeric title describing the data in the column below it. The title is usually 8 or fewer characters except for custom fields which use the field’s name as a title. Each row below the header row is a single T.O.V.A. test session, consisting of data separated by a comma. Cells with commas in them are escaped with double quotes (“”). For more information on CSV file format, please see http://en.wikipedia.org/wiki/Comma-separated_values.

Here’s an example of a raw CSV file:

```
SUBNUM,NAME,DOB,AGE,AGEYR,AGEMO,AGEDAY,GENDER,SESNUM,TDATE,TTIME,CMTS, ...
1,John Doe,1985-11-01,29.758219178082193,29,9,11,M,1,2015-08-15,12:52,, ...
2,Jane Smith,1990-10-01,25.002739726027396,25,0,12,F,2,2015-10-05,11:22,, ..
```

And on importing the data to a spreadsheet program (like Microsoft Excel) you’d expect to see something like:

	A	B	C	D	E	F	G	H	I	J	K	L
1	SUBNUM	NAME	DOB	AGE	AGEYR	AGEMO	AGEDAY	GENDER	SESNUM	TDATE	TTIME	CMTS
2	1	John Doe	1985-Nov-01	29.758219178082193	29	9	11	M	1	2015-08-15	12:52	
3	2	Jane Smith	1990-Oct-01	25.002739726027396	25	0	12	M	2	2015-10-05	11:22	
4												

The data in the comma-separated variable export from the T.O.V.A. are roughly grouped together by variable type. See the Table of Contents (above) for a list of those rough groups.

If you have any questions about this format, or using T.O.V.A. variables in statistical analyses, please don’t hesitate to contact us!

Email: research@tovacompany.com
Phone: 800.729.2886 (562.594.7700)

8.2 Part 1: Subject Information

Information on the subject. For subjects with multiple sessions, the subject information is simply repeated for each session.

Note that if “Remove Protected Health Information” was left checked during the export process, all Protected Health Information (PHI) is removed (fields are present, but left blank). In the subject information variable group, PHI currently only applies to the subject’s name.

Header	Description	Range & Units
SUBNUM	Subject number: An identification number automatically assigned to T.O.V.A. subjects. Deprecated in the T.O.V.A. 8. For sessions administered with the T.O.V.A. version 7.x, SUBNUM is the T.O.V.A. 7 Group Number added to the T.O.V.A. 7 Subject Number.	0-999999
NAME	Subject Name: first name, followed by a space, followed by the last name. NOTE: This field is considered Protected Health Information (PHI) and will be cleared (left blank) if “Remove PHI” is checked during export.	String (255 char max)
DOB	Subject Date of Birth	yyyy/mm/dd [ISO date]
AGE	Subject age (on the day of testing)	03.500 - 99.999 [decimal years]
AGEYR	Subject age, years component	3 and up [integer years]
AGEMO	Subject age, months component	0-11 [integer months]
AGEDAY	Subject age, days component (within approx. ± 1 day)	0-31[integer days]
GENDER	Gender	M/F

8.3 Part 2: Custom Subject Fields

Custom subject fields are custom database fields that a T.O.V.A. user can create that are associated with subjects (not sessions). For example, ‘Weight’, ‘Other diagnoses’, etc.

Important: this section has a variable number of columns. Each custom subject field will create one column in the CSV file. In other words: if there are any custom subject fields in your exported file, they are included as one column per custom subject field. If there are no custom subject fields, there will be no columns in this section.

Note that if “Remove Protected Health Information” was left checked during the export process, the data in custom subject fields that were attributed as PHI will be cleared (left blank).

Header	Description	Range & Units
Custom subject field name	Optional: Data from custom subject field. NOTE: If this field is marked as Protected Health Information (PHI), then this field will be cleared if “Remove PHI” is checked during export.	String (255 char max)

8.4 Part 3: Session Information

Information on the session (the "test"), including date and time, tester comments, recorded treatments, and the type of T.O.V.A. test given.

Important: this section has a variable number of columns set by the number of treatments in the sessions that were export. In other words: if there are any treatments in the sessions included in the CSV file, they are included as three columns per treatment entered. For example, if one or more session has two treatments entered, then there will be six treatment columns. If there are no treatments in any exported sessions, then there will be no treatment columns.

Header	Description	Range & Units
SESNUM	Session Number (may not be available)	1-99 [integer]
TDATE	Date of test (local)	yyyy/mm/dd [ISO date]
TTIME	Time of test (local)	hh:mm, 00:00 - 23:59 [ISO time]
CMTS	Session comments: Notes on the session, with carriage returns and line feeds stripped out.	String (1024 char max)
TRTNAMi	Optional: Treatment #i name: This is either the medication name or the more generic "Treatment" field where the user can record information on the treatment being monitored by this particular session.	String (255 char max).
TRTCHAi	Optional: Treatment #i challenge medication status: A flag indicating if this session is being used to monitor a specific short-acting treatment (e.g., an "on" medication trial).	'TRUE' or 'FALSE'
TRTDOSi	Optional: Treatment #i dosage: Dosage of a medication (or treatment).	0-999.99 [mg]
TRTINTi	Optional: Treatment #i medication-test interval: The length of time from when the subject took the medication to the beginning of the test session.	0-99.9 [hours]
TESTER	Name or identifier of user administering the T.O.V.A. session	String (255 char max)
TTYPE	Test Type: either visual or auditory test	'V' or 'A'
TFORM	Test Format #: Which format of the T.O.V.A. test was administered. The standard form, #1, is the standard 21.6-minute test used for ages 6.0 years and above. The short form, #6, is the short 10.8-minute test used for ages less than 6.0 years.	0-9 [integer]

8.5 Part 4: Session Format Details Information

Information on the T.O.V.A. session type, format, and testing details, including the T.O.V.A. version information.

Header	Description	Range & Units
ISI	Inter-Stimulus Interval: Time between stimuli. Default: 2000 ms.	0-9999 [ms]
STIMON	Stimulus on time: Time from the start of the ISI (where time = 0) to when the stimulus will be presented. Default: 200 ms.	0-9999 [ms]
STIMOFF	Stimulus off time: Time from the start of the ISI (where time = 0) to when the stimulus will be turned off. Default: 300 ms.	0-9999 [ms]
ANTTIME	Anticipatory cutoff time: Time from the STIMON time (the presentation of the stimuli) to the longest response to be considered an anticipatory response. Default: 150 ms.	0-9999 [ms]
VERSION	Software version: Version of the T.O.V.A. test that administered the test. Typical values include '6.08', '7.0.3', 'HT1.1', '7.1', '7.2', '7.3', '8.X-XX-gXXXXXXXX'.	Fixed strings (255 char max)
SERIAL	Hardware serial #: the serial number of the T.O.V.A. test that administered the test.	000000 - 999999 (6 digits)
USERTYPE	User type: Either 'clinical' or 'screening'	Fixed strings (255 char max)
CALMEAN	Calibration data mean: the mean value of the screen calibration data. Note that response times already have this delay subtracted; this value is for reference only.	floating point [s]
CALSTATE	Calibration data outcome: the success or failure of the calibration algorithm. Typical results are: GOOD, MORE_DATA, BAD_SLOPE, BAD_VAR, BAD_TIME, BAD_ZEROS.	Fixed strings (255 char max)
FILNAME	Imported filename: the filename of the session if the session was imported into the T.O.V.A. (typically a T.O.V.A. 7 filename).	String (255 char max)

8.6 Part 5: Custom Session Fields

Custom session fields are custom database fields that a T.O.V.A. user can create that are associated with sessions (not subjects). For example, 'Sleep the night before', 'Coffee intake', etc.

Important: this section has a variable number of columns. Each custom session field will create one column in the CSV file. In other words: if there are any custom session fields in your exported file, they are included as one column per custom session field. If there are no custom session fields, there will be no custom session field columns.

Note that if "Remove Protected Health Information" was left checked during the export process, the data in custom session fields that were marked as PHI will be cleared (left blank).

Header	Description	Range & Units
Custom session field name	Optional: Data from custom session field. NOTE: If this field is marked as Protected Health Information (PHI), then this field will be cleared if "Remove PHI" is checked during export.	String (255 char max)

8.7 Part 6: Conversion Information

The version information on the T.O.V.A. software that created the CSV file.

Header	Description	Range & Units
CVERSN	Converter Version: this is version of the T.O.V.A. software that exported the CSV file. In the form of '8.X-XX-gXXXXXXXX'.	Fixed string (255 char max)

8.8 Part 7: Tabulated Data

These columns are the tabulated raw data for the test, and is not the comparison to the norming study.

Each variable is tabulated into seven data "blocks": Quarters 1 to 4, Half 1 and 2, and the Total, indicated by the suffixes Q1, Q1, Q2, Q3, Q4, H1, H2 or T. For example, "CORRSPxx" becomes "CORRSPQ1", "CORRSPQ2", "CORRSPQ3", "CORRSPQ4", "CORRSPH1", "CORRSPH2", and "CORRSPT".

Header	Description	Range & Units
CORRSPxx	# of Correct Trials: responses to targets and nonresponses to nontargets	Integer
CORTGTxx	# of Correct responses: responses to targets	Integer
CORNONxx	# of Correct nonresponses: nonresponses to nontargets	Integer
COMERRxx	# of Commission Errors: responses to nontargets	Integer
COMPERxx	% of Commission Errors	Floating point, 0 - 1
COMPSTxx	# of Post-Commission Error responses: a correct response immediately after a commission error	Integer
OMERRxx	# of Omission Errors: nonresponse to a target	Integer
OMPERxx	% of Omission Errors	Floating point, 0 - 1
ANTERRxx	# of Anticipatory Responses: a response before the ability to distinguish target from nontarget	Integer
ANTPERxx	% of Anticipatory Responses	Floating point, 0 - 1
ANTTGTxx	# of Anticipatory Responses to targets	Integer
ANTNONxx	# of Anticipatory Responses to nontargets	Integer
MULTxx	# of Multiple responses: multiple microswitch pushes in one stimulus interval	Integer
UINTxx	# of user interrupts: The times in each block that session was interrupted by the user pressing 'Esc'.	Integer
HDWERRxx	# of session interruptions caused by a hardware errors.	Integer

8.9 Part 8: Receiver Operator Characteristics

These columns are the raw receiver operator characteristics (ROC) analysis for the session.

Each variable is tabulated into seven "blocks": Quarters 1 to 4, Half 1 and 2, and the Total, indicated by the suffixes Q1, Q1, Q2, Q3, Q4, H1, H2 or T. For example, "DPRIMExx" becomes "DPRIMEQ1", "DPRIMEQ2", "DPRIMEQ3", "DPRIMEQ4", "DPRIMEH1", "DPRIMEH2", and "DPRIMET".

Header	Description	Range & Units
DPRIMExx	D prime	Floating point
BETAxx	Beta	Floating point

8.10 Part 9: Response Times

These columns are the raw response time analysis for the session.

Each variable is tabulated into seven "blocks": Quarters 1 to 4, Half 1 and 2, and the Total, indicated by the suffixes Q1, Q1, Q2, Q3, Q4, H1, H2 or T. For example, "RTMEANxx" becomes "RTMEANQ1", "RTMEANQ2", "RTMEANQ3", "RTMEANQ4", "RTMEANH1", "RTMEANH2", and "RTMEANT".

Header	Description	Range & Units
RTMEANxx	Correct Response Time Mean: the mean response time of the correct responses.	Floating point [sec]
RTVARxx	Correct Response Time Variability: the first standard deviation of the correct response times.	Floating point [sec]
PCRTMxx	Post-commission Response Time Mean: the mean response time of a correct response that occurred immediately after a commission error.	Floating point [sec]
PCRTVxx	Post-commission Response Time variability: the first standard deviation of the correct response times that occurred immediately after a commission error.	Floating point [sec]
CERTMxx	Commission Response Time Mean: the mean response time of commission errors.	Floating point [sec]
CERTVxx	Commission Response Time variability: the first standard deviation of the response times of commission errors.	Floating point [sec]
EXGMUxx	ExGaussian Mu: The mean response time of the correct responses, modeled using the ExGaussian distribution.	Floating point [sec]
EXGSIGxx	ExGaussian Sigma: The variability of the correct response times, modeled using the ExGaussian distribution.	Floating point [sec]
EXGTAUxx	ExGaussian Tau: The exponential decay (or "right hand tail") of the correct response times, modeled using the ExGaussian distribution.	Floating point [sec]
MODExx	Correct response mode: Mode of the correct response times.	Floating point [sec]
SKEWxx	Correct response Deviation: Deviation from the mode for correct response times.	Floating point [sec]

8.11 Part 10: Comparison Scores: Standard Scores and Z Scores

These variables are the comparison of the tabulated raw data to the T.O.V.A. norming study. They are presented as both standard scores and as standard deviations from the mean.

Each variable is tabulated into seven "blocks": Quarters 1 to 4, Half 1 and 2, and the Total, indicated by the suffixes Q1, Q1, Q2, Q3, Q4, H1, H2 or T. For example, "VARSSxx" becomes "VARSSQ1", "VARSSQ2", "VARSSQ3", "VARSSQ4", "VARSSH1", "VARSSH2", and "VARSST".

Some notes:

- It is important to remember that H1, H2 and T are not a simple average of the quarters or halves - they are recalculations of the data set for that block and thus may be quite different from an average of their sub-blocks.
- The norming study used to create the spreadsheet file is the latest T.O.V.A. norming study. Do not be surprised if the variables in the file have slightly to significantly different values from older versions of the T.O.V.A. (e.g., 7.0.3). Numbers in the norming study change, for example, when the norming population is increased or any smoothing or other statistical work is done (as indicated in the latest version of the T.O.V.A. Professional Manual).
- Be aware that the T.O.V.A. rounds its data for the human-readable report, while this conversion file keeps many more significant figures since they may be used in future calculations.
- In the T.O.V.A. report, all analysis variables using are marked "< 0" and "> 160" for all standard scores below 0 SS and above 160 SS respectively. In this conversion file, the directly calculated standard scores are given and thus no limits are placed on the numeric values. In extreme cases, this leads to unlikely numbers in the analysis variables, e.g., negative standard scores and huge standard deviations. It is up to the researcher to decide if any of the analysis variables should be numerically limited.
- **There are many reasons why an analysis may be considered "invalid", in the sense that a clinician should use caution when interpreting the data. It is up to the researcher to decide if an invalid analysis variable should be used in their research study. Note that validity can be checked using the validation variables (see Part 14 below).**

Header	Description	Range & Units
VARSSxx	Standard score of response time variability	Floating point [std score]
RTMSSxx	Standard score of mean response time	Floating point [std score]
COMSSxx	Standard score of commission errors	Floating point [std score]
OMSSxx	Standard score of omission errors	Floating point [std score]
DPRSSxx	Standard score of D prime	Floating point [std score]

Header	Description	Range & Units
VARZxx	Z score (standard deviation) of response time variability	Floating point [std dev]
RTMZxx	Z score (standard deviation) of mean response Time	Floating point [std dev]
COMZxx	Z score (standard deviation) of commission errors	Floating point [std dev]
OMZxx	Z score (standard deviation) of omission errors	Floating point [std dev]
DPRZxx	Z score (standard deviation) of D prime	Floating point [std dev]

8.12 Part 11: Performance Validity (PV)

Performance validity is a flag for unusual performance on the T.O.V.A., such as poor effort, malingering, and fake bad.

Note that the Symptom Exaggeration Index (SEI) from T.O.V.A. 8.0 and 8.1 has been deprecated in favor of Performance Validity (PV) in the T.O.V.A. 8.2 and later.

PV is only valid for visual T.O.V.A. tests given to subjects ages 17 and up.

Header	Description	Range & Units
SEI1	Deprecated: SEI Rule 1: If (O(T) $<$ -4 SD) OR (C(T) $<$ -4 SD)	Boolean, 0,1
SEI2	Deprecated: SEI Rule 2: If (V(T) $>$ 180 ms)	Boolean, 0,1
SEI3	Deprecated: SEI Rule 3: If (C#(T) $>$ 6) and (CERT(T) $\geq$ RT(T)	Boolean, 0,1
SEI4	Deprecated: SEI Rule 4: If (PC#(T) $>$ 6) and (PCRT(T) $\leq$ RT(T))	Boolean, 0,1
SEITOTAL	Deprecated: SEI Score: the addition of rules SEI1 through SEI4	Integer, 0-4
SEISTATE	Deprecated: SEI State: See "PV and SEI State" table below.	Fixed string (255 char max)
PV1	PV Rule 1: If number of omission errors (total) $>$ 30	Boolean, 0,1
PV2	PV Rule 2: If number of commission errors (total) $>$ 10	Boolean, 0,1
PV3	PV Rule 3: If response time skew (half 2) is $>$ 150 ms	Boolean, 0,1
PV4	PV Rule 4: If number of commission errors (half 2) $>$ 6 and commission error response time (CERT) (half 2) - mean response time (half 2) is $>$ 75 ms	Boolean, 0,1
PVSTATE	PV State: See "PV and SEI State" table below.	Fixed string (255 char max)

Possible outcome states for the SEI and PV are:

PV (and SEI) State	Description
NA-AGE	The PV (and SEI) is not applicable to subjects younger than 17 years old.
NA-NORMAL	The PV (and SEI) is not applicable to normal T.O.V.A. results.
NA-AUDITORY	The PV (and SEI) is not yet applicable to auditory tests.
OK	The PV score was 0: No unusual pattern of performance.
CAUTION	The PV score was $\geq$ 1: An unusual pattern of performance was detected.
OK	The SEI score was 0 or 1: "No evidence" of possible symptom exaggeration.
NOTE	The SEI score was 2: "Some evidence" of possible symptom exaggeration.
CAUTION	The SEI score was 3: "Strong evidence" of possible symptom exaggeration.
WARNING	The SEI score was 4: "Very strong evidence" of possible symptom exaggeration.

8.13 Part 12: Experimental Indicies

This section contains experimental statistics and indicies used in research. Please contact us for more information if you're interested in adding more scores to the T.O.V.A. CSV export.

Header	Description	Range & Units
IMPINDxx	Impulsivity Index: standard score of mean response time divided by the standard score of commission errors (experimental)	FP

8.14 Part 13: Comparison Summaries and States

These columns are the conclusions of the T.O.V.A.'s interpretation algorithms for each block, as well as a summary of the state of the entire test.

Variables with the 'xx' suffix are tabulated into seven blocks: Quarters 1 to 4, Half 1 and 2, and the Total, indicated by the suffixes Q1, Q1, Q2, Q3, Q4, H1, H2 or T. For example, NRMSTxx becomes NRMSTQ1, NRMSTQ2, NRMSTQ3, NRMSTQ4, NRMSTH1, NRMSTH2, and NRMSTT.

Header	Description	Range & Units
NRMSTxx	Norming study comparison state: Interpretation of the subject's performance with the T.O.V.A. normative study. Possible values are: NORMAL, BORDERLINE, and NWNL (not within normal limits).	Fixed string (255 char max)
MAXNRMST	Summary, or "worst case", value across all blocks of the norming state: Possible values are: NORMAL, BORDERLINE, and NWNL (not within normal limits).	Fixed string (255 char max)
ACS	Attention Comparison Score: a composite cutoff score comparing the subject's performance to a study of independently diagnosed ADHD individuals (was called the Attention Performance Index, or API, in previous T.O.V.A. versions).	Floating point [sum of std devs]
ACSTATE	ACS state: Interpretation of the ACS. Possible values are: NORMAL, NWNL (not within normal limits), NA-TYPE (Not applicable because of an auditory session), and NA-DATA (not applicable because of lack of data)	Fixed string (255 char max)
COMPSUM	Summary of the Comparison Analysis: combines "worst case" values of the norming study comparison state and the ACS. Possible values are: WNL (within normal limits) or NWNL (not within normal limits)	Fixed string (255 char max)

8.15 Part 14: Session and Response Validity

This section gives session and response validity flags for T.O.V.A. test and it's blocks (quarters, halves and total). These validity indicators allow you to prune out T.O.V.A. sessions that may not be valid. Deciding on exactly which validity states to accept is highly dependent on what population you are studying and the goals of your research.; we strongly encourage you to contact us to discuss what might be best for your study.

Variables with the 'xx' suffix are tabulated into seven blocks: Quarters 1 to 4, Half 1 and 2, and the Total, indicated by the suffixes Q1, Q1, Q2, Q3, Q4, H1, H2 or T. For example, BLKVALxx becomes BLKVALQ1, BLKVALQ2, BLKVALQ3, BLKVALQ4, BLKVALH1, BLKVALH2, and BLKVALT.

Header	Description	Range & Units
BLKVALxx	Block Validity: the validity of the data in each block See "Block Validity" table below.	String (255 char max)
RSPVALxx	Subject response validity: the validity of the subject's response data in each block. See "Response Validity" table below.	String (255 char max)
MAXRSPVL	Maximum value ("worst case") of the Response validity across all blocks. See "Response Validity" table below.	String (255 char max)
SESSVAL	T.O.V.A. session validity: the validity of the test administration compared to the norming study. See "Session validity" table below.	String (255 char max)

Block Validity can be:

Block Validity	Description
OK	There are no block validity issues with this session.
INTERRUPTED	There are serious validity issues with this block because of one or more test interruptions. This block has all of its trials, and may be used for analysis.
INCOMPLETE	There are serious validity issues with this block because the test was interrupted and trial data is missing. Because this block has greater than 50 % of the trials, it may be used for analysis.
UNUSABLE	This block is unusable for analysis because less than 50 % of the trials in this block have data (the block was interrupted and not restarted).
EMPTY	This block is unusable for analysis because there are no trial data in this block (this block was never started).

Response Validity can be:

Response Validity	Description
OK	There are no subject response validity issues with this block.
CAUTION	The subject's responses may be invalid: either the anticipatory response rate is uncharacteristically high (> 10 %) or there were less than 25 % correct responses in this block.

Session Validity can be:

Session Validity	Description
OK	There are no validity issues with this session.
CAUTION	There are serious validity issues with this session compared to the norms. This state is caused by test interruptions, such as a user interrupt or hardware error interrupt.
SCORED_DATA_ONLY	Only raw scores and tabulated data are available; no comparison to the norms or ADHD study is possible. This state is caused by invalid test parameters, such as the wrong test format for a given age, different ISI timing, etc.

9 References

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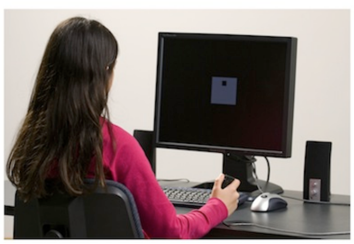
10 Appendices

10.1 Appendix A: Sample T.O.V.A. 9.0 Report

The Test Of Variables of Attention (T.O.V.A.®)

The **Test of Variables of Attention (T.O.V.A.)** is an FDA-cleared, state-of-the-art continuous performance test that provides objective measurements of attention and inhibitory control, which aid in the assessment of attention deficits, including attention-deficit/hyperactivity disorder (ADHD). T.O.V.A. results are available for children and adults (ages 4 - 80+), and should only be interpreted by qualified healthcare professionals.

The T.O.V.A. continuously measures performance during a 10.8-minute task or a 21.6-minute task, depending on age. It records speed, accuracy, and consistency of responses to a series of squares (in the Visual T.O.V.A. test) or tones (in the Auditory T.O.V.A. test) that are presented in two-second intervals. These measurements (accurate to ±1 ms) are then compared by age and gender to a large normative sample (a sample of people without attention problems). This comparison determines whether the test results are "within normal limits" or not. The T.O.V.A. also compares results to a group of people independently diagnosed with ADHD. The T.O.V.A. report is based on these two comparisons, as well as performance, session, and response validity measures.



If you have questions about this report, please contact the person who provided it to you. For more information about attention and the T.O.V.A., please visit our website at http://www.tovatest.com/. To contact us please email info@tovatest.com or call 800.PAY.ATTN (562.594.7700).

ID: **1**	**Example Subject** (Jul 1, 2004) **Male - 12y 11m 0d**	**Visual T.O.V.A.** (v9.0-71-gd6132b7 sn30000) Jun 1, 2017 at 12:34 PM

Session, Response, and Performance Validity

This session meets session, response and performance validity criteria.

T.O.V.A. Interpretation

The results of this T.O.V.A. are not within normal limits, and may be suggestive of a possible attention deficit, including ADHD. Please see the Interpretation Notes page for additional information.

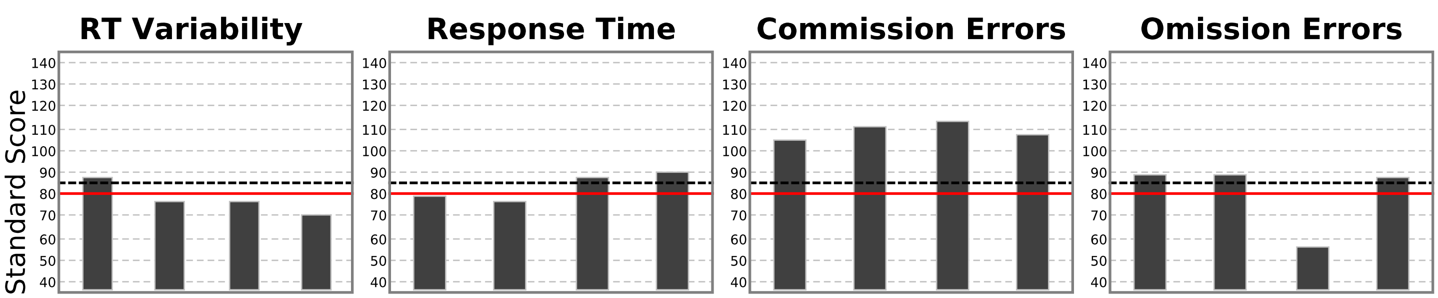
Treatment

No treatments entered.

Comparison to the Normative Sample

These scores compare this subject's performance to the performance of individuals of the same gender and age in the T.O.V.A. Normative Sample, a study of individuals who did not have attention problems.

Results are reported as standard scores (average = 100 with a standard deviation of 15) and are compared to a large normative sample stratified by gender and age. Scores above 85 are within normal limits, 80-85 are borderline, and below 80 are not within normal limits. See the Interpretation Notes page and the Analyzed Data page for more detailed information on these variables and on the subject's performance.

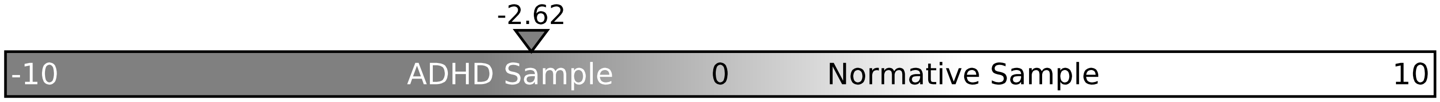


	RT Variability Q1	Q2	Q3	Q4	Response Time Q1	Q2	Q3	Q4		Commission Errors Q1	Q2	Q3	Q4	Omission Errors Q1	Q2	Q3	Q4
SS	88	77	77	71	79	77	87	90	**SS**	105	111	113	107	89	89	56	88
%ile	21%	6%	6%	3%	8%	6%	19%	25%	**#**	1	0	2	4	1	1	6	3

▲ Above graph ▼ Below graph -- Borderline — Not within normal limits ■ Valid quarter □ Interrupted quarter

Attention Comparison Score

The Attention Comparison Score (ACS) is a subset of T.O.V.A. variables used to compare the subject's performance to a sample of individuals independently diagnosed with ADHD. Scores below 0 suggest a performance more similar to that of individuals with ADHD.



ID: **1** **Example Subject** (Jul 1, 2004)
Male - 12y 11m 0d

Visual T.O.V.A. (v9.0-71-gd6132b7 sn30000)
Jun 1, 2017 at 12:34 PM

Session, Response, and Performance Validity

Performance Validity

Performance Validity is applicable only to ages 17 or above.

Notes on the Comparison to the Normative Sample

Variability is a precise measure of variations in correct response times, and measures the consistency of response times. **Variability was borderline in Half 1, and not within normal limits in Quarters 2, 3, and 4, Half 2, and Total.**

Response Time is the average speed of correct responses to targets, and is a measure of information processing speed. **Response Time was borderline in the Total, and not within normal limits in Quarters 1 and 2, and Half 1.**

Commission Errors occur when the subject incorrectly responds to a nontarget, and are a measure of inhibitory control. **Commission Errors were within normal limits.**

Omission Errors occur when the subject does not respond to a target, and are a measure of sustained attention. **Omission Errors were not within normal limits in Quarter 3, Half 1 and 2, and Total.**

Other Notes

Consider administering an Auditory T.O.V.A. to this subject for a more comprehensive assessment of attention. This is important because an individual can have markedly different results on one test versus the other.

ID: **1** **Example Subject** (Jul 1, 2004)
Male - 12y 11m 0d

Visual T.O.V.A. (v9.0-71-gd6132b7 sn30000)
Jun 1, 2017 at 12:34 PM

Treatment

No treatments entered.

Comparison to the Normative Sample

Results below are reported as standard scores (average standard = 100; standard deviation = 15). Scores indicate deviation from the performance of a large normative sample stratified by gender and age. Standard scores above 85 are considered to be in the normal range, scores between 85 and 80 are considered borderline, and scores below 80 are considered not within normal limits. Scores less than 70 are considered significantly below normal range. Standard scores less than 40 are more than 4 standard deviations from normal and are denoted as "<40". Quarters, Halves and Totals are independently calculated and are not averages.

	Quarter				Half		Total
	1	2	3	4	1	2	
RT Variability	88	77	77	71	81	73	72
Response Time	79	77	87	90	77	88	85
Commission Errors	105	111	113	107	108	111	111
Omission Errors	89	89	56	88	79	72	72
	Infrequent		Frequent				

Key: Borderline, Not within normal limits, Invalid

Attention Comparison Score

The Attention Comparison Score (ACS) is a subset of T.O.V.A. variables used to compare the subject's performance to a sample of individuals independently diagnosed with ADHD. Scores below 0 suggest a performance more similar to that of individuals with ADHD.

The formula for calculating the ACS is:

Response Time (Half 1)	-1.57
D Prime (Half 2)	-1.00
Variability (Total)	-1.86
Calibration constant	1.80
Attention Comparison Score	-2.62

TOVA

Tabulated Data

ID: **1** **Example Subject** (Jul 1, 2004) **Visual T.O.V.A.** (v9.0-71-gd6132b7 sn30000)
Male - 12y 11m 0d Jun 1, 2017 at 12:34 PM

This page contains tabulated raw data and documents T.O.V.A. session parameters.

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Half 1	Half 2	Total
RT Variability	ms	115	154	155	188	139	172	171
Response Time	ms	492	550	426	409	521	417	441
Post-commission responses	#	0	0	2	2	0	4	4
Response Time	ms	0	0	479	428	0	454	454
Variability	ms	0	0	7	73	0	58	58
Commission Errors	#	1/126	0/126	2/36	4/36	1/252	6/72	7/324
Percentage	%	0.8	0	5.6	11.1	0.4	8.3	2.2
Response Time	ms	643	0	252	327	643	302	351
Omission Errors	#	1/36	1/36	6/126	3/126	2/72	9/252	11/324
Percentage	%	2.8	2.8	4.8	2.4	2.8	3.6	3.4
D Prime		4.33	6.18	3.26	3.2	4.57	3.19	3.85
Standard Score		78	93	84	86	83	85	84
Beta		2.93	1425.08	0.88	0.3	5.43	0.51	1.46
Anticipatory	%	0	0	0	0.6	0	0.3	0.2
To Nontargets	#	0	0	0	1	0	1	1
To Targets	#	0	0	0	0	0	0	0
Multiple Responses	#	0	1	0	0	1	0	1
Total Correct	#	160/162	161/162	154/162	154/162	321/324	308/324	629/648
Correct Responses	#	35/36	35/36	120/126	123/126	70/72	243/252	313/324
Correct Nonresponses	#	125/126	126/126	34/36	31/36	251/252	65/72	316/324
Skew	ms	-14	115	78	51	88	59	83
User Interrupts	#	0	0	0	0	0	0	0
Hardware errors	#	0	0	0	0	0	0	0
		Infrequent		Frequent				

Session parameters

Format:	1 (standard)
ISI:	2000 ms
Stimulus On Time:	200 ms
Stimulus Off Time:	300 ms
Anticipatory Cutoff	150 ms

Session information

Import Filename:	example-subject.tova
Import Date:	Jun 12, 2017 12:05:17 PM
Errors/Warnings:	

Hardware information

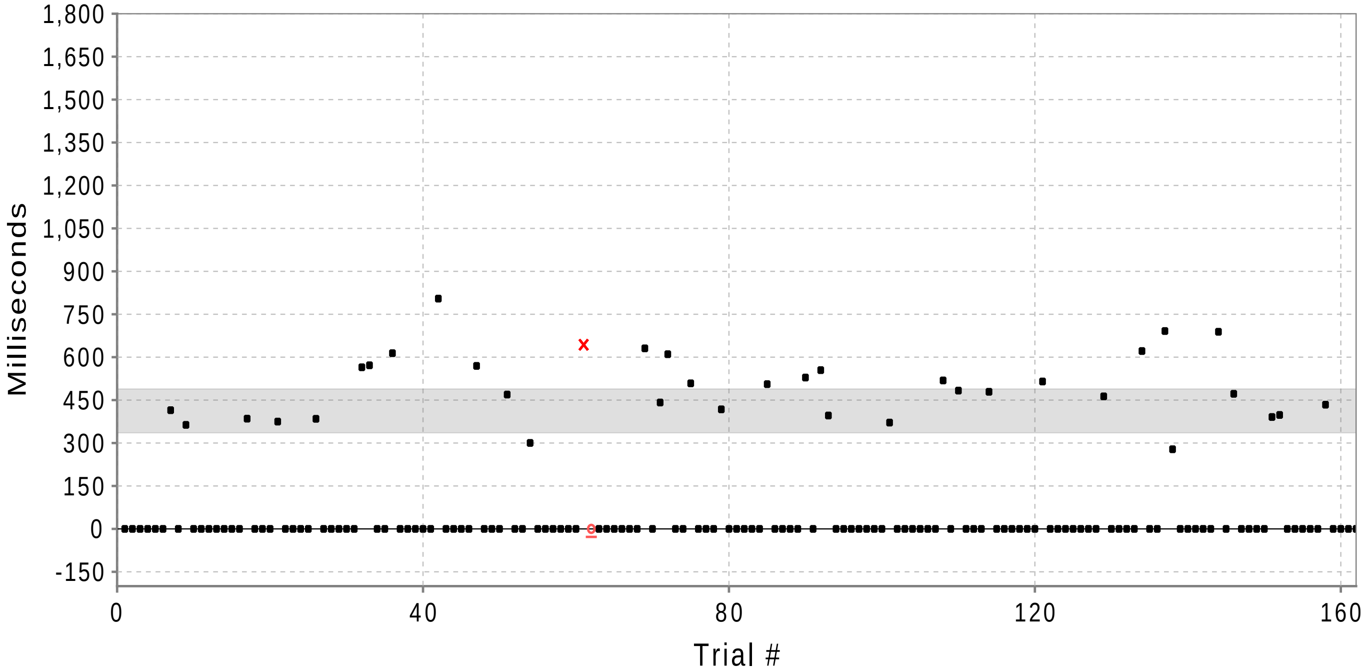
Test mode:	PTE
USB device:	HW 3, BD 0, FW 1.1-89-g664fc9a
Microswitch:	HW 3, BD 0, FW 4
Monitor calibration:	15487, 15039, 15904, 15168, 15744, 15263, 15776, 14976, 15807, 15328, 15744, 15072, 15839, 14976, 15104, 15007, 15359, 15200, 15168, 15168, 15231, 15168, 15200, 15007, 16160, 15359, 14976, 15200, 15231, 15328

ID: **1** **Example Subject** (Jul 1, 2004)
Male - 12y 11m 0d

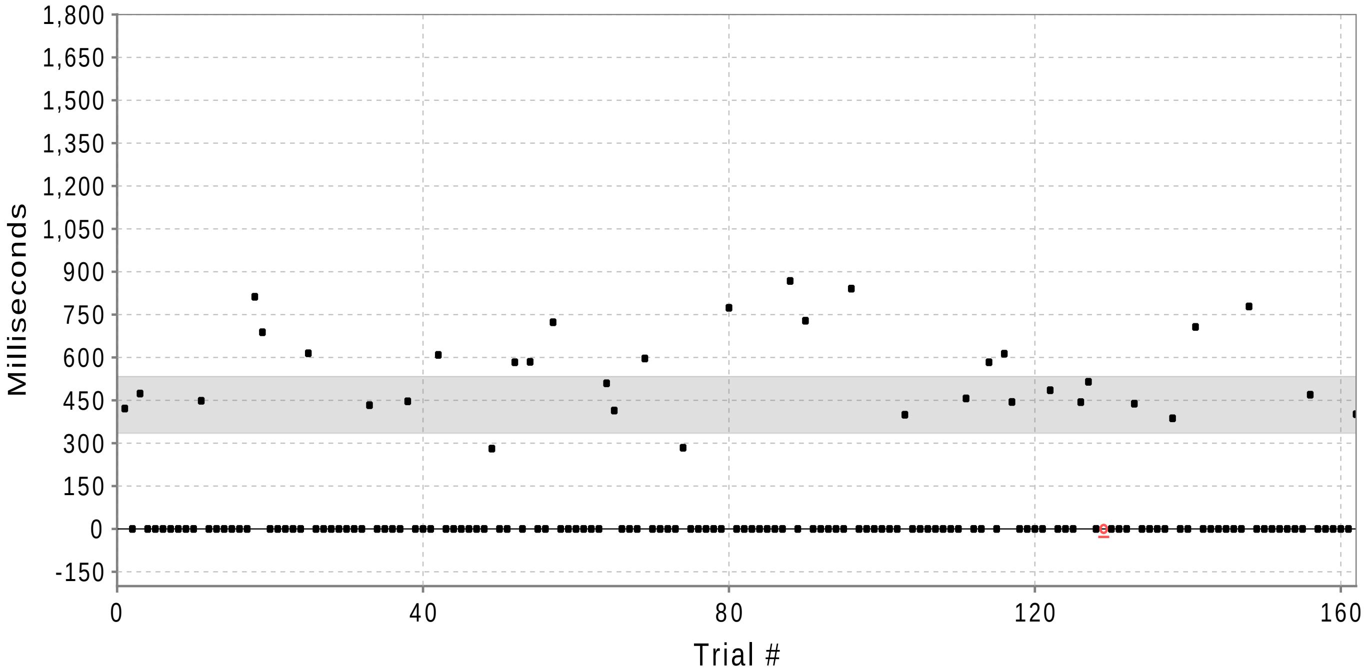
Visual T.O.V.A. (v9.0-71-gd6132b7 sn30000)
Jun 1, 2017 at 12:34 PM

This page graphically displays the subject's responses. Black squares mark correct responses and correct nonresponses. Red 'X's mark commission errors, red squares mark anticipatory responses, and underlined red circles mark omission errors. The light gray region represents the normative range of responses. Commission errors followed by a correct response are linked by a line: an upward slope (light gray) indicates slowing down following an error (typical), and a downward slope (black) indicates speeding up after making an error (unusual). Red numbers above the zero line indicate the number of missed targets (if three or more in a row), and the red number below the zero line indicates the number of seconds elapsed between correct target responses.

Q1



Q2



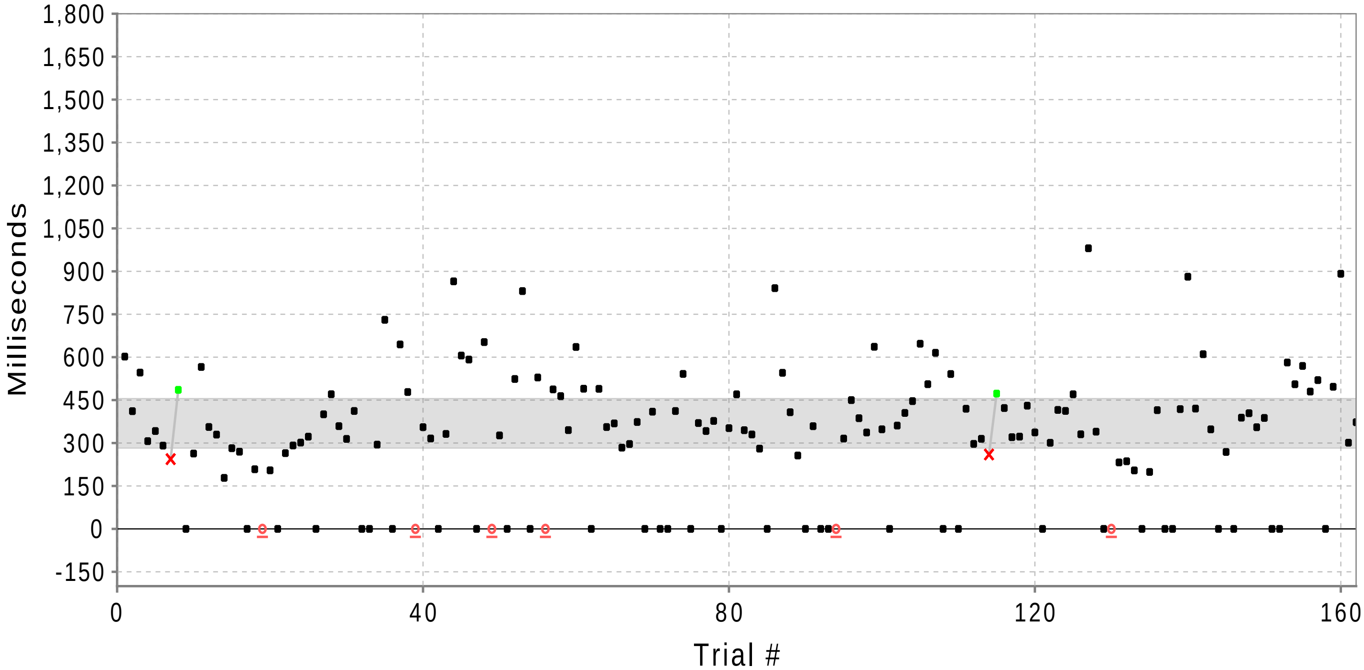
Correct response | Correct non-response | Commission error | Omission error | Anticipatory response
Post-commission error correct response | Slower post-commission RT | Faster post-commission RT
Off-scale resp./error | Normative range | Interruption | 3 10s Response gap (# Targets and Sec)

ID: **1** **Example Subject** (Jul 1, 2004) **Male - 12y 11m 0d**

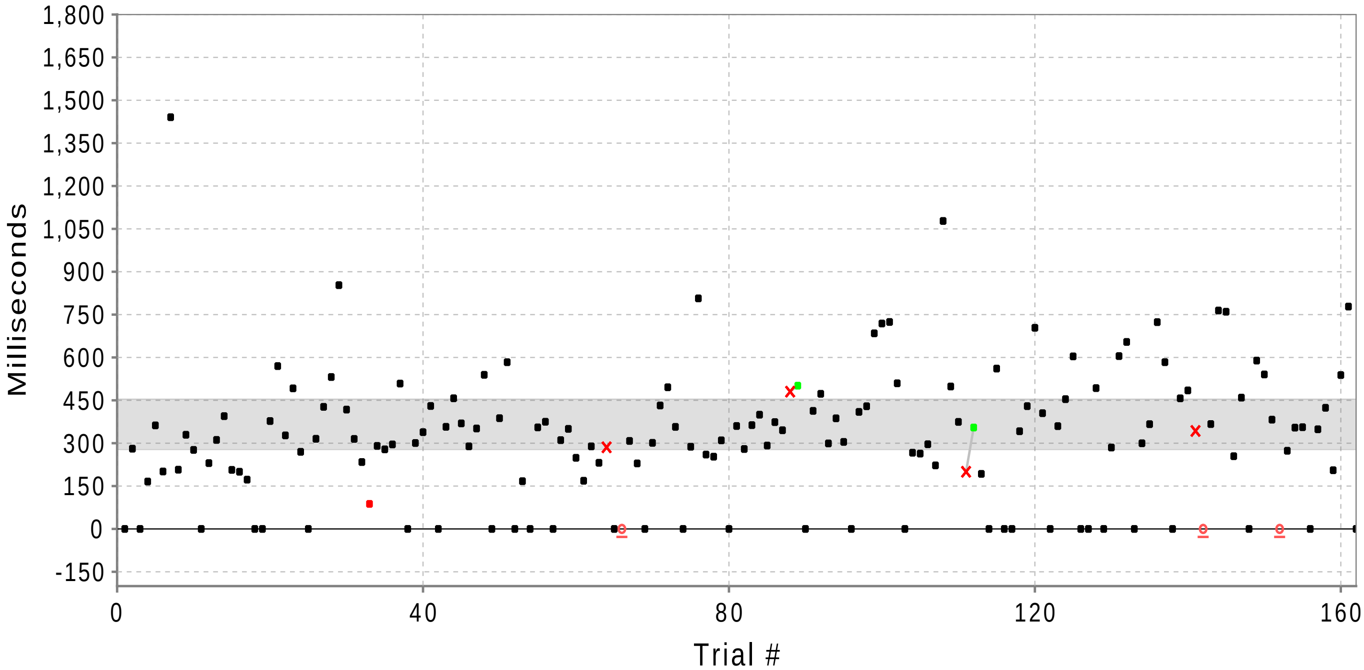
Visual T.O.V.A. (v9.0-71-gd6132b7 sn30000) Jun 1, 2017 at 12:34 PM

This page graphically displays the subject's responses. Black squares mark correct responses and correct nonresponses. Red 'X's mark commission errors, red squares mark anticipatory responses, and underlined red circles mark omission errors. The light gray region represents the normative range of responses. Commission errors followed by a correct response are linked by a line: an upward slope (light gray) indicates slowing down following an error (typical), and a downward slope (black) indicates speeding up after making an error (unusual). Red numbers above the zero line indicate the number of missed targets (if three or more in a row), and the red number below the zero line indicates the number of seconds elapsed between correct target responses.

Q3



Q4



▪ Correct response · Correct non-response · × Commission error · Omission error · ▪ Anticipatory response

▪ Post-commission error correct response · Slower post-commission RT · Faster post-commission RT

▲△ Off-scale resp./error · Normative range · | Interruption · 3 10s Response gap (# Targets and Sec)

ID: **1** **Example Subject** (Jul 1, 2004)
Male - 12y 11m 0d

Visual T.O.V.A. (v9.0-71-gd6132b7 sn30000)
Jun 1, 2017 at 12:34 PM

This page shows a trial-by-trial view of T.O.V.A. test data. Each entry in the table indicates the stimulus type (target or nontarget) and the subject's response to that stimulus. Error responses are shown in red, and response times are in milliseconds. A negative response time indicates a response that was made before the stimulus was presented.

1-27	28-54	55-81	82-108	109-135	136-162
N	N	N	N	N	N
N	N	N	N	T 483	T 691
N	N	N	N	N	T 278
N	N	N	T 505	N	N
N	T 564	N	N	N	N
N	T 571	N	N	T 479	N
T 414	N	C 643	N	N	N
N	N	O	N	N	N
T 363	T 613	N	T 528	N	T 688
N	N	N	N	N	N
N	N	N	T 554	N	T 471
N	N	N	T 396	N	N
N	N	N	N	T 515	N
N	N	N	N	N	N
N	T 804	T 630	N	N	N
N	N	N	N	N	T 390
T 385	N	T 441	N	N	T 398
N	N	T 610	N	N	N
N	N	N	N	N	N
N	T 569	N	T 371	N	N
T 374	N	T 508	N	T 463	N
N	N	N	N	N	N
N	N	N	N	N	T 433
N	T 469	N	N	N	N
N	N	T 417	N	N	N
T 384	N	N	N	T 621	N
N	T 300	N	T 518	N	N

163-189	190-216	217-243	244-270	271-297	298-324
T 421	N	N	N	N	N
N	N	N	N	N	N
T 473	N	T 723	N	T 456	T 387
N	N	N	N	N	N
N	N	N	N	N	N
N	T 433	N	N	T 583	T 706
N	N	N	T 867	N	N
N	N	N	N	T 613	N
N	N	N	T 728	T 444	N
N	N	T 509	N	N	N
T 448	T 446	T 414	N	N	N
N	N	N	N	N	N
N	N	N	N	N	T 778
N	N	N	N	T 485	N
N	T 608	T 596	T 840	N	N
N	N	N	N	N	N
N	N	N	N	N	N
T 812	N	N	N	T 443	N
T 688	N	N	N	T 514	N
N	N	T 284	N	N	N
N	N	N	N	O	T 469
N	T 280	N	T 399	N	N
N	N	N	N	N	N
N	N	N	N	N	N
T 614	T 583M	N	N	T 438	N
N	N	T 773	N	N	N
N	T 584	N	N	N	T 401

325-351	352-378	379-405	406-432	433-459	460-486
T 602	T 470	T 529	T 344	T 541	T 414
T 411	T 359	O	T 329	N	N
T 546	T 314	T 487	T 280	T 419	N
T 306	T 412	T 464	N	T 297	T 418
T 342	N	T 345	T 841	T 314	T 881
T 290	N	T 635	T 545	C 259	T 420
C 243	T 294	T 489	T 407	T 472	T 610
T 485	T 730	N	T 256	T 422	T 347
N	N	T 489	N	T 320	N
T 263	T 644	T 355	T 358	T 322	T 268
T 565	T 478	T 368	N	T 430	N
T 356	O	T 283	N	T 337	T 388
T 329	T 355	T 296	O	N	T 404
T 178	T 315	T 373	T 315	T 300	T 355
T 281	N	N	T 450	T 415	T 387
T 269	T 331	T 409	T 386	T 412	N
N	T 864	N	T 336	T 470	N
T 208	T 605	N	T 636	T 330	T 581
O	T 591	T 411	T 347	T 980	T 505
T 204	N	T 541	N	T 339	T 569
N	T 652	N	T 361	N	T 479
T 264	O	T 369	T 405	O	T 519
T 291	T 326	T 342	T 446	T 232	N
T 301	N	T 377	T 646	T 236	T 496
T 322	T 523	N	T 505	T 204	T 891
N	T 830	T 352	T 615	N	T 301
T 400	N	T 470	N	T 199	T 372

487-513	514-540	541-567	568-594	595-621	622-648
N	T 531	T 355	T 279	T 498	T 723
T 280	T 853	T 375	T 363	T 374	T 583
N	T 417	N	T 399	C 199	N
T 165	T 314	T 310	T 291	T 354	T 457
T 362	T 234	T 350	T 373	T 192	T 484
T 201	NA 87	T 248	T 345	N	C 342
T 1440	T 290	T 168	C 480	T 561	O
T 207	T 278	T 288	T 501	N	T 367
T 329	T 295	T 231	N	N	T 764
T 276	T 508	C 285	T 413	T 341	T 760
N	N	N	T 472	T 429	T 254
T 230	T 300	O	T 299	T 703	T 459
T 311	T 338	T 307	T 387	T 405	N
T 394	T 430	T 229	T 304	N	T 589
T 206	N	N	N	T 359	T 540
T 200	T 357	T 301	T 409	T 454	T 382
T 172	T 457	T 431	T 429	T 603	O
N	T 369	T 495	T 684	N	T 273
N	T 289	T 357	T 718	N	T 354
T 377	T 351	N	T 724	T 492	T 356
T 569	T 539	T 287	T 509	N	N
T 327	N	T 806	N	T 284	T 348
T 491	T 387	T 260	T 266	T 604	T 423
T 269	T 583	T 252	T 263	T 654	T 205
N	N	T 310	T 296	N	T 538
T 315	T 167	N	T 222	T 299	T 778
T 427	N	T 360	T 1077	T 366	N

T = Correct response to target
N = Correct nonresponse to nontarget
Green = Post-Commission-error correct response
O = Omission error
C = Commission error
U = User interrupt
A = Anticipatory response
M = Multiple response
H = Hardware interrupt

10.2 Appendix B: Visual Norms

Table 57: Norms Summary (See end of this section for reference key.)

Years of Age	Omission Errors(%): Inattention $Mean \pm SD$	Commission Errors(%): Impulsivity $Mean \pm SD$	Response Time (ms) $Mean \pm SD$	Variability (SD, ms) $Mean \pm SD$	D PRIME: Hit/ False Alarm Rate $Mean \pm SD$]
Age 4					
Male (N=24)	28.81 ± 20.51	17.34 ± 12.54	783.42 ± 87.71	330.08 ± 65.98	1.68 ± 0.69
Female (N=26)	33.38 ± 21.06	10.75 ± 7.46	826.69 ± 104.27	325.46 ± 91.67	1.86 ± 0.84
Age 5					
Male (N=66)	14.17 ± 11.90	10.27 ± 6.92	723.69 ± 147.40	262.94 ± 63.33	2.59 ± 0.65
Female (N=80)	14.95 ± 12.92	6.91 ± 7.05	767.90 ± 126.78	260.4 ± 55.69	2.93 ± 0.98
Age 6					
Male (N=19)	8.95 ± 7.80	10.37 ± 6.85	604.32 ± 120.24	236.95 ± 54.41	2.96 ± 0.94
Female (N=23)	8.87 ± 9.77	6.78 ± 4.16	667.00 ± 74.27	248.04 ± 38.79	3.10 ± 0.70
Age 7					
Male (N=61)	6.54 ± 7.55	10.97 ± 8.47	558.70 ± 108.12	223.15 ± 54.93	3.19 ± 1.04
Female (N=61)	4.00 ± 4.30	6.89 ± 5.02	608.28 ± 99.87	215.87 ± 47.89	3.84 ± 1.20
Age 8					
Male (N=36)	2.17 ± 2.94	8.61 ± 5.23	487.19 ± 86.14	176.92 ± 47.66	4.22 ± 1.24
Female (N=38)	1.87 ± 2.46	6.61 ± 4.28	544.34 ± 79.54	192.79 ± 37.89	4.31 ± 1.19
Age 9					
Male (N=57)	4.35 ± 14.22	9.39 ± 6.52	458.56 ± 80.75	161.74 ± 43.81	4.25 ± 1.44
Female (N=55)	1.07 ± 1.50	6.53 ± 4.17	498.80 ± 71.53	164.82 ± 38.17	4.71 ± 1.23
Age 10					
Male (N=33)	2.45 ± 6.87	7.70 ± 3.20	402.15 ± 58.04	137.39 ± 39.30	4.60 ± 1.29
Female (N=34)	$.53 \pm .90$	5.65 ± 4.23	438.47 ± 74.24	138.32 ± 38.78	5.39 ± 1.41
Age 11					
Male (N=55)	1.93 ± 7.28	8.69 ± 5.34	379.33 ± 66.01	123.82 ± 33.70	4.69 ± 1.48
Female (N=60)	$.68 \pm 1.26$	6.65 ± 4.16	412.80 ± 71.07	130.95 ± 34.36	5.06 ± 1.17
Age 12					
Male (N=37)	$.68 \pm 1.15$	6.34 ± 3.82	389.92 ± 73.81	125.05 ± 37.09	4.97 ± 1.15
Female (N=49)	$.53 \pm .92$	4.59 ± 4.16	410.29 ± 80.96	122.33 ± 40.89	5.34 ± 1.26
Age 13					
Male (N=66)	$.67 \pm 1.44$	4.93 ± 3.93	379.74 ± 60.77	108.35 ± 33.71	5.16 ± 1.22
Female (N=69)	$.55 \pm 1.39$	3.81 ± 2.85	379.71 ± 56.85	103.09 ± 29.61	5.14 ± 1.14
Age 14					
Male (N=46)	$.31 \pm .47$	3.97 ± 3.31	383.43 ± 65.82	104.70 ± 35.07	5.32 ± 1.05
Female (N=36)	.27[10] $\pm .65$	2.95 ± 2.60	383.36 ± 62.93	100.39 ± 34.64	5.71 ± 1.12
Age 15					
Male (N=61)	$.69 \pm 1.31$	3.64 ± 2.82	361.15 ± 53.54	96.59 ± 27.34	5.25 ± 1.19
Female (N=58)	$.41 \pm .82$	3.45 ± 3.39	374.41 ± 61.85	90.93 ± 22.71	5.63 ± 1.42

Table 58: Norms - Summary, continued (See end of this section for reference key.)

Age 16					
Male (N=22)	.77 ± 1.42	4.19 ± 4.54	354.82 ± 51.97	91.59 ± 25.77	5.16 ± 1.36
Female (N=29)	.72 ± 1.42	2.87 ± 2.46	379.62 ± 60.33	100.83 ± 32.13	5.56 ± 1.31
Age 17					
Male (N=18)	.27[10] ± .30	2.79 ± 3.11	377.89 ± 45.92	95.94 ± 27.72	5.63 ± 1.51
Female (N=18)	.38 ± .75	2.21 ± 2.26	376.72 ± 48.55	89.56 ± 20.04	5.88 ± 1.08
Age 18					
Male (N=32)	.35 ± .42	3.86 ± 3.04	373.94 ± 64.20	89.84 ± 29.15	5.18 ± 1.04
Female (N=66)	.35 ± .80	3.21 ± 2.87	402.44 ± 60.60	86.58 ± 23.18	5.49 ± 1.08
Age 19					
Male (N=25)	.07 ± .18[10]	2.17 ± 1.52	404.04 ± 56.86	82.92 ± 20.07	6.24 ± 1.00
Female (N=54)	.58 ± 1.81	3.73 ± 3.38	403.52 ± 49.63	86.06 ± 23.46	5.44 ± 1.14
Age 20 - 29					
Male (N=19)	.37 ± .72	4.81 ± 3.48	383.58 ± 52.36	83.53 ± 20.86	5.30 ± 1.08
Female (N=30)	.55 ± 1.21	2.29 ± 2.66	421.07 ± 71.26	88.63 ± 29.06	5.89 ± 1.25
Age 30 - 39					
Male (N=4)	.00 ± .01[10]	1.62 ± 1.05	355.25 ± 72.94	64.00 ± 12.83	6.49 ± 0.36
Female (N=22)	.14 ± .25[10]	1.77 ± 1.56	369.77 ± 53.53	81.36 ± 24.57	6.05 ± 0.96
Age 40 - 49					
Male (N=14)	.02 ± .08[10]	2.76 ± 1.80	331.93 ± 31.25	66.14 ± 11.60	6.29 ± 0.84
Female (N=19)	.06 ± .13[10]	1.88 ± 2.01	405.32 ± 66.85	81.89 ± 21.06	6.21 ± 0.85
Age 50 - 59					
Male (N=8)	.19 ± .28[10]	2.16 ± 1.22	442.88 ± 46.85	75.38 ± 11.55	5.71 ± 1.02
Female (N=16)	.15 ± .32[10]	1.85 ± 2.33	432.06 ± 41.57	79.56 ± 17.37	6.20 ± 1.22
Age 60 - 69					
Male (N=12)	.10 ± .24[10]	1.95 ± 2.22	447.17 ± 35.92	86.50 ± 22.93	6.19 ± 0.91
Female (N=24)	.22 ± .31[10]	2.69 ± 2.53	442.75 ± 57.71	81.67 ± 16.73	5.76 ± 1.23
Age 70 - 79					
Male (N=12)	1.47 ± 2.22	4.17 ± 3.32	476.75 ± 55.65	107.08 ± 33.85	4.77 ± 1.35
Female (N=39)	.73 ± 1.71	2.55 ± 2.03	480.23 ± 50.35	97.87 ± 26.33	5.21 ± 1.01
Age 80 and up					
Male (N=8)	2.47 ± 2.47	5.83 ± 3.87	502.25 ± 68.44	128.88 ± 21.68	3.80 ± 0.58
Female (N=23)	2.12 ± 3.11	3.50 ± 3.64	509.57 ± 63.09	115.00 ± 48.39	4.63 ± 1.21

Table 59: Visual Norms - Omissions (%)(See end of this section for reference key.)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
Age 4							
Male (N=24)	32.75 ± 18.04		27.68 ± 22.54				28.81 ± 20.51
Female (N=26)	41.56 ± 27.96		31.04 ± 20.30				33.38 ± 21.06
Age 5							
Male (N=66)	16.09 ± 12.60		13.62 ± 12.61				14.17 ± 11.90
Female (N=80)	15.96 ± 16.26		14.66 ± 13.83				14.95 ± 12.92
Age 6							
Male (N=19)	4.84 ± 5.58	9.53 ± 9.07	7.21 ± 7.79	12.11 ± 11.24	7.11 ± 6.61	9.58 ± 8.66	8.95 ± 7.80
Female (N=23)	7.91 ± 11.24	9.26 ± 12.23	7.52 ± 7.73	10.39 ± 12.42	8.61 ± 11.52	8.96 ± 9.88	8.87 ± 9.77
Age 7							
Male (N=61)	5.10 ± 11.19	7.98 ± 12.13	5.18 ± 6.41	8.10 ± 9.60	6.46 ± 11.32	6.59 ± 7.57	6.54 ± 7.55
Female (N=61)	3.97 ± 6.62	3.70 ± 4.18	3.38 ± 4.51	4.97 ± 5.80	3.74 ± 4.32	4.11 ± 4.82	4.00 ± 4.30
Age 8							
Male (N=36)	1.89[4] ± 3.05	2.72[4] ± 4.05	1.61 ± 2.09	2.53 ± 4.53	2.31 ± 3.19	1.97 ± 3.09	2.17 ± 2.94
Female (N=38)	1.74 ± 2.34[4]	2.34[4] ± 3.05	1.18 ± 1.86	2.53 ± 4.57	1.97 ± 1.95	1.82 ± 2.79	1.87 ± 2.46
Age 9							
Male (N=57)	4.81 ± 15.59	3.51 ± 13.29	4.42 ± 16.36	4.49 ± 14.42	4.09 ± 13.43	4.35 ± 14.59	4.35 ± 14.22
Female (N=55)	1.44[4] ± 3.70	1.33 ± 2.07[4]	.76[2] ± 1.22	1.42 ± 2.45	1.29 ± 2.39	1.04[6] ± 1.60	1.07 ± 1.50
Age 10							
Male (N=33)	3.42 ± 8.06	3.36 ± 9.08	3.12 ± 12.52	1.30 ± 2.08	3.33 ± 8.06	2.18 ± 7.00	2.45 ± 6.87
Female (N=34)	.65 ± 2.00[4]	.764 ± 2.10	.41 ± .78[2]	.68[2] ± 1.01	.71 ± 1.71	.41 ± .78[6]	.53 ± .90
Age 11							
Male (N=55)	1.75[4] ± 7.18	2.55 ± 8.17	2.04 ± 10.61	1.85 ± 4.43	2.07 ± 7.67	1.91 ± 7.30	1.93 ± 7.28
Female (N=60)	1.13[4] ± 3.15	1.02[4] ± 2.05	.45[2] ± .87	.75[2] ± 1.32	1.00 ± 2.22	.52 ± 1.03[6]	.68 ± 1.26
Age 12							
Male (N=37)	.53 ± 1.95[4]	.98[4] ± 1.83	.58[2] ± .88	.93 ± 1.71	.70 ± 1.54	.72 ± 1.24[6]	.68 ± 1.15
Female (N=49)	.61 ± 1.39[4]	.83 ± 1.61[4]	.44[2] ± .85	.57[2] ± 1.49	.72 ± 1.27	.50 ± 1.03[6]	.53 ± .92
Age 13							
Male (N=66)	.68 ± 1.97[4]	.76 ± 1.48[4]	.56[2] ± 1.43	.86 ± 1.85	.71 ± 1.50	.67 ± 1.56[6]	.67 ± 1.44
Female (N=69)	.33 ± 1.05[4]	.61[4] ± 2.02	.57[2] ± .92	.63[2] ± 2.26	.47 ± 1.43	.56 ± 1.41[6]	.55 ± 1.39
Age 14							
Male (N=46)	.37 ± 1.12[4]	.36 ± .95[4]	.32[2] ± .79	.25 ± .53[2]	.35[8] ± .73	.29 ± .53[6]	.31 ± .47
Female (N=36)	.08 ± .46[4]	.16 ± .67[4]	.41[2] ± 1.03	.30 ± .77[2]	.10 ± .36[8]	.31 ± .82[6]	.27[10] ± .65
Age 15							
Male (N=61)	.47 ± 1.76[4]	1.89[4] ± 6.04	.66[2] ± 1.07	.39[2] ± 1.24	1.18 ± 3.33	.53 ± 1.02[6]	.69 ± 1.31
Female (N=58)	.29 ± 1.00[4]	.58 ± 1.14[4]	.36 ± .72[2]	.57[2] ± 1.58	.42 ± .78	.40 ± .97[6]	.41 ± .82

Table 60: Visual Norms - Omissions (%), continued(See end of this section for reference key.)

Age 16							
Male (N=22)	.63 ± 1.19[4]	.63 ± 1.70[4]	.76[2] ± 1.26	.87 ± 2.27	.63 ± 1.11	.81[6] ± 1.69	.77 ± 1.42
Female (N=29)	.86[4] ± 2.98	.77 ± 2.34[4]	.77[2] ± 1.64	.63[2] ± 1.15	.81 ± 2.61	.70 ± 1.27[6]	.72 ± 1.42
Age 17							
Male (N=18)	.46 ± 1.07[4]	.00 ± .00[4]	.35 ± .49[2]	.22 ± .46[2]	.23[8] ± .53	.29 ± .30[6]	.27[10] ± .30
Female (N=18)	.62 ± 1.52[4]	.15 ± .65[4]	.13 ± .30[2]	.62[2] ± 1.55	.39 ± .80	.37 ± .90[6]	.38 ± .75
Age 18							
Male (N=32)	.17 ± .68[4]	.17 ± .68[4]	.37 ± .49[2]	.42 ± .75[2]	.17[8] ± .59	.40 ± .48[6]	.35 ± .42
Female (N=66)	.21 ± .74[4]	.29 ± .99[4]	.31 ± .60[2]	.43[2] ± 1.48	.25[8] ± .69	.37 ± .99[6]	.35 ± .80
Age 19							
Male (N=25)	.00 ± .01[4]	.11 ± .56[4]	.10 ± .26[2]	.06 ± .32[2]	.068 ± .28[8]	.08 ± .20[6]	.07 ± .18[10]
Female (N=54)	.21 ± .73[4]	.62 ± 1.84[4]	.54[2] ± 2.05	.71[2] ± 2.47	.41 ± 1.16	.62[6] ± 2.23	.58 ± 1.81
Age 20 - 29							
Male (N=19)	.29 ± .88[4]	.29 ± .88[4]	.33[2] ± .97	.46[2] ± 1.00	.29[8] ± .58	.40 ± .88[6]	.37 ± .72
Female (N=30)	.56 ± 1.85[4]	.37 ± .96[4]	.26[2] ± .82	.87 ± 2.14	.46 ± 1.17	.57 ± 1.34[6]	.55 ± 1.21
Age 30 - 39							
Male (N=4)	.00 ± .01[4]	.00 ± .01[4]	.00 ± .01[2]	.00 ± .01[2]	.00 ± .01[8]	.00 ± .01[6]	.00 ± .01[10]
Female (N=22)	.25 ± .82[4]	.13 ± .59[4]	.11 ± .28[2]	.14 ± .31[2]	.19[8] ± .49	.13 ± .23[6]	.14 ± .25[10]
Age 40 - 49							
Male (N=14)	.00 ± .01[4]	.00 ± .01[4]	.06 ± .21[2]	.00 ± .01[2]	.00[8] ± .018	.03 ± .11[6]	.02 ± .08[10]
Female (N=19)	.00 ± .01[4]	.15 ± .64[4]	.13 ± .30[2]	.00 ± .01[2]	.07 ± .32[8]	.06 ± .15[6]	.06 ± .13[10]
Age 50 - 59							
Male (N=8)	.35 ± .98[4]	.35 ± .98[4]	.10 ± .28[2]	.20 ± .56[2]	.35[8] ± .64	.15 ± .30[6]	.19 ± .28[10]
Female (N=16)	.17 ± .69[4]	.00 ± .01[4]	.25 ± .63[2]	.10 ± .40[2]	.09 ± .35[8]	.17 ± .35[6]	.15[10] ± .32
Age 60 - 69							
Male (N=12)	.00 ± .01[4]	.00 ± .01[4]	.20 ± .49[2]	.07 ± .23[2]	.00 ± .01[8]	.13 ± .31[6]	.10 ± .24[10]
Female (N=24)	.35 ± .94[4]	.23 ± .78[4]	.33 ± .66[2]	.07 ± .22[2]	.29[8] ± .71	.20 ± .39[6]	.22[10] ± .31
Age 70 - 79							
Male (N=12)	.23 ± .80[4]	1.16 ± 2.50[4]	1.19 ± 1.81	2.18 ± 3.42	.69 ± 1.26	1.69 ± 2.56	1.47 ± 2.22
Female (N=39)	.21 ± .75[4]	1.21 ± 2.69[4]	.81 ± 1.63	.65[2] ± 2.20	.71 ± 1.52	.73[6] ± 1.82	.73 ± 1.71
Age 80 and up							
Male (N=8)	3.13 ± 3.77	3.47 ± 4.39	2.58 ± 1.93	1.88 ± 2.61	3.30 ± 3.92	2.23 ± 2.15	2.47 ± 2.47
Female (N=23)	1.57[4] ± 3.63	1.21 ± 2.34[4]	1.83 ± 3.11	2.83 ± 5.82	1.39 ± 2.78	2.33 ± 3.73	2.12 ± 3.11

Table 61: Visual Norms - Commissions (%)(See end of this section for reference key.)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
Age 4							
Male (N=24)	12.60 ± 14.18		33.91 ± 18.61				17.34 ± 12.54
Female (N=26)	6.23 ± 8.16		26.60 ± 14.60				10.75 ± 7.46
Age 5							
Male (N=66)	5.33 ± 6.79		27.55 ± 15.95				10.27 ± 6.92
Female (N=80)	3.85 ± 7.82		17.64 ± 12.01				6.91 ± 7.05
Age 6							
Male (N=19)	4.26 ± 5.49	3.05 ± 4.77	29.74 ± 16.47	39.95 ± 18.07	3.63 ± 5.16	34.84 ± 16.58	10.37 ± 6.85
Female (N=23)	2.39 ± 3.87	1.91 ± 3.33	20.17 ± 11.73	27.70 ± 14.26	2.00 ± 3.25	23.96 ± 11.52	6.78 ± 4.16
Age 7							
Male (N=61)	4.61 ± 7.57	3.66 ± 8.57	31.38 ± 18.61	41.16 ± 18.24	4.03 ± 7.86	36.25 ± 17.33	10.97 ± 8.47
Female (N=61)	2.72 ± 4.67	1.39 ± 2.33	21.05 ± 14.55	28.98 ± 16.67	1.95 ± 3.46	25.02 ± 14.41	6.89 ± 5.02
Age 8							
Male (N=36)	3.72 ± 4.60	1.72 ± 2.84	24.81 ± 12.98	35.42 ± 17.19	2.58 ± 3.74	30.08 ± 13.91	8.61 ± 5.23
Female (N=38)	1.92 ± 2.55	.82 ± 1.61	23.00 ± 16.39	29.34 ± 15.26	1.34[5] ± 1.95	26.18 ± 14.80	6.61 ± 4.28
Age 9							
Male (N=57)	3.60 ± 4.30	2.35 ± 4.15	28.14 ± 17.83	37.82 ± 21.11	2.89 ± 4.11	32.74 ± 18.82	9.39 ± 6.52
Female (N=55)	1.89 ± 2.94	1.02 ± 1.79	20.15 ± 13.54	30.24 ± 16.28	1.38 ± 2.31	25.24 ± 14.08	6.53 ± 4.17
Age 10							
Male (N=33)	1.97 ± 1.40	.88 ± 1.11	26.45 ± 12.67	34.06 ± 12.99	1.27 ± 1.04	30.15 ± 11.38	7.70 ± 3.20
Female (N=34)	2.00 ± 2.61	.76[1] ± 1.21	18.59 ± 14.88	22.71 ± 15.56	1.26 ± 1.83	20.59 ± 14.08	5.65 ± 4.23
Age 11							
Male (N=55)	2.62 ± 2.65	1.65 ± 2.12	28.67 ± 19.01	36.18 ± 19.40	2.09 ± 2.27	32.42 ± 18.49	8.69 ± 5.34
Female (N=60)	2.05 ± 2.17	1.07 ± 1.40	21.65 ± 14.81	28.22 ± 16.88	1.42 ± 1.73	24.85 ± 14.71	6.65 ± 4.16
Age 12							
Male (N=37)	1.15 ± 1.51	.78[1] ± 1.29	23.60 ± 14.95	27.35 ± 15.93	.91 ± 1.28[5]	25.50 ± 14.01	6.34 ± 3.82
Female (N=49)	.83 ± 1.10	.56[1] ± .86	16.16 ± 15.25	21.15 ± 18.78	.57 ± .89[5]	18.70 ± 16.50	4.59 ± 4.16
Age 13							
Male (N=66)	1.57 ± 2.16	.76[1] ± .89	17.80 ± 14.09	19.22 ± 17.18	1.15[5] ± 1.40	18.46 ± 14.45	4.93 ± 3.93
Female (N=69)	.77[1] ± 1.05	.54[1] ± .84	14.47 ± 12.52	16.29 ± 12.76	.64 ± .86[5]	15.37 ± 12.21	3.81 ± 2.85
Age 14							
Male (N=46)	.78 ± 1.08	.68[1] ± .90	15.36 ± 12.96	15.30 ± 14.33	.72 ± .85[5]	15.35 ± 12.81	3.97 ± 3.31
Female (N=36)	.58[1] ± 1.01	.37[1] ± .671	10.98 ± 9.18	12.48 ± 11.78	.46 ± .69[5]	11.77 ± 9.92	2.95 ± 2.60
Age 15							
Male (N=61)	.72[1] ± 1.23	.45[1] ± .83	14.27 ± 10.65	14.80 ± 12.22	.56 ± .92[5]	14.56 ± 10.74	3.64 ± 2.82
Female (N-58)	.73[1] ± 1.08	.24 ± .54[1]	13.38 ± 14.04	14.89 ± 13.89	.45 ± .66[5]	14.12 ± 13.41	3.45 ± 3.39

Table 62: Visual Norms - Commissions (%), continued. (See end of this section for reference key.)

Age 16							
Male (N=22)	1.19 ± 1.76	.61[1] ± .88	15.15 ± 15.78	16.29 ± 18.47	.90 ± 1.24[5]	15.72 ± 16.58	4.19 ± 4.54
Female (N=29)	.57[1] ± .95	.36 ± .62[1]	9.87 ± 9.32	12.74 ± 10.69	.47 ± .75[5]	11.30 ± 9.24	2.87 ± 2.46
Age 17							
Male (N=18)	.71[1] ± 1.36	.26 ± .54[1]	9.72 ± 12.14	12.04 ± 13.10	.49 ± .90[5]	10.88 ± 12.17	2.79 ± 3.11
Female (N=18)	.62[1] ± 1.00	.31 ± .48[1]	6.48 ± 7.13	10.19 ± 10.74	.46 ± .64[5]	8.33 ± 8.52	2.21 ± 2.26
Age 18							
Male (N=32)	.55 ± .74[1]	.69[1] ± 1.14	14.41 ± 13.00	16.84 ± 15.18	.62 ± .64[5]	15.19 ± 12.54	3.86 ± 3.04
Female (N=66)	.48 ± .68[1]	.44[1] ± .79	12.16 ± 12.50	13.43 ± 12.82	.46 ± .61[5]	12.82 ± 12.15	3.21 ± 2.87
Age 19							
Male (N=25)	.41 ± .61[1]	.16 ± .32[1]	8.33 ± 5.50	9.22 ± 8.44	.29 ± .31[5]	8.78 ± 6.36	2.17 ± 1.52
Female (N=54)	.71[1] ± 1.05	.51[1] ± .93	14.40 ± 14.72	14.87 ± 13.49	.61 ± .85[5]	14.63 ± 13.38	3.73 ± 3.38
Age 20 - 29							
Male (N=19)	.75 ± .72[1]	.75[1] ± .93	18.71 ± 13.70	19.30 ± 16.16	.75 ± .66[5]	19.01 ± 14.22	4.81 ± 3.48
Female (N=30)	.37 ± .74[1]	.40[1] ± .93	9.26 ± 10.43	8.70 ± 11.60	.38 ± .62[5]	8.98 ± 10.58	2.29 ± 2.66
Age 30 - 39							
Male (N=4)	.00 ± .01[1]	.20 ± .40[1]	6.94 ± 4.81	6.94 ± 5.78	.10 ± .20[5]	6.94 ± 4.39	1.62 ± 1.05
Female (N=22)	.14 ± .31[1]	.61[1] ± 1.75	5.18 ± 5.24	8.08 ± 7.90	.38 ± .87[5]	6.63 ± 5.84	1.77 ± 1.56
Age 40 - 49							
Male (N=14)	.51 ± .59[1]	.28 ± .39[1]	9.33 ± 7.11	12.70 ± 9.42	.40 ± .35[5]	11.01 ± 7.32	2.76 ± 1.80
Female (N=19)	.84 ± 1.82	.67[1] ± 1.80	6.14 ± 4.95	5.56 ± 4.44	.75[5] ± 1.78	5.85 ± 4.28	1.88 ± 2.01
Age 50 - 59							
Male (N=8)	.60[1] ± .92	.30 ± .41[1]	6.25 ± 5.51	10.07 ± 6.95	.45 ± .39[5]	8.16 ± 5.11	2.16 ± 1.22
Female (N=16)	.74[1] ± 1.80	.20 ± .54[1]	5.73 ± 6.21	7.64 ± 8.70	.47 ± 1.12[5]	6.68 ± 6.96	1.85 ± 2.33
Age 60 - 69							
Male (N=12)	.60[1] ± .96	.26 ± .52[1]	7.41 ± 10.14	7.18 ± 7.05	.43 ± .60[5]	7.29 ± 8.27	1.95 ± 2.22
Female (N=24)	.63[1] ± .84	.33 ± .57[1]	10.30 ± 10.05	10.53 ± 11.38	.48 ± .63[5]	10.42 ± 10.13	2.69 ± 2.53
Age 70 - 79							
Male (N=12)	1.46 ± 2.03	1.26 ± 1.71	13.89 ± 9.02	14.12 ± 10.01	1.36[5] ± 1.75	14.00 ± 8.95	4.17 ± 3.32
Female (N=39)	1.00 ± 1.24	.49 ± .72[1]	9.54 ± 7.69	8.19 ± 7.73	.74 ± .84[5]	8.87 ± 7.05	2.55 ± 2.03
Age 80 and up							
Male (N=8)	.99 ± .92	1.49 ± 1.56	20.83 ± 12.60	22.92 ± 17.43	1.24 ± .94[5]	21.88 ± 14.71	5.83 ± 3.87
Female (N=23)	1.62 ± 2.71	.76[1] ± 1.45	10.75 ± 11.70	12.44 ± 10.36	1.19[5] ± 2.03	11.59 ± 10.37	3.50 ± 3.64

Table 63: Visual Norms - Response Times (ms)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
Age 4							
Male (N=24)	896.79 ± 114.19		725.42 ± 74.63				783.42 ± 87.71
Female (N=26)	911.85 ± 150.15		801.38 ± 102.03				826.69 ± 104.27
Age 5							
Male (N=66)	805.88 ± 158.20		699.76 ± 149.94				723.69 ± 147.40
Female (N=80)	834.94 ± 134.51		748.91 ± 131.64				767.90 ± 126.78
Age 6							
Male (N=19)	642.53 ± 111.13	696.37 ± 144.04	584.63 ± 123.85	586.11 ± 121.16	669.05 ± 121.66	585.11 ± 120.83	604.32 ± 120.24
Female (N=23)	706.17 ± 94.35	764.48 ± 114.98	648.22 ± 79.10	648.09 ± 83.97	735.13 ± 96.26	647.74 ± 78.43	667.00 ± 74.27
Age 7							
Male (N=61)	609.13 ± 103.16	652.57 ± 123.35	543.30 ± 116.95	534.39 ± 112.93	630.62 ± 108.85	538.87 ± 110.85	558.70 ± 108.12
Female (N=61)	655.16 ± 102.72	691.89 ± 105.57	591.02 ± 103.20	587.25 ± 113.71	673.51 ± 99.51	589.25 ± 106.33	608.28 ± 99.87
Age 8							
Male (N=36)	530.44 ± 75.32	566.61 ± 87.97	475.36 ± 90.45	463.39 ± 101.67	548.61 ± 77.61	469.42 ± 92.25	487.19 ± 86.14
Female (N=38)	589.03 ± 83.95	615.39 ± 90.16	522.34 ± 90.57	533.74 ± 89.86	602.50 ± 80.48	527.95 ± 86.62	544.34 ± 79.54
Age 9							
Male (N=57)	512.70 ± 73.40	547.75 ± 79.09	439.81. ± 85.77	433.86 ± 97.86	530.37 ± 73.67	437.67 ± 88.09	458.56 ± 80.75
Female (N=55)	552.42 ± 77.01	583.89 ± 79.39	476.69 ± 72.17	481.64 ± 86.88	568.25 ± 73.36	478.96 ± 76.25	498.80 ± 71.53
Age 10							
Male (N=33)	440.91 ± 59.25	476.58 ± 63.75	385.67 ± 61.71	387.18 ± 69.62	458.82 ± 57.90	386.15 ± 61.48	402.15 ± 58.04
Female (N=34)	488.21 ± 67.69	506.62 ± 83.11	424.06 ± 74.68	419.53 ± 90.49	497.38 ± 73.11	421.74 ± 78.61	438.47 ± 74.24
Age 11							
Male (N=55)	424.82 ± 57.55	452.64 ± 68.79	365.25 ± 69.53	358.25 ± 76.57	439.45 ± 61.47	362.15 ± 71.52	379.33 ± 66.01
Female (N=60)	458.60 ± 62.94	486.07 ± 73.95	401.58 ± 77.84	389.98 ± 77.60	472.75 ± 66.69	395.82 ± 75.66	412.80 ± 71.07
Age 12							
Male (N=37)	432.86 ± 63.18	442.76 ± 81.61	382.84 ± 80.15	368.97 ± 81.40	437.81 ± 69.14	376.14 ± 78.21	389.92 ± 73.81
Female (N=49)	463.90 ± 78.84	467.73 ± 77.58	394.33 ± 81.08	395.39 ± 94.64	465.82 ± 75.85	394.96 ± 85.47	410.29 ± 80.96
Age 13							
Male (N=66)	412.23 ± 57.49	433.98 ± 74.54	368.89 ± 65.22	365.70 ± 66.32	423.15 ± 62.50	367.41 ± 62.90	379.74 ± 60.77
Female (N=69)	420.65 ± 62.87	445.68 ± 72.40	365.54 ± 58.18	363.35 ± 61.97	433.17 ± 65.30	364.43 ± 58.42	379.71 ± 56.85
Age 14							
Male (N=46)	403.48 ± 58.24	426.83 ± 76.63	371.15 ± 64.68	378.04 ± 80.91	415.15 ± 64.36	374.67 ± 69.30	383.43 ± 65.82
Female (N=36)	424.97 ± 69.54	442.58 ± 72.56	371.42 ± 67.33	366.94 ± 62.95	433.58 ± 69.89	369.28 ± 63.24	383.36 ± 62.93
Age 15							
Male (N=61)	390.61 ± 56.57	414.74 ± 70.48	345.66 ± 53.17	353.41 ± 64.31	402.36 ± 60.35	349.51 ± 56.41	361.15 ± 53.54
Female (N-58)	412.38 ± 56.93	423.31 ± 61.71	363.34 ± 66.87	360.84 ± 66.66	417.91 ± 57.80	362.09 ± 65.38	374.41 ± 61.85

Table 64: Visual Norms - Response Times (ms), continued

Age 16							
Male (N=22)	391.64 ± 48.46	406.18 ± 59.30	346.32 ± 56.84	338.86 ± 58.50	398.82 ± 51.18	342.45 ± 55.47	354.82 ± 51.97
Female (N=29)	410.17 ± 51.56	430.69 ± 53.35	364.79 ± 68.77	371.69 ± 71.75	420.10 ± 50.90	368.28 ± 68.50	379.62 ± 60.33
Age 17							
Male (N=18)	426.44 ± 45.92	434.61 ± 48.61	364.78 ± 54.52	360.83 ± 52.52	430.50 ± 46.46	362.94 ± 51.90	377.89 ± 45.92
Female (N=18)	411.89 ± 44.03	418.56 ± 45.98	366.94 ± 52.43	365.00 ± 56.89	415.06 ± 43.63	365.83 ± 52.75	376.72 ± 48.55
Age 18							
Male (N=32)	406.91 ± 68.20	423.16 ± 73.43	363.50 ± 65.88	361.81 ± 72.04	415.31 ± 69.38	362.91 ± 66.95	373.94 ± 64.20
Female (N=66)	431.68 ± 53.86	445.55 ± 66.97	392.74 ± 65.02	393.11 ± 66.39	438.06 ± 59.57	392.53 ± 63.94	402.44 ± 60.60
Age 19							
Male (N=25)	438.04 ± 55.96	441.12 ± 50.34	394.96 ± 59.55	391.88 ± 66.82	439.12 ± 50.06	393.36 ± 60.80	404.04 ± 56.86
Female (N=54)	422.54 ± 41.50	444.63 ± 60.57	393.13 ± 47.43	397.33 ± 62.98	433.22 ± 49.89	394.69 ± 54.13	403.52 ± 49.63
Age 20 - 29							
Male (N=19)	414.68 ± 47.36	428.37 ± 62.11	377.21 ± 51.14	370.63 ± 59.22	420.58 ± 55.47	372.79 ± 54.80	383.58 ± 52.36
Female (N=30)	445.50 ± 59.80	470.63 ± 77.15	409.90 ± 74.12	411.07 ± 81.33	457.80 ± 65.80	410.50 ± 74.80	421.07 ± 71.26
Age 30 - 39							
Male (N=4)	386.00 ± 62.90	388.00 ± 69.02	341.50 ± 77.52	351.00 ± 77.19	386.75 ± 65.76	346.00 ± 76.62	355.25 ± 72.94
Female (N=22)	401.59 ± 52.29	413.36 ± 64.35	364.64 ± 57.13	357.55 ± 65.78	405.91 ± 57.01	365.09 ± 66.59	369.77 ± 53.53
Age 40 - 49							
Male (N=14)	360.71 ± 37.63	367.43 ± 41.36	327.79 ± 34.25	318.57 ± 32.18	364.00 ± 38.72	323.29 ± 32.20	331.93 ± 31.25
Female (N=19)	443.89 ± 85.19	452.32 ± 78.17	401.16 ± 68.60	385.26 ± 64.33	448.16 ± 80.71	393.11 ± 65.32	405.32 ± 66.85
Age 50 - 59							
Male (N=8)	452.75 ± 49.90	477.38 ± 65.23	432.50 ± 48.77	439.88 ± 45.03	465.25 ± 57.18	436.13 ± 45.45	442.88 ± 46.85
Female (N=16)	472.88 ± 46.75	480.81 ± 60.94	428.00 ± 49.93	410.19 ± 39.62	476.81 ± 52.21	419.06 ± 42.10	432.06 ± 41.57
Age 60 - 69							
Male (N=12)	450.67 ± 44.15	474.75 ± 33.90	432.25 ± 36.86	452.17 ± 59.43	471.08 ± 51.46	442.83 ± 40.29	447.17 ± 35.92
Female (N=24)	466.17 ± 47.06	478.83 ± 48.21	438.50 ± 66.75	430.08 ± 62.23	472.54 ± 45.39	434.33 ± 62.87	442.75 ± 57.71
Age 70 - 79							
Male (N=12)	493.00 ± 54.26	501.08 ± 53.03	456.83 ± 52.80	485.25 ± 72.08	496.92 ± 52.95	470.75 ± 59.38	476.75 ± 55.65
Female (N=39)	500.10 ± 56.73	519.28 ± 69.56	475.05 ± 57.90	468.56 ± 54.06	510.03 ± 61.43	471.72 ± 51.73	480.23 ± 50.35
Age 80 and up							
Male (N=8)	541.25 ± 31.30	540.13 ± 37.49	487.75 ± 75.53	495.00 ± 88.28	540.13 ± 31.76	491.38 ± 80.46	502.25 ± 68.44
Female (N=23)	522.17 ± 51.18	532.30 ± 61.40	494.74 ± 70.13	515.22 ± 77.57	527.26 ± 55.54	504.87 ± 70.71	509.57 ± 63.09

Table 65: Visual Norms - Variability (ms)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
Age 4							
Male (N=24)	280.88 ± 69.79		334.29 ± 73.84				330.08 ± 65.98
Female (N=26)	254.42 ± 88.97		331.81 ± 100.49				325.46 ± 91.67
Age 5							
Male (N=66)	228.68 ± 63.68		263.20 ± 74.57				262.94 ± 63.33
Female (N=80)	217.40 ± 69.44		264.23 ± 62.44				260.4 ± 55.69
Age 6							
Male (N=19)	170.58 ± 48.78	212.37 ± 79.58	221.26 ± 53.09	261.05 ± 71.52	198.84 ± 60.20	242.32 ± 58.90	236.95 ± 54.41
Female (N=23)	192.74 ± 64.03	212.09 ± 66.69	239.13 ± 48.97	258.52 ± 46.37	210.74 ± 56.80	250.70 ± 40.60	248.04 ± 38.79
Age 7							
Male (N=61)	168.75 ± 52.74	184.26 ± 67.28	212.59 ± 61.39	236.33 ± 69.74	181.72 ± 54.83	227.54 ± 59.96	223.15 ± 54.93
Female (N=61)	166.95 ± 46.95	175.38 ± 50.43	203.90 ± 56.53	230.02 ± 66.30	176.69 ± 40.63	218.79 ± 55.08	215.87 ± 47.89
Age 8							
Male (N=36)	145.75 ± 55.27	151.61 ± 47.17	162.11 ± 53.94	185.17 ± 55.85	154.28 ± 43.82	176.47 ± 52.58	176.92 ± 47.66
Female (N=38)	149.21 ± 47.83	156.08 ± 46.52	173.76 ± 45.25	207.53 ± 52.04	160.18 ± 34.54	193.92 ± 43.81	192.79 ± 37.89
Age 9							
Male (N=57)	127.07 ± 48.50	135.88 ± 44.90	146.65 ± 48.46	164.93 ± 54.82	135.70 ± 40.64	158.58 ± 48.76	161.74 ± 43.81
Female (N=55)	126.65 ± 41.17	133.40 ± 45.24	149.27 ± 41.65	172.22 ± 52.65	135.22 ± 37.11	163.60 ± 43.55	164.82 ± 38.17
Age 10							
Male (N=33)	107.09 ± 34.15	116.06 ± 36.90	122.33 ± 39.41	142.85 ± 57.76	116.27 ± 30.08	135.61 ± 46.21	137.39 ± 39.30
Female (N=34)	122.00 ± 40.99	114.26 ± 38.44	127.09 ± 41.47	135.59 ± 50.41	122.79 ± 31.66	134.38 ± 44.50	138.32 ± 38.78
Age 11							
Male (N=55)	101.89 ± 34.33	105.98 ± 40.43	110.96 ± 34.47	124.36 ± 47.27	107.33 ± 34.19	119.35 ± 38.34	123.82 ± 33.70
Female (N=60)	108.77 ± 32.18	114.98 ± 38.61	118.47 ± 37.96	131.40 ± 45.66	114.83 ± 32.65	127.37 ± 38.73	130.95 ± 34.36
Age 12							
Male (N=37)	103.92 ± 39.45	110.97 ± 50.52	114.22 ± 40.87	124.35 ± 45.16	110.57 ± 43.21	121.84 ± 40.93	125.05 ± 37.09
Female (N=49)	111.14 ± 52.75	100.39 ± 39.25	110.14 ± 43.82	120.76 ± 45.96	109.10 ± 42.76	117.73 ± 44.21	122.33 ± 40.89
Age 13							
Male (N=66)	89.41 ± 31.40	93.86 ± 38.91	100.21 ± 35.21	107.61 ± 40.91	95.39 ± 34.64	106.33 ± 36.42	108.35 ± 33.71
Female (N=69)	79.70 ± 29.14	92.32 ± 36.08	94.19 ± 32.66	100.22 ± 32.75	89.67 ± 30.47	98.83 ± 31.10	103.09 ± 29.61
Age 14							
Male (N=46)	79.89 ± 23.84	81.41 ± 27.27	99.28 ± 37.30	105.70 ± 41.70	84.39 ± 25.94	105.39 ± 39.15	104.70 ± 35.07
Female (N=36)	79.89 ± 32.68	78.92 ± 22.62	94.81 ± 39.52	97.97 ± 42.41	81.72 ± 25.34	98.39 ± 39.25	100.39 ± 34.64
Age 15							
Male (N=61)	74.41 ± 26.99	82.16 ± 35.97	88.75 ± 27.82	94.89 ± 31.94	82.31 ± 30.53	93.89 ± 28.53	96.59 ± 27.34
Female (N-58)	70.71 ± 19.69	72.95 ± 21.10	86.43 ± 28.68	88.88 ± 28.50	73.79 ± 18.56	89.28 ± 26.59	90.93 ± 22.71

Table 66: Visual Norms - Variability (ms), continued

Age 16							
Male (N=22)	70.00 ± 21.72	81.77 ± 38.97	82.55 ± 24.27	89.18 ± 37.82	79.27 ± 27.89	88.23 ± 28.70	91.59 ± 25.77
Female (N=29)	81.28 ± 26.84	76.10 ± 22.98	90.72 ± 33.58	101.38 ± 45.17	81.14 ± 22.41	98.41 ± 37.46	100.83 ± 32.13
Age 17							
Male (N=18)	87.17 ± 47.37	83.33 ± 47.36	84.78 ± 22.72	91.56 ± 25.83	86.78 ± 45.63	89.50 ± 22.28	95.94 ± 27.72
Female (N=18)	74.72 ± 28.62	63.78 ± 17.93	83.33 ± 22.85	89.44 ± 32.48	71.11 ± 21.48	88.61 ± 24.59	89.56 ± 20.04
Age 18							
Male (N=32)	77.28 ± 36.32	74.09 ± 39.22	80.09 ± 29.40	86.75 ± 34.28	78.13 ± 35.75	86.16 ± 30.31	89.84 ± 29.15
Female (N=66)	64.74 ± 18.93	69.11 ± 19.52	81.03 ± 28.34	84.92 ± 27.06	70.08 ± 17.14	85.24 ± 26.68	86.58 ± 23.18
Age 19							
Male (N=25)	68.68 ± 16.74	69.48 ± 34.41	74.64 ± 20.52	79.36 ± 28.48	72.52 ± 25.00	79.88 ± 23.27	82.92 ± 20.07
Female (N=54)	62.50 ± 15.59	66.37 ± 27.91	80.56 ± 20.11	87.74 ± 33.39	67.70 ± 21.42	85.93 ± 26.30	86.06 ± 23.46
Age 20 - 29							
Male (N=19)	64.79 ± 26.78	70.58 ± 20.78	78.79 ± 17.20	80.84 ± 29.13	69.84 ± 22.77	81.11 ± 22.02	83.53 ± 20.86
Female (N=30)	64.60 ± 20.77	74.10 ± 33.94	81.20 ± 28.39	87.73 ± 39.15	74.13 ± 28.14	86.93 ± 33.09	88.63 ± 29.06
Age 30 - 39							
Male (N=4)	48.75 ± 9.00	50.00 ± 14.09	63.00 ± 15.64	61.25 ± 11.76	49.50 ± 11.09	63.00 ± 12.96	64.00 ± 12.83
Female (N=22)	67.32 ± 30.38	63.27 ± 25.75	76.68 ± 24.25	75.45 ± 24.15	69.41 ± 25.96	80.32 ± 26.37	81.36 ± 24.57
Age 40 - 49							
Male (N=14)	52.86 ± 12.46	52.50 ± 10.76	64.07 ± 14.37	64.14 ± 15.40	54.14 ± 7.59	65.21 ± 11.97	66.14 ± 11.60
Female (N=19)	69.21 ± 27.82	63.95 ± 19.45	79.37 ± 20.50	75.74 ± 22.28	69.11 ± 20.59	79.37 ± 19.83	81.89 ± 21.06
Age 50 - 59							
Male (N=8)	62.00 ± 19.68	60.50 ± 24.73	70.13 ± 8.89	79.00 ± 15.66	63.38 ± 21.31	75.88 ± 10.48	75.38 ± 11.55
Female (N=16)	68.06 ± 26.07	67.88 ± 27.30	76.75 ± 20.55	67.56 ± 17.13	70.81 ± 23.40	74.69 ± 17.88	79.56 ± 17.37
Age 60 - 69							
Male (N=12)	83.17 ± 36.61	75.00 ± 28.87	77.08 ± 19.77	82.00 ± 21.80	82.50 ± 29.77	84.42 ± 25.19	86.50 ± 22.93
Female (N=24)	66.13 ± 20.95	69.88 ± 21.84	76.29 ± 15.59	80.08 ± 26.82	70.54 ± 18.55	80.00 ± 20.06	81.67 ± 16.73
Age 70 - 79							
Male (N=12)	86.92 ± 31.18	77.08 ± 26.62	94.33 ± 31.02	117.92 ± 48.92	83.50 ± 26.79	110.33 ± 38.62	107.08 ± 33.85
Female (N=39)	83.64 ± 34.23	77.69 ± 28.94	99.26 ± 34.41	91.54 ± 27.30	84.46 ± 27.45	97.15 ± 26.78	97.87 ± 26.33
Age 80 and up							
Male (N=8)	114.38 ± 32.15	102.13 ± 16.56	124.75 ± 35.62	128.75 ± 29.24	110.75 ± 17.52	128.38 ± 29.51	128.88 ± 21.68
Female (N=23)	84.83 ± 27.75	78.57 ± 25.77	108.52 ± 50.81	123.52 ± 63.45	83.30 ± 24.68	118.78 ± 55.67	115.00 ± 48.39

Table 67: Visual Norms - D Prime (Perceptual Sensitivity)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
Age 4							
Male (N=24)	1.99 + 1.07		1.18 + 0.63				1.68 + 0.69
Female (N=26)	2.25 + 1.64		1.38 + 0.86				1.86 + 0.84
Age 5							
Male (N=66)	3.18 + 1.15		1.99 + 0.86				2.59 + 0.65
Female (N=80)	3.78 + 1.67		2.40 + 1.05				2.93 + 0.98
Age 6							
Male (N=19)	5.05 ± 1.68	4.70 ± 2.24	2.37 ± 0.96	1.74 ± 1.03	4.45 ± 1.79	2.02 ± 0.97	2.96 ± 0.94
Female (N=23)	4.31 ± 1.39	4.85 ± 1.90	2.91 ± 1.34	2.22 ± 0.95	4.62 ± 1.56	2.40 ± 0.91	3.10 ± 0.70
Age 7							
Male (N=61)	4.77 ± 1.59	4.59 ± 1.89	2.77 ± 1.43	2.18 ± 1.44	4.44 ± 1.62	2.37 ± 1.20	3.19 ± 1.04
Female (N=61)	5.40 ± 1.74	5.77 ± 1.95	3.53 ± 1.40	2.84 ± 1.34	5.31 ± 1.82	3.06 ± 1.31	3.84 ± 1.20
Age 8							
Male (N=36)	5.47 ± 1.66	5.94 ± 1.99	3.78 ± 1.28	3.43 ± 1.44	5.41 ± 1.79	3.64 ± 1.36	4.22 ± 1.24
Female (N=38)	5.98 ± 1.55	6.41 ± 1.85	4.14 ± 1.30	3.65 ± 1.33	5.64 ± 1.66	3.74 ± 1.29	4.31 ± 1.19
Age 9							
Male (N=57)	5.52 ± 1.86	6.06 ± 1.85	3.79 ± 1.48	3.27 ± 1.58	5.49 ± 1.75	3.54 ± 1.46	4.25 ± 1.44
Female (N=55)	6.36 ± 1.67	6.43 ± 1.50	4.35 ± 1.31	3.84 ± 1.45	6.05 ± 1.64	4.01 ± 1.33	4.71 ± 1.23
Age 10							
Male (N=33)	5.66 ± 1.59	6.70 ± 1.72	4.07 ± 1.21	3.74 ± 1.30	5.86 ± 1.65	3.83 ± 1.31	4.60 ± 1.29
Female (N=34)	6.63 ± 1.21	7.21 ± 1.72	4.88 ± 1.35	4.34 ± 1.43	6.73 ± 1.51	4.65 ± 1.32	5.39 ± 1.41
Age 11							
Male (N=55)	6.21 ± 1.56	6.30 ± 2.04	4.15 ± 1.48	3.67 ± 1.62	6.01 ± 1.88	3.84 ± 1.57	4.69 ± 1.48
Female (N=60)	6.34 ± 1.42	6.79 ± 1.72	4.61 ± 1.20	4.09 ± 1.30	6.43 ± 1.49	4.43 ± 1.17	5.06 ± 1.17
Age 12							
Male (N=37)	7.04 + 1.46	6.96 ± 1.71	4.35 ± 1.44	4.26 ± 1.49	6.62 ± 1.47	4.22 ± 1.41	4.97 ± 1.15
Female (N=49)	7.09 ± 1.50	7.18 ± 1.42	4.93 ± 1.39	4.84 ± 1.50	7.04 ± 1.51	4.64 ± 1.29	5.34 ± 1.26
Age 13							
Male (N=66)	6.60 ± 1.53	6.92 ± 1.64	4.82 ± 1.45	4.72 ± 1.66	6.31 ± 1.53	4.61 ± 1.43	5.16 ± 1.22
Female (N=69)	7.30 ± 1.38	7.39 ± 1.35	4.80 ± 1.58	4.89 ± 1.45	6.98 ± 1.40	4.53 ± 1.33	5.14 ± 1.14
Age 14							
Male (N=46)	7.24 ± 1.06	7.19 ± 1.37	5.08 ± 1.17	5.17 ± 1.39	6.77 ± 1.20	4.83 ± 1.14	5.32 ± 1.05
Female (N=36)	7.72 ± 1.04	7.75 ± 1.13	5.29 ± 1.48	5.47 ± 1.64	7.45 ± 1.07	5.06 ± 1.26	5.71 ± 1.12
Age 15							
Male (N=61)	7.41 ± 1.47	7.34 ± 1.53	4.84 ± 1.64	5.08 ± 1.38	6.92 ± 1.55	4.68 ± 1.32	5.25 ± 1.19
Female (N-58)	7.31 ± 1.36	7.66 ± 1.36	5.20 ± 1.58	5.23 ± 1.88	7.10 ± 1.44	5.10 ± 1.58	5.63 ± 1.42

Table 68: Visual Norms - D Prime (Perceptual Sensitivity), continued

Age 16							
Male (N=22)	6.82 ± 1.87	7.27 ± 1.47	4.85 ± 1.88	5.04 ± 1.81	6.59 ± 1.80	4.58 ± 1.53	5.16 ± 1.36
Female (N=29)	7.41 ± 1.48	7.56 ± 1.52	5.28 ± 1.53	5.03 ± 1.62	7.27 ± 1.49	4.88 ± 1.38	5.56 ± 1.31
Age 17							
Male (N=18)	7.33 ± 1.51	8.09 ± 0.85	5.47 ± 1.97	5.81 ± 2.09	7.36 ± 1.32	5.00 ± 1.74	5.63 ± 1.51
Female (N=18)	7.23 ± 1.51	7.77 ± 0.99	6.07 ± 1.55	5.46 ± 1.68	7.05 ± 1.27	5.60 ± 1.57	5.88 ± 1.08
Age 18							
Male (N=32)	7.46 ± 1.03	7.24 ± 1.16	4.76 ± 1.36	4.98 ± 1.79	6.93 ± 0.98	4.48 ± 1.17	5.18 ± 1.04
Female (N=66)	7.55 ± 1.22	7.60 ± 1.23	5.14 ± 1.37	5.26 ± 1.33	7.20 ± 1.26	4.92 ± 1.20	5.49 ± 1.08
Age 19							
Male (N=25)	7.82 ± 0.97	8.07 ± 1.04	5.77 ± 1.08	5.90 ± 1.19	7.56 ± 1.03	5.64 ± 1.17	6.24 ± 1.00
Female (N=54)	7.29 ± 1.16	7.45 ± 1.37	5.22 ± 1.52	5.13 ± 1.52	6.98 ± 1.28	4.88 ± 1.36	5.44 ± 1.14
Age 20 - 29							
Male (N=19)	7.03 ± 1.42	7.21 ± 1.28	4.94 ± 1.14	4.88 ± 1.28	6.77 ± 1.36	4.75 ± 1.15	5.30 ± 1.08
Female (N=30)	7.78 ± 1.29	7.63 ± 1.44	5.85 ± 1.50	5.75 ± 1.82	7.30 ± 1.35	5.50 ± 1.51	5.89 ± 1.25
Age 30 - 39							
Male (N=4)	8.53 ± 0.01	8.07 ± 0.93	5.81 ± 0.34	6.35 ± 1.47	8.13 ± 0.81	5.84 ± 0.44	6.49 ± 0.36
Female (N=22)	7.98 ± 1.13	7.92 ± 1.30	6.30 ± 1.42	5.66 ± 1.25	7.58 ± 1.47	5.55 ± 0.94	6.05 ± 0.96
Age 40 - 49							
Male (N=14)	7.57 ± 1.00	7.87 ± 0.92	6.01 ± 1.47	5.67 ± 0.92	7.32 ± 0.81	5.64 ± 1.04	6.29 ± 0.84
Female (N=19)	7.58 ± 1.06	7.67 + 1.27	5.82 ± 0.92	6.37 ± 1.17	7.29 ± 1.10	5.77 ± 0.87	6.21 ± 0.85
Age 50 - 59							
Male (N=8)	7.45 ± 1.70	7.54 ± 1.07	6.19 ± 1.05	5.38 ± 1.03	6.73 ± 1.52	5.32 ± 0.94	5.71 ± 1.02
Female (N=16)	7.71 ± 1.11	8.27 ± 0.72	6.10 ± 1.76	6.25 ± 1.53	7.79 ± 1.01	5.61 ± 1.38	6.20 ± 1.22
Age 60 - 69							
Male (N=12)	7.69 ± 1.05	8.04 ± 0.88	6.09 ± 1.76	5.89 ± 1.18	7.62 ± 0.97	5.75 ± 1.30	6.19 ± 0.91
Female (N=24)	7.25 ± 1.35	7.76 ± 1.36	5.54 ± 1.44	5.71 ± 1.17	7.13 ± 1.42	5.40 ± 1.27	5.76 ± 1.23
Age 70 - 79							
Male (N=12)	7.19 ± 1.57	6.64 ± 1.89	4.54 ± 1.79	4.53 ± 1.58	6.43 ± 1.85	4.17 ± 1.46	4.77 ± 1.35
Female (N=39)	7.17 ± 1.29	7.03 ± 1.54	4.92 ± 1.35	5.64 ± 1.46	6.55 ± 1.42	4.78 ± 1.13	5.21 ± 1.01
Age 80 and up							
Male (N=8)	5.62 ± 2.06	5.56 ± 1.64	2.94 ± 0.62	4.02 ± 2.07	5.13 ± 1.66	3.04 ± 0.71	3.80 ± 0.58
Female (N=23)	6.51 ± 1.51	7.04 ± 1.92	4.75 ± 1.68	4.22 ± 1.74	6.32 ± 1.72	4.05 ± 1.35	4.63 ± 1.21

Table 69: REFERENCE KEY

Ref. #	Type	Description
1	Q1/Q2 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).*
2	Q3/Q4 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).*
3	Q3/Q4 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).*
4	Q1/Q2 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).*
5	H1 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).*
6	H2 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).*
7	H2 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).*
8	H1 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).*
9	T commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*
10	T omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*
	*	Omission and commission errors are not normally distributed. This makes a comparison to a norming group difficult, especially when some norming groups (e.g., adults) made no omission/commission errors. Norming groups with no errors (which implies a zero in the norming standard deviation) causes a single error to distort distribution values such as z scores. Because one omission or one commission error is not clinically relevant, the norming standard deviations have been bounded at a minimum of one error.

10.3 Appendix C: Auditory Norms

Table 70: Auditory Norms - Summary

Years of Age	Omission Errors (%): Inattention $Mean \pm SD$	Commission Errors (%): Impulsivity $Mean \pm SD$	Response Time (ms) $Mean \pm SD$	Variability (SD & ms) $Mean \pm SD$	D PRIME: Hit Rate/False Alarm Rate $Mean \pm SD$
Age 6					
Male (N=85)	18.96 + 20.82	10.43 + 14.64	775.63 + 127.05	309.01. + 73.42	2.69 ± 1.48
Female (N=90)	19.05 + 20.51	8.38 + 13.27	806.51 + 117.35	309.98 + 61.16	2.82 ± 1.32
Age 7					
Male (N=92)	12.20 + 18.97	6.58 + 8.13	701.82 + 127.34	266.41 + 70.79	3.35 ± 1.42
Female (N=82)	15.03 + 21.43	5.41 + 7.95	752.50 + 137.70	272.92 + 67.98	3.56 ± 1.69
Age 8					
Male (N=97)	6.50 + 13.15	4.15 + 4.34	663.21 + 109.48	240.06 + 65.38	4.02 ± 1.39
Female (N=108)	6.46 + 13.53	3.10 + 3.54	681.88 + 119.08	225.43 + 64.57	4.28 ± 1.49
Age 9-					
Male (N=104)	4.49 + 11.32	3.07 + 3.89	640.90 + 107.58	215.02 + 66.30	4.41 ± 1.30
Female (N=100)	4.19 + 9.42	2.64 + 2.29	636.17 + 111.07	205.02 + 63.36	4.51 ± 1.33
Age 10					
Male (N=106)	2.35 + 8.38	2.32 + 2.83	588.63 + 93.15	180.28 + 54.41	5.06 ± 1.48
Female (N=107)	1.50 + 3.12	1.51 + 1.44	585.33 + 98.77	171.90 + 59.36	5.42 ± 1.37
Age 11					
Male (N=96)	.88 + 1.69	1.54 + 1.27	562.04 + 92.64	162.40 + 55.80	5.54 ± 1.30
Female (N=104)	1.49 + 3.42	1.44 + 1.39	573.87 + 113.87	164.03 + 61.52	5.45 ± 1.48
Age 12					
Male (N=87)	1.50 + 7.81	1.40 + 1.53	569.63 + 104.86	167.43 + 58.33	5.74 ± 1.57
Female (N=94)	.74 + 1.36	1.08 + 1.04	574.14 + 108.32	161.31 + 60.52	5.78 ± 1.38
Age 13					
Male (N=98)	1.03 + 2.21	1.17 + 1.36	559.24 + 96.89	164.35 + 58.13	5.79 ± 1.50
Female (N=91)	2.17 + 5.99	1.33 + 1.68	548.52 + 93.68	163.11 + 64.67	5.60 ± 1.55
Age 14					
Male (N=100)	1.45 + 6.17	1.20 + 1.69	523.00 + 95.95	159.70 + 62.84	5.95 ± 1.46
Female (N=101)	.69 + 1.18	.85 + .97	521.12 + 93.05	146.99 + 56.91	6.03 ± 1.49
Age 15					
Male (N=98)	.51 + 1.28	.88 + .93	510.76 + 111.05	148.95 + 62.30	6.15 ± 1.32
Female (N=90)	1.47 + 7.16	1.13 + 2.35	517.72 + 106.38	150.68 + 64.76	5.88 ± 1.55
Age 16					
Male (N=94)	.72 + 1.40	.71 + .79	511.30 + 109.41	144.78 + 53.66	6.14 ± 1.44
Female (N=87)	.78 + 1.90	.68 + 1.16	499.97 + 109.84	135.79 + 57.39	6.54 ± 1.59
Age 17					
Male (N=99)	.49 + .98	.67 + 1.29	480.81 + 84.41	132.75 + 49.76	6.47 ± 1.56
Female (N=107)	.84 + 2.58	.97 + 3.56	492.13 + 109.23	126.53 + 57.96	6.58 ± 1.62
Age 18					
Male (N=101)	.43 + 1.78	.52 + .71	477.90 + 88.76	127.39 + 47.52	6.65 ± 1.39
Female (N=101)	.55 + 1.38	.38 + .53	492.42 + 98.42	125.11 + 50.23	6.81 ± 1.44
Age 19					
Male (N=22)	.44 + 1.03	.49 + .90	476.40 + 94.67	127.09 + 47.34	6.89 ± 1.60
Female (N=10)	.34 + .71	.56 + .76	450.59 + 90.54	128.72 + 60.26	7.00 ± 1.62
Age 20 - 29					
Male (N=54)	1.22 ± 3.26	1.571 ± 1.59	490.33 ± 127.47	119.28 ± 62.97	5.88 ± 1.31
Female (N=75)	.56 ± 1.20	1.11 ± 1.40	511.97 ± 120.63	115.59 ± 49.73	6.34 ± 1.38

Table 71: Auditory Norms - Omissions (%)(See end of this section for reference key.)

Years of Age	Quarter 1	2	3	4	Half 1	2	Total
Age 6							
Male (N=85)	11.61 ± 14.91	13.43 ± 17.45	19.60 ± 22.66	21.99 ± 25.09	12.52 ± 15.58	20.87 ± 23.59	18.96 ± 20.82
Female (N=90)	11.26 ± 13.40	16.37 ± 17.54	20.54 ± 23.90	20.66 ± 23.56	13.80 ± 14.69	20.59 ± 23.36	19.05 ± 20.51
Age 7							
Male (N=92)	6.15 ± 12.04	8.42 ± 13.84	13.30 ± 21.49	13.90 ± 22.65	7.28 ± 11.95	13.61 ± 21.65	12.20 ± 18.97
Female (N=82)	8.81 ± 14.45	10.37 ± 16.56	16.94 ± 24.82	16.26 ± 25.15	9.59 ± 14.84	16.62 ± 24.43	15.03 ± 21.43
Age 8							
Male (N=97)	2.01[4] ± 4.39	3.59 ± 7.88	7.13 ± 15.36	8.08 ± 17.12	2.80 ± 5.52	7.59 ± 15.91	6.50 ± 13.15
Female (N=108)	4.12 ± 11.28	4.16 ± 9.01	7.40 ± 16.47	6.89 ± 14.96	4.14 ± 9.57	7.14 ± 15.48	6.46 ± 13.53
Age 9							
Male (N=104)	1.99[4] ± 5.22	2.17[4] ± 5.59	5.35 ± 14.36	5.04 ± 13.34	2.08 ± 5.13	5.19 ± 13.67	4.49 ± 11.32
Female (N=100)	1.72[4] ± 4.18	2.26[4] ± 4.61	4.87 ± 12.15	4.79 ± 10.88	1.98 ± 3.92	4.84 ± 11.27	4.19 ± 9.42
Age 10							
Male (N=106)	.85 ± 2.25[4]	1.24[4] ± 3.41	3.01 ± 10.72	2.46 ± 10.25	1.05 ± 2.54	2.73 ± 10.42	2.35 ± 8.38
Female (N=107)	1.17[4] ± 5.85	1.07 ± 2.40[4]	1.72 ± 4.42	1.50 ± 2.60	1.12 ± 3.90	1.61 ± 3.29	1.50 ± 3.12
Age 11							
Male (N=96)	.29 ± 1.18[4]	.46 ± 1.55[4]	1.18 ± 2.54	.88 ± 1.76	.38[8] ± 1.18	1.03[6] ± 1.99	.88 ± 1.69
Female (N=104)	.73 ± 2.43[4]	.89 ± 2.18[4]	1.79 ± 4.89	1.58 ± 3.59	.81 ± 2.05	1.69 ± 4.11	1.49 ± 3.42
Age 12							
Male (N=87)	.53[4] ± 3.09	1.62[4] ± 7.78	1.57 ± 8.14	1.66 ± 9.03	1.08 ± 5.42	1.61 ± 8.56	1.50 ± 7.81
Female (N=94)	.36 ± 1.80[4]	.77 ± 2.17[4]	.69[2] ± 1.38	.87 ± 1.62	.56 ± 1.76	.79 ± 1.36[6]	.74 ± 1.36
Age 13							
Male (N=98)	.65 ± 2.21[4]	.79 ± 2.71[4]	.99 ± 2.38	1.26 ± 2.86	.72 ± 2.24	1.12[6] ± 2.54	1.03 ± 2.21
Female (N=91)	.74 ± 2.16[4]	1.51[4] ± 3.80	2.24 ± 6.28	2.70 ± 8.08	1.12 ± 2.85	2.47 ± 7.09	2.17 ± 5.99
Age 14							
Male (N=100)	.34 ± 1.17[4]	1.04[4] ± 4.51	1.64 ± 6.61	1.75 ± 8.59	.69 ± 2.77	1.69 ± 7.53	1.45 ± 6.17
Female (N=101)	.50 ± 2.28[4]	.63 ± 1.61[4]	.77[2] ± 1.54	.66[2] ± 1.37	.57 ± 1.68	.72 ± 1.28[6]	.69 ± 1.18
Age 15							
Male (N=98)	.31 ± 1.59[4]	.31 ± 1.38[4]	.50[2] ± 1.26	.63[2] ± 2.06	.31[8] ± 1.14	.57[6] ± 1.56	.51 ± 1.28
Female (N=90)	.37 ± 1.68[4]	.71[4] ± 2.81	1.49 ± 7.81	1.98 ± 10.50	.54 ± 2.14	1.73 ± .9.11	1.47 ± 7.16
Age 16							
Male (N=94)	.24 ± .89[4]	.83 ± 2.11[4]	.58[2] ± 1.15	.96 ± 2.39	.53 ± 1.21	.77[6] ± 1.64	.72 ± 1.40
Female (N=87)	.35 ± 1.19[4]	.89[4] ± 3.75	.58[2] ± 1.35	1.07 ± 3.27	.62 ± 2.17	.82[6] ± 2.01	.78 ± 1.90
Age 17							
Male (N=99)	.22 ± 1.03[4]	.45 ± 1.30[4]	.46[2] ± .88	.61[2] ± 2.14	.34[8] ± .85	.54 ± 1.21[6]	.49 ± .98
Female (N=107)	.31 ± 1.17[4]	.60 ± 1.75[4]	1.09 ± 3.59	.81 ± 2.91	.46 ± 1.37	.95[6] ± .3.16	.84 ± 2.58
Age 18							
Male (N=101)	.25 ± .80[4]	.36 ± 2.07[4]	.44[2] ± 1.52	.49[2] ± 2.58	.30[8] ± 1.22	.47[6] ± 1.98	.43 ± 1.78
Female (N=101)	.17 ± .95[4]	.30 ± 1.36[4]	.49[2] ± 1.17	.80 ± 2.45	.23[8] ± .96	.64[6] ± 1.65	.55 ± 1.38
Age 19							
Male (N=22)	.00 ± .01[4]	.13 ± .59[4]	.76[2] ± 2.20	.33 ± .64[2]	.06 ± .30[8]	.55 ± 1.33[6]	.44 ± 1.03
Female (N=10)	.00 ± .01[4]	.00 ± .01[4]	.64[2] ± 1.19	.24 ± .75[2]	.00 ± .01[8]	.44 ± .91[6]	.34 ± .71
Age 20-29							
Male (N=54)	.51 ± 2.02[4]	.41 ± .1.13[4]	.76[2] ± 1.88	2.10 ± 6.66	.46 ± 1.40	1.43 ± 1.10[6]	1.22 ± 3.26
Female (N=75)	1.26 ± 1.13[4]	.78[4] ± 3.75	.49[2] ± 1.06	.66[2] ± 1.59	.52 ± 2.17	.57 ± 1.21[6]	.56 ± 1.20

Table 72: Auditory Norms - Commissions (%)(See end of this section for reference key.)

Years of Age	Quarter 1	2	3	4	Half 1	2	Total
Age 6							
Male (N=85)	6.29 ± 16.52	5.98 ± 15.93	24.96 ± 18.98	28.32 ± 21.79	6.12 ± 15.90	26.54 ± 19.13	10.43 ± 14.64
Female (N=90)	4.40 ± 12.39	5.72 ± 15.84	17.13 ± 18.34	24.53 ± 20.71	5.05 ± 13.88	20.77 ± 18.58	8.38 ± 13.27
Age 7							
Male (N=92)	2.88 ± 9.04	2.44 ± 7.59	17.96 ± 16.75	23.79 ± 19.66	2.63 ± 7.40	20.87 ± 17.36	6.58 ± 8.13
Female (N=82)	2.89 ± 8.40	2.12 ± 7.97	13.44 ± 14.53	18.65 ± 17.27	2.50 ± 7.91	15.97 ± 14.56	5.41 ± 7.95
Age 8							
Male (N=97)	1.18 ± 3.41	.81 ± 3.46	13.96 ± 12.61	17.31 ± 16.05	.99[5] ± 3.38	15.63 ± 13.43	4.15 ± 4.34
Female (N=108)	1.08 ± 2.45	.75[1] ± 2.46	9.20 ± 11.36	12.69 ± 13.50	.91[5] ± 1.92	10.94 ± 11.82	3.10 ± 3.54
Age 9							
Male (N=104)	.92 ± 2.10	.62[1] ± 2.09	9.30 ± 12.70	13.34 ± 16.07	.77[5] ± 1.96	11.30 ± 13.68	3.07 ± 3.89
Female (N=100)	.70[1] ± 1.56	.21 ± .42[1]	8.00 ± 8.09	12.99 ± 12.30	.46 ± .82[5]	10.47 ± 9.29	2.64 ± 2.29
Age 10							
Male (N=106)	.54[1] ± 1.41	.33[1] ± .83	8.04 ± 11.34	10.30 ± 14.27	.43 ± .92[5]	9.16 ± 12.43	2.32 ± 2.83
Female (N=107)	.42[1] ± 1.14	.10 ± .29[1]	4.76 ± 6.46	7.16 ± 6.68	.26 ± .59[5]	5.95 ± 5.92	1.51 ± 1.44
Age 11							
Male (N=96)	.45 ± .68[1]	.15 ± .33[1]	4.93 ± 4.95	7.03 ± 7.44	.30 ± .40[5]	5.96 ± 5.14	1.54 ± 1.27
Female (N=104)	.21 ± .46[1]	.15 ± .37[1]	4.35 ± 4.74	7.52 ± 8.55	.18 ± .34[5]	5.93 ± 6.13	1.44 ± 1.39
Age 12							
Male (N=87)	.40 ± .70[1]	.24 ± .74[1]	4.91 ± 6.45	5.64 ± 7.80	.32 ± .66[5]	5.28 ± 6.65	1.40 ± 1.53
Female (N=94)	.29 ± .67[1]	.11 ± .30[1]	3.08 ± 3.54	5.28 ± 5.59	.20 ± .38[5]	4.18 ± 3.96	1.08 ± 1.04
Age 13							
Male (N=98)	.31 ± .70[1]	.11 ± .33[1]	3.67 ± 4.53	5.49 ± 7.40	.21[5] ± .37	4.57 ± 5.45	1.17 ± 1.36
Female (N=91)	.30 ± .55[1]	.12 ± .37[1]	4.57 ± 7.27	6.09 ± 7.92	.21[5] ± .39	5.32 ± 6.97	1.33 ± 1.68
Age 14							
Male (N=100)	.25 ± .59[1]	.28[1] ± .82	4.22 ± 7.29	4.99 ± 8.05	.27 ± .58[5]	4.60 ± 7.34	1.20 ± 1.69
Female (N=101)	.18 ± .40[1]	.13 ± .33[1]	2.83 ± 4.34	3.76 ± 4.83	.15 ± .27[5]	3.30 ± 3.98	.85 ± .97
Age 15							
Male (N=98)	.22 ± .46[1]	.13 ± .34[1]	3.22 ± 4.18	3.54 ± 4.31	.17 ± .29[5]	3.38 ± 3.67	.88 ± .93
Female (N=90)	.14 ± .49[1]	.10 ± .33[1]	3.98 ± 9.18	5.36 ± 11.70	.12 ± .33[5]	4.67 ± 10.23	1.13 ± 2.35
Age 16							
Male (N=94)	.17 ± .40[1]	.13 ± .31[1]	2.65[3] ± 3.81	2.83 ± 3.90	.15 ± .25[5]	2.73 ± 3.36	.71 ± .79
Female (N=87)	.20[1] ± .81	.07 ± .29[1]	2.11[3] ± 3.94	3.08 ± 5.83	.14 ± .44[5]	2.61 ± 4.54	.68 ± 1.16
Age 17							
Male (N=99)	.15 ± .39[1]	.09 ± .25[1]	2.52[3] ± 6.93	2.99 ± 6.85	.12 ± .25[5]	2.76 ± 6.74	.67 ± 1.29
Female (N=107)	.21[1] ± .91	.49[1] ± 4.47	2.86 ± 8.05	3.59 ± 8.38	.35[5] ± 2.63	3.22 ± 8.01	.97 ± 3.56
Age 18							
Male (N=101)	.12 ± .32[1]	.05 ± .20[1]	1.88[3] ± 3.19	2.25[3] ± 3.84	.09 ± .19[5]	2.06 ± 3.16	.52 ± .71
Female (N=101)	.07 ± .30[1]	.03 ± .15[1]	1.16 ± 2.53[3]	1.94[3] ± 2.89	.05 ± .17[5]	1.55 ± 2.29	.38 ± .53
Age 19							
Male (N=22)	.07 ± .24[1]	.07 ± .23[1]	2.08[3] ± 5.15	1.99[3] ± 3.78	.07 ± .16[5]	2.03 ± 4.17	.49 ± .90
Female (N=10)	.16 ± .33[1]	.08 ± .25[1]	2.32[3] ± 3.78	1.94[3] ± 2.94	.12 ± .19[5]	2.12 ± 3.27	.56 ± .76
Age 20-29							
Male (N=54)	.34 ± .61[1]	.18 ± .32[1]	6.26 ± 7.34	6.39 ± 7.35	.23 ± .33[5]	6.63 ± 6.74	1.57 ± 1.59
Female (N=75)	.23 ± 1.14[1]	.78v ± 3.75	4.40 ± 3.10	4.33 ± 5.95	.18 ± .59[5]	4.37 ± 5.70	1.11 ± 1.40

Table 73: Auditory Norms - Response Time (ms)

Years of Age	Quarter 1	2	3	4	Half 1	2	Total
Age 6							
Male (N=85)	755.55 ± 148.49	805.03 ± 154.90	765.92 ± 150.78	782.39 ± 163.65	779.88 ± 145.27	779.04 ± 136.72	775.63 ± 127.05
Female (N=90)	772.06 ± 131.58	857.25 ± 149.63	810.08 ± 149.67	818.02 ± 151.79	812.84 ± 130.67	809.13 ± 130.53	806.51 ± 117.35
Age 7							
Male (N=92)	634.11 ± 135.10	700.45 ± 160.09	698.72 ± 129.88	712.68 ± 156.54	666.22 ± 140.93	711.05 ± 129.74	701.82 ± 127.34
Female (N=82)	702.74 ± 155.52	751.57 ± 165.76	755.44 ± 157.94	773.46 ± 147.82	726.89 ± 155.16	765.92 ± 148.99	752.50 ± 137.70
Age 8							
Male (N=97)	605.18 ± 110.17	672.24 ± 130.49	655.92 ± 122.84	693.91 ± 132.78	638.12 ± 115.27	674.55 ± 123.40	663.21 ± 109.48
Female (N=108)	641.04 ± 127.83	685.73 ± 121.89	682.38 ± 141.07	698.25 ± 139.17	661.87 ± 112.03	690.00 ± 135.62	681.88 ± 119.08
Age 9							
Male (N=104)	574.69 ± 94.04	627.57 ± 108.36	640.99 ± 117.55	661.60 ± 144.47	601.03 ± 97.43	654.89 ± 118.73	640.90 ± 107.58
Female (N=100)	585.32 ± 92.93	634.21 ± 106.55	632.77 ± 121.62	654.71 ± 131.57	609.73 ± 96.28	643.63 ± 122.55	636.17 ± 111.07
Age 10							
Male (N=106)	531.05 ± 80.41	584.58 ± 99.00	590.99 ± 100.26	610.84 ± 127.00	557.68 ± 86.77	600.37 ± 105.54	588.63 ± 93.15
Female (N=107)	539.26 ± 93.24	579.55 ± 101.03	585.40 ± 106.26	600.64 ± 116.12	559.44 ± 94.77	592.97 ± 107.09	585.33 ± 98.77
Age 11							
Male (N=96)	508.87 ± 86.73	554.75 ± 99.35	559.01 ± 95.77	582.67 ± 109.43	531.81 ± 90.36	570.84 ± 99.01	562.04 ± 92.64
Female (N=104)	532.50 ± 94.77	567.31 ± 111.43	574.22 ± 122.03	587.88 ± 132.19	549.92 ± 99.64	580.91 ± 123.48	573.87 ± 113.87
Age 12							
Male (N=87)	506.63 ± 85.36	557.93 ± 109.87	572.60 ± 115.18	588.66 ± 123.59	531.39 ± 93.05	580.68 ± 115.54	569.63 ± 104.86
Female (N=94)	531.11 ± 85.81	580.81 ± 102.53	575.54 ± 121.37	583.43 ± 128.14	555.87 ± 90.77	579.48 ± 120.99	574.14 ± 108.32
Age 13							
Male (N=98)	519.10 ± 90.88	574.62 ± 122.11	554.73 ± 99.81	570.81 ± 114.32	546.88 ± 103.29	562.74 ± 102.09	559.24 ± 96.89
Female (N=91)	512.87 ± 89.07	555.82 ± 107.46	541.39 ± 102.03	563.93 ± 106.35	534.27 ± 95.47	552.62 ± 100.98	548.52 ± 93.68
Age 14							
Male (N=100)	478.43 ± 86.90	516.93 ± 112.84	517.19 ± 102.98	543.11 ± 111.06	497.50 ± 96.05	530.16 ± 102.35	523.00 ± 95.95
Female (N=101)	489.02 ± 86.32	530.85 ± 109.31	521.91 ± 97.64	526.65 ± 107.54	509.87 ± 95.75	524.30 ± 98.26	521.12 ± 93.05
Age 15							
Male (N=98)	470.84 ± 103.44	502.43 ± 120.13	509.66 ± 110.62	525.84 ± 131.25	486.58 ± 108.36	517.81 ± 117.42	510.76 ± 111.05
Female (N=90)	501.21 ± 106.36	532.54 ± 126.98	517.92 ± 119.14	519.97 ± 113.61	516.90 ± 113.52	519.06 ± 112.34	517.72 ± 106.38
Age 16							
Male (N=94)	487.77 ± 102.33	528.74 ± 125.06	502.89 ± 122.29	521.46 ± 117.90	508.10 ± 109.96	512.26 ± 117.12	511.30 ± 109.41
Female (N=87)	497.81 ± 105.88	536.73 ± 128.70	496.64 ± 116.45	493.66 ± 118.03	517.09 ± 114.25	495.12 ± 113.93	499.97 ± 109.84
Age 17							
Male (N=99)	471.04 ± 81.82	498.56 ± 98.21	475.08 ± 93.49	483.78 ± 96.92	484.76 ± 87.76	479.49 ± 90.44	480.81 ± 84.41
Female (N=107)	484.82 ± 95.11	515.31 ± 109.75	491.23 ± 117.83	488.82 ± 123.28	500.02 ± 99.83	490.03 ± 117.19	492.13 ± 109.23
Age 18							
Male (N=101)	468.38 ± 94.34	489.55 ± 109.41	469.63 ± 91.95	485.48 ± 101.25	478.91 ± 99.53	477.60 ± 91.87	477.90 ± 88.76
Female (N=101)	487.80 ± 90.53	518.55 ± 107.60	488.75 ± 108.55	489.82 ± 107.15	503.19 ± 96.45	489.36 ± 104.94	492.42 ± 98.42
Age 19							
Male (N=22)	465.19 ± 76.92	500.17 ± 103.66	466.88 ± 104.39	482.00 ± 111.98	482.73 ± 85.79	474.55 ± 103.77	476.40 ± 94.67
Female (N=10)	464.87 ± 92.09	464.70 ± 110.54	439.82 ± 92.73	452.87 ± 107.66	464.81 ± 99.41	446.54 ± 90.72	450.59 ± 90.54
Age 20-29							
Male (N=54)	488.28 ± 132.77	509.09 ± 144.16	479.50 ± 128.39	496.96 ± 136.66	498.67 ± 136.22	488.05 ± 130.05	490.33 ± 127.47
Female (N=75)	499.95 ± 108.35	522.39 ± 127.94	504.39 ± 124.75	520.59 ± 130.93	510.88 ± 115.62	512.47 ± 125.56	511.97 ± 120.63

Table 74: Auditory Norms - Variability (ms)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
Age 6							
Male (N=85)	244.75 ± 80.21	263.95 ± 84.24	307.98 ± 84.47	321.13 ± 89.94	261.24 ± 76.15	321.99 ± 81.79	309.01 ± 73.42
Female (N=90)	247.01 ± 80.30	272.10 ± 78.37	306.12 ± 75.47	316.06 ± 72.03	270.78 ± 70.35	317.79 ± 65.56	309.98 ± 61.16
Age 7							
Male (N=92)	196.89 ± 78.55	212.53 ± 77.79	260.68 ± 80.61	280.16 ± 86.72	211.74 ± 71.85	274.90 ± 74.79	266.41 ± 70.79
Female (N=82)	208.12 ± 81.63	223.67 ± 85.30	265.60 ± 80.28	283.00 ± 86.80	223.50 ± 77.10	281.18 ± 78.06	272.92 ± 67.98
Age 8							
Male (N=97)	160.48 ± 59.21	193.29 ± 77.20	234.58 ± 70.20	259.66 ± 82.67	184.56 ± 63.71	250.94 ± 72.79	240.06 ± 65.38
Female (N=108)	174.79 ± 68.30	187.11 ± 63.51	217.32 ± 70.00	234.37 ± 77.88	188.58 ± 61.04	229.32 ± 70.74	225.43 ± 64.57
Age 9							
Male (N=104)	150.98 ± 64.09	170.77 ± 71.30	205.41 ± 70.95	228.86 ± 79.00	167.75 ± 61.78	221.76 ± 71.32	215.02 ± 66.30
Female (N=100)	151.77 ± 65.35	161.70 ± 64.06	200.30 ± 70.58	213.92 ± 72.30	162.90 ± 59.23	210.56 ± 68.03	205.02 ± 63.36
Age 10							
Male (N=106)	124.76 ± 50.75	137.80 ± 53.89	176.73 ± 61.87	190.18 ± 67.44	137.17 ± 49.37	188.47 ± 61.79	180.28 ± 54.41
Female (N=107)	125.04 ± 58.26	140.25 ± 59.99	165.25 ± 67.24	177.35 ± 64.95	137.71 ± 55.55	175.00 ± 63.55	171.90 ± 59.36
Age 11							
Male (N=96)	109.41 ± 39.59	128.62 ± 50.86	157.25 ± 58.06	171.09 ± 65.18	124.62 ± 42.76	167.50 ± 59.92	162.40 ± 55.80
Female (N=104)	127.97 ± 59.00	128.44 ± 58.70	155.78 ± 69.02	169.62 ± 67.32	134.84 ± 53.01	166.12 ± 66.68	164.03 ± 61.52
Age 12							
Male (N=87)	113.31 ± 44.06	133.99 ± 59.54	160.42 ± 61.90	171.92 ± 67.75	129.70 ± 50.71	169.93 ± 62.44	167.43 ± 58.33
Female (N=94)	111.81 ± 48.53	133.73 ± 57.65	153.24 ± 64.80	164.18 ± 70.52	129.22 ± 50.91	162.58 ± 65.47	161.31 ± 60.52
Age 13							
Male (N=98)	119.37 ± 46.68	135.66 ± 59.40	154.30 ± 61.96	171.03 ± 66.33	134.76 ± 51.91	166.64 ± 62.94	164.35 ± 58.13
Female (N=91)	112.59 ± 57.07	124.66 ± 56.53	156.24 ± 70.75	172.04 ± 71.96	124.01 ± 55.04	167.54 ± 69.06	163.11 ± 64.67
Age 14							
Male (N=100)	109.84 ± 52.85	123.25 ± 55.88	153.19 ± 65.55	166.92 ± 73.63	122.37 ± 52.89	164.19 ± 67.35	159.70 ± 62.84
Female (N=101)	101.26 ± 47.05	119.51 ± 56.47	139.41 ± 56.32	152.73 ± 69.26	115.92 ± 49.68	149.77 ± 61.69	146.99 ± 56.91
Age 15							
Male (N=98)	98.05 ± 44.31	109.61 ± 49.97	144.67 ± 65.62	155.16 ± 70.64	109.04 ± 46.78	153.77 ± 66.80	148.95 ± 62.30
Female (N=90)	99.93 ± 41.13	119.49 ± 66.03	145.18 ± 67.38	152.78 ± 73.32	115.86 ± 52.83	154.26 ± 66.96	150.68 ± 64.76
Age 16							
Male (N=94)	105.83 ± 43.43	116.50 ± 49.55	136.53 ± 54.80	147.11 ± 63.74	118.39 ± 42.98	145.47 ± 57.85	144.78 ± 53.66
Female (N=87)	101.42 ± 52.40	111.62 ± 64.03	127.11 ± 58.97	136.48 ± 68.37	113.17 ± 55.25	135.79 ± 61.17	135.79 ± 57.39
Age 17							
Male (N=99)	97.44 ± 37.82	106.68 ± 51.71	123.79 ± 55.12	135.01 ± 58.64	106.40 ± 42.31	134.18 ± 53.83	132.75 ± 49.76
Female (N=107)	88.54 ± 39.10	99.68 ± 49.63	119.83 ± 63.49	130.00 ± 64.47	99.51 ± 41.91	128.63 ± 63.03	126.53 ± 57.96
Age 18							
Male (N=101)	102.05 ± 46.07	102.98 ± 48.10	114.80 ± 45.24	129.97 ± 62.11	107.37 ± 42.25	126.98 ± 52.53	127.39 ± 47.52
Female (N=101)	85.47 ± 36.59	96.83 ± 41.52	119.59 ± 53.39	127.64 ± 60.03	96.72 ± 36.74	126.53 ± 55.78	125.11 ± 50.23
Age 19							
Male (N=22)	98.08 ± 39.02	106.35 ± 56.34	119.32 ± 52.92	124.22 ± 51.05	109.02 ± 46.47	125.53 ± 51.58	127.09 ± 47.34
Female (N=10)	81.77 ± 32.06	77.45 ± 40.26	119.12 ± 54.21	140.75 ± 77.14	82.71 ± 35.11	136.44 ± 67.78	128.72 ± 60.26
Age 20-29							
Male (N=54)	78.14 ± 35.72	91.34 ± 57.55	110.26 ± 57.58	128.83 ± 73.65	89.79 ± 46.87	122.13 ± 64.31	119.28 ± 62.97
Female (N=75)	80.65 ± 40.29	86.84 ± 48.99	109.98 ± 46.94	121.45 ± 57.97	88.08 ± 44.12	118.66 ± 52.17	115.59 ± 49.73

Table 75: Auditory Norms - D Prime (Perceptual Sensitivity)

Years of Age	Quarter 1	2	3	4	Half 1	2	Total
Age 6							
Male (N=85)	4.38 ± 2.24	4.58 ± 2.43	2.08 ± 1.66	1.89 ± 1.76	4.05 ± 2.05	1.90 ± 1.58	2.69 ± 1.48
Female (N=90)	4.87 ± 2.42	4.50 ± 2.21	2.59 ± 1.94	2.21 ± 1.69	4.06 ± 1.88	2.22 ± 1.56	2.82 ± 1.32
Age 7							
Male (N=92)	5.79 ± 2.29	5.50 ± 2.33	2.98 ± 2.04	2.63 ± 2.09	5.08 ± 2.12	2.57 ± 1.67	3.35 ± 1.42
Female (N=82)	5.60 ± 2.39	5.86 ± 2.41	3.34 ± 2.24	2.96 ± 2.12	5.23 ± 2.26	2.90 ± 1.87	3.56 ± 1.69
Age 8							
Male (N=97)	6.58 ± 1.79	6.72 ± 2.07	3.77 ± 1.99	3.48 ± 1.98	5.97 ± 1.89	3.26 ± 1.59	4.02 ± 1.39
Female (N=108)	6.34 ± 2.00	6.74 ± 2.02	4.38 ± 2.23	4.01 ± 2.06	5.98 ± 1.98	3.79 ± 1.78	4.28 ± 1.49
Age 9							
Male (N=104)	6.93 ± 1.76	7.15 ± 1.80	4.38 ± 1.88	4.03 ± 2.27	6.49 ± 1.75	3.76 ± 1.57	4.41 ± 1.30
Female (N=100)	7.03 ± 1.89	7.19 ± 1.62	4.52 ± 1.94	4.05 ± 1.76	6.50 ± 1.72	3.92 ± 1.55	4.51 ± 1.33
Age 10							
Male (N=106)	7.41 ± 1.52	7.47 ± 1.61	4.99 ± 2.10	4.89 ± 2.06	6.94 ± 1.64	4.47 ± 1.74	5.06 ± 1.48
Female (N=107)	7.54 ± 1.37	7.71 ± 1.24	5.80 ± 1.95	5.09 ± 1.81	7.22 ± 1.42	4.93 ± 1.59	5.42 ± 1.37
Age 11							
Male (N=96)	7.58 ± 1.27	7.92 ± 1.08	5.74 ± 1.94	5.37 ± 1.71	7.36 ± 1.34	5.04 ± 1.51	5.54 ± 1.30
Female (N=104)	7.80 ± 1.35	7.69 ± 1.38	5.80 ± 2.02	5.26 ± 1.81	7.41 ± 1.43	5.07 ± 1.72	5.45 ± 1.48
Age 12							
Male (N=87)	7.64 ± 1.30	7.68 ± 1.54	6.04 ± 1.99	5.88 ± 2.11	7.26 ± 1.52	5.52 ± 1.95	5.74 ± 1.57
Female (N=94)	7.89 ± 1.11	7.84 ± 1.34	6.34 ± 1.91	5.69 ± 1.96	7.47 ± 1.35	5.41 ± 1.60	5.78 ± 1.38
Age 13							
Male (N=98)	7.69 ± 1.36	7.94 ± 1.16	6.16 ± 1.88	5.88 ± 2.10	7.40 ± 1.40	5.46 ± 1.77	5.79 ± 1.50
Female (N=91)	7.61 ± 1.45	7.75 ± 1.39	5.91 ± 2.01	5.47 ± 2.09	7.36 ± 1.59	5.14 ± 1.74	5.60 ± 1.55
Age 14							
Male (N=100)	7.80 ± 1.29	7.75 ± 1.41	6.19 ± 2.05	6.14 ± 1.91	7.43 ± 1.48	5.64 ± 1.78	5.95 ± 1.46
Female (N=101)	7.95 ± 1.13	7.84 ± 1.20	6.47 ± 1.89	6.20 ± 1.86	7.54 ± 1.34	5.73 ± 1.76	6.03 ± 1.49
Age 15							
Male (N=98)	7.95 ± 1.10	8.08 ± 1.02	6.51 ± 1.79	6.25 ± 1.80	7.74 ± 1.14	5.81 ± 1.57	6.15 ± 1.32
Female (N=90)	8.11 ± 1.03	7.96 ± 1.18	6.36 ± 2.01	5.81 ± 2.33	7.78 ± 1.26	5.57 ± 1.91	5.88 ± 1.55
Age 16							
Male (N=94)	8.01 ± .95	7.77 ± 1.22	6.51 ± 1.84	6.39 ± 1.94	7.52 ± 1.26	5.96 ± 1.75	6.14 ± 1.44
Female (N=87)	7.99 ± 1.17	8.09 ± 1.08	6.94 ± 1.73	6.58 ± 1.97	7.75 ± 1.30	6.29 ± 1.82	6.54 ± 1.59
Age 17							
Male (N=99)	8.09 ± .96	8.01 ± 1.07	6.80 ± 1.91	6.73 ± 1.87	7.75 ± 1.20	6.22 ± 1.85	6.47 ± 1.56
Female (N=107)	8.05 ± 1.09	7.96 ± 1.21	6.99 ± 1.82	6.72 ± 1.90	7.76 ± 1.30	6.41 ± 1.82	6.58 ± 1.62
Age 18							
Male (N=101)	8.08 ± 1.10	8.25 ± 0.75	7.04 ± 1.72	6.99 ± 1.74	7.94 ± 1.10	6.53 ± 1.70	6.65 ± 1.39
Female (N=101)	8.30 ± 0.67	8.28 ± 0.78	7.35 ± 1.44	6.86 ± 1.87	8.15 ± 0.90	6.58 ± 1.70	6.81 ± 1.44
Age 19							
Male (N=22)	8.36 ± 0.55	8.25 ± 0.71	7.13 ± 1.88	7.14 ± 1.72	8.14 ± 0.74	6.65 ± 1.79	6.89 ± 1.60
Female (N=10)	8.16 ± 0.78	8.34 ± 0.59	7.02 ± 2.17	7.28 ± 1.77	8.05 ± 0.78	6.90 ± 2.00	7.00 ± 1.62
Age 20-29							
Male (N=54)	7.72 ± 1.31	7.97 ± 1.23	5.60 ± 1.72	5.65 ± 1.83	7.46 ± 1.35	5.36 ± 1.51	5.88 ± 1.31
Female (N=75)	8.12 ± 1.11	7.97 ± 1.15	6.23 ± 1.67	6.32 ± 1.77	7.80 ± 1.23	5.93 ± 1.54	6.34 ± 1.38

Table 76: REFERENCE KEY

Ref. #	Type	Description
1	Q1/Q2 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).*
2	Q3/Q4 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).*
3	Q3/Q4 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).*
4	Q1/Q2 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).*
5	H1 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).*
6	H2 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).*
7	H2 commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).*
8	H1 omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).*
9	T commissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*
10	T omissions	Norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*
	*	Omission and commission errors are not normally distributed. This makes a comparison to a norming group difficult, especially when some norming groups (e.g., adults) made no omission/commission errors. Norming groups with no errors (which implies a zero in the norming standard deviation) causes a single error to distort distribution values such as z scores. Because one omission or one commission error is not clinically relevant, the norming standard deviations have been bounded at a minimum of one error.

10.4 Appendix D: Pearson Product Coefficients, Visual

Table 77: Pearson Product Coefficients - Visual - All Variables

	OM1QT	OM2QT	OM3QT	OM4QT	OM1HF	OM2HF	OMTOT	CO1QT	CO2QT	CO3QT	CO4QT	CO1HF	CO2HF	COTOT	RT1QT	RT2QT	RT3QT
OM1QT	.1																
OM2QT	.6724	.1															
OM3QT	.5863	.6668	.1														
OM4QT	.5934	.6075	.6187	.1													
OM1HF	.9092	.9179	.6889	.6551	.1												
OM2HF	.6566	.7076	.9027	.8947	.7472	.1											
OMOT	.7516	.7952	.8927	.8792	.8466	.9847	.1										
CO1QT	.1355	.1469	.1186	.208	.1505	.1796	.1802	.1									
CO2QT	.1429	.2137	.2002	.2441	.1939	.2421	.2433	.554	.1								
CO3QT	.1063	.1436	.0664	.1736	.1347	.1299	.1391	.358	.4325	.1							
CO4QT	.1687	.2323	.1403	.2511	.2164	.211	.2267	.5265	.4495	.7701	.1						
CO1HF	.1554	.1981	.1735	.2558	.1911	.2359	.2359	.9047	.8258	.5422	.5341	.1					
CO2HF	.149	.2048	.1128	.2301	.1908	.1851	.1987	.5632	.4694	.926	.9527	.5701	.1				
COTOT	.1587	.2111	.1331	.2446	.1993	.2051	.2159	.71	.6064	.9069	.9234	.7334	.9729	.1			
RT1QT	.3188	.3324	.2615	.4102	.3518	.3684	.384	.0828	.0376	.0892	.2158	.0507	.1697	.1433	.1		
RT2QT	.3375	.383	.3013	.453	.3895	.4153	.4316	.1159	.0691	.097	.2369	.0874	.1855	.1654	.9294	.1	
RT3QT	.2211	.2739	.2546	.3752	.266	.3458	.3458	.0398	.0343	-.0806	.0523	.0232	-.0071	-.0094	.8554	.8697	.1
RT4QT	.2125	.2523	.2461	.3877	.2495	.3486	.3415	.0207	.0289	-.0853	-.0034	.0112	-.0419	-.0404	.8144	.839	.9262
RT1HF	.334	.3621	.2848	.4384	.3761	.3974	.4137	.1016	.0527	.0958	.2319	.0697	.1822	.158	.9794	.9839	.8778
RT2HF	.2217	.2679	.2549	.3879	.263	.3532	.3498	.0303	.0313	-.0847	.0236	.0167	-.0259	-.0263	.8506	.87	.9795
RTTOT	.2461	.2892	.268	.4079	.288	.3714	.3707	.049	.0376	-.0428	.0744	.0307	.0239	.0179	.9002	.9163	.9787
V1QT	.3371	.3288	.2484	.3931	.3595	.3518	.3717	.2943	.1576	.2638	.3679	.2442	.3416	.3433	.7396	.6788	.5952
V2QT	.3079	.373	.2988	.4218	.3671	.3982	.4116	.2913	.2301	.2815	.402	.2783	.3706	.3726	.6484	.7509	.5995
V3QT	.2993	.36	.3252	.471	.3539	.4353	.4404	.2373	.2	.2614	.3683	.2208	.3413	.3328	.7511	.7867	.789
V4QT	.2939	.3559	.3053	.5012	.3494	.4417	.4424	.2641	.2232	.2775	.4022	.2568	.3684	.3637	.7296	.7724	.7266
V1HF	.3419	.3878	.3008	.444	.3937	.4106	.4278	.3103	.2159	.2849	.4069	.282	.3749	.3782	.7343	.7816	.6471
V2HF	.3025	.3648	.3187	.4974	.3584	.4466	.4496	.2567	.2185	.2734	.393	.2454	.3613	.3552	.7625	.803	.7796
VTOT	.3306	.3839	.3245	.5054	.3843	.4549	.4624	.2782	.2209	.3044	.4304	.2601	.398	.3894	.7934	.8328	.7598
D1QT	-.4924	-.3884	-.3181	-.406	-.4697	-.3922	-.4262	-.5413	-.3247	-.4614	-.5182	-.4594	-.5148	-.5572	-.336	-.3608	-.2457
D2QT	-.3063	-.5304	-.3267	-.4266	-.449	-.4052	-.4329	-.4522	-.5114	-.4521	-.5087	-.5028	-.5066	-.565	-.3086	-.3481	-.2474
D3QT	-.2785	-.3358	-.3535	-.4031	-.3296	-.4068	-.4043	-.4	-.3116	-.6491	-.6	-.3763	-.6513	-.6193	-.2981	-.3204	-.1692
D4QT	-.3169	-.3806	-.3369	-.5111	-.3729	-.4567	-.4553	-.4133	-.3308	-.5796	-.7114	-.3925	-.6811	-.6468	-.3367	-.3718	-.2098
D1HF	-.4031	-.4738	-.3195	-.4232	-.4684	-.4024	-.4339	-.523	-.4337	-.4787	-.5299	-.5161	-.5302	-.5867	-.3139	-.3563	-.241
D2HF	-.3271	-.3896	-.3938	-.5108	-.3838	-.4919	-.484	-.4204	-.3292	-.6093	-.6582	-.3987	-.6659	-.6385	-.3394	-.3771	-.2165
DTOT	-.3673	-.4506	-.3984	-.5102	-.4381	-.492	-.5023	-.427	-.3489	-.5415	-.6016	-.412	-.6012	-.599	-.3703	-.4132	-.2653

Table 78: Pearson Product Coefficients - Visual - All Variables, continued

	CRMQ4	CRMH1	CRMH2	CRMTOT	CRVQ1	CRVQ2	CRVQ3	CRVQ4	CRVH1	CRVH2	CRVTOT	D1QT	D2QT	D3QT	D4QT	D1HF	D2HF	DTOT
CRMQ4	0.1																	
CRMH1	0.7508	0.1																
CRMH2	0.9509	0.8093	0.1															
CRMTOT	0.9372	0.8845	0.9857	0.1														
CRVQ1	0.5988	0.7369	0.6431	0.6884	0.1													
CRVQ2	0.6158	0.7458	0.6509	0.694	0.7488	0.1												
CRVQ3	0.7146	0.6866	0.7587	0.7619	0.746	0.7683	0.1											
CRVQ4	0.7537	0.6521	0.7317	0.7412	0.7051	0.732	0.8654	0.1										
CRVH1	0.6551	0.7984	0.697	0.7445	0.9125	0.9462	0.8059	0.768	0.1									
CRVH2	0.7661	0.6914	0.7796	0.7804	0.7522	0.78	0.9632	0.9546	0.8176	0.1								
CRVTOT	0.7705	0.7306	0.7927	0.8061	0.8004	0.8275	0.9535	0.9436	0.8702	0.9875	0.1							
D1QT	-0.4339	-0.5103	-0.4719	-0.4949	-0.6428	-0.5904	-0.6015	-0.5473	-0.6485	-0.5994	-0.62	0.1						
D2QT	-0.4481	-0.5493	-0.4948	-0.5204	-0.6349	-0.6502	-0.6386	-0.5842	-0.6815	-0.6383	-0.6573	0.6347	0.1					
D3QT	-0.4537	-0.4589	-0.4845	-0.4868	-0.602	-0.603	-0.7088	-0.6601	-0.6358	-0.7115	-0.7062	0.5844	0.6018	0.1				
D4QT	-0.4684	-0.4804	-0.501	-0.5035	-0.6076	-0.6171	-0.6975	-0.6932	-0.6465	-0.7252	-0.7205	0.567	0.5893	0.7388	0.1			
D1HF	-0.4678	-0.5474	-0.5098	-0.5331	-0.6671	-0.662	-0.6689	-0.6161	-0.703	-0.6682	-0.6873	0.8727	0.8718	0.6413	0.6345	0.1		
D2HF	-0.4837	-0.485	-0.5121	-0.5145	-0.6263	-0.6369	-0.7366	-0.7104	-0.667	-0.7528	-0.7467	0.5845	0.6044	0.8869	0.9223	0.6504	0.1	
DTOT	-0.5115	-0.5218	-0.5432	-0.5498	-0.6607	-0.671	-0.7591	-0.7241	-0.7052	-0.7728	-0.7728	0.668	0.6801	0.8664	0.8926	0.7525	0.9655	0.1

Table 79: Pearson Product Coefficients Visual Condition 1

	OM1QT	OM2QT	OM1HF	OMTOT	CO1QT	CO2QT	CO1HF	COTOT	RT1QT	RT2QT	RT1HF	RTTOT	V1QT	V2QT	V1HF	VTOT
OM1QT	1															
OM2QT	0.6724	1														
OM1HF	0.9092	0.9179	1													
OMTOT	0.7516	0.7952	0.8466	1												
CO1QT	0.1355	0.1469	0.1505	0.1802	1											
CO2QT	0.1429	0.2137	0.1939	0.2433	0.554	1										
CO1HF	0.1554	0.1981	0.1911	0.2359	0.9047	0.8258	1									
COTOT	0.1587	0.2111	0.1993	0.2159	0.71	0.6064	0.7334	1								
RT1QT	0.3188	0.3324	0.3518	0.384	0.0828	0.0376	0.0507	0.1433	1							
RT2QT	0.3375	0.383	0.3895	0.4316	0.1159	0.0691	0.0874	0.1654	0.9294	1						
RT1HF	0.334	0.3621	0.3761	0.4137	0.1016	0.0527	0.0697	0.158	0.9794	0.9839	1					
RTTOT	0.2461	0.2892	0.288	0.3707	0.049	0.0376	0.0307	0.0179	0.9002	0.9163	0.9249	1				
V1QT	0.3371	0.3288	0.3595	0.3717	0.2943	0.1576	0.2442	0.3433	0.7396	0.6788	0.7197	0.6368	1			
V2QT	0.3079	0.373	0.3671	0.4116	0.2913	0.2301	0.2783	0.3726	0.6484	0.7509	0.7142	0.6388	0.6994	1		
V1HF	0.3419	0.3878	0.3937	0.4278	0.3103	0.2159	0.282	0.3782	0.7343	0.7816	0.772	0.6904	0.8935	0.9385	1	
VTOT	0.3306	0.3839	0.3843	0.4624	0.2782	0.2209	0.2601	0.3894	0.7934	0.8328	0.8282	0.8011	0.8088	0.8397	0.8928	1

Table 80: Pearson Product Coefficients Visual Condition 2

	OM3QT	OM4QT	OM2HF	OMTOT	CO3QT	CO4QT	CO2HF	COTOT	RT3QT	RT4QT	RT2HF	RTTOT	V3QT	V4QT	V2HF	VTOT
OM3QT	1															
OM4QT	0.6187	1														
OM2HF	0.9027	0.8947	1													
OMTOT	0.8927	0.8792	0.9847	1												
CO3QT	0.0664	0.1736	0.1299	0.1391	1											
CO4QT	0.1403	0.2511	0.211	0.2267	0.7701	1										
CO2HF	0.1128	0.2301	0.1851	0.1987	0.926	0.9527	1									
COTOT	0.1331	0.2446	0.2051	0.2159	0.9069	0.9234	0.9729	1								
RT3QT	0.2546	0.3752	0.3458	0.3458	-0.0806	0.0523	-0.0071	-0.0094	1							
RT4QT	0.2461	0.3877	0.3486	0.3415	-0.0853	-0.0034	-0.0419	-0.0404	0.9262	1						
RT2HF	0.2549	0.3879	0.3532	0.3498	-0.0847	0.0236	-0.0259	-0.0263	0.9795	0.9823	1					
RTTOT	0.268	0.4079	0.3714	0.3707	-0.0428	0.0744	0.0239	0.0179	0.9787	0.9712	0.9931	1				
V3QT	0.3252	0.471	0.4353	0.4404	0.2614	0.3683	0.3413	0.3328	0.789	0.7285	0.7717	0.7927	1			
V4QT	0.3053	0.5012	0.4417	0.4424	0.2775	0.4022	0.3684	0.3637	0.7266	0.7692	0.7615	0.7802	0.8676	1		
V2HF	0.3187	0.4974	0.4466	0.4496	0.2734	0.393	0.3613	0.3552	0.7796	0.7811	0.7947	0.8136	0.9545	0.9728	1	
VT	0.3245	0.5054	0.4549	0.4624	0.3044	0.4304	0.398	0.3894	0.7598	0.7518	0.7697	0.8011	0.9463	0.9592	0.9874	1

10.5 Appendix E: Pearson Product Coefficients, Auditory

Table 81: Pearson Product Coefficients - Auditory All Variables

	OMPQ1	OMPQ2	OMPQ3	OMPQ4	OMPH1	OMPH2	OMPTOT	COPQ1	COPQ2	COPQ3	COPQ4	COPH1	COPH2	COPTOT	CRMQ1	CRMQ2	CRMQ3
OMPQ1	.1																
OMPQ2	.8082	.1															
OMPQ3	.6756	.7336	.1														
OMPQ4	.6405	.7055	.9358	.1													
OMPH1	.9416	.9593	.7432	.7102	.1												
OMPH2	.669	.731	.9834	.9842	.7385	.1											
OMPTOT	.7325	.7896	.9806	.9769	.8024	.9949	.1										
COPQ1	.4108	.3769	.3736	.3996	.4117	.3948	.4143	.1									
COPQ2	.46	.4135	.3768	.3971	.4562	.3947	.4203	.8664	.1								
COPQ3	.4829	.458	.542	.5592	.4932	.5597	.5685	.4269	.4779	.1							
COPQ4	.4518	.4305	.4952	.489	.4628	.4996	.5104	.3268	.3563	.8299	.1						
COPH1	.4514	.4099	.3884	.4121	.45	.4085	.4319	.9635	.9683	.4697	.3544	.1					
COPH2	.486	.4621	.5391	.5433	.4972	.5498	.56	.3867	.4284	.9476	.9645	.4231	.1				
COPTOT	.5481	.5075	.5302	.5476	.5523	.5487	.57	.8599	.8841	.7778	.7051	.9033	.7701	.1			
CRMQ1	.5544	.5661	.4986	.4847	.5894	.4993	.5289	.2073	.2258	.3582	.39	.2247	.392	.344	.1		
CRMQ2	.4962	.5449	.4803	.4822	.5494	.4889	.5137	.2031	.2198	.339	.3736	.2194	.3736	.3313	.9149	.1	
CRMQ3	.4469	.4748	.5259	.5094	.4855	.5257	.5366	.2008	.2121	.3115	.3439	.214	.3438	.3149	.7822	.8106	.1
CRMQ4	.3718	.4044	.4417	.4377	.4096	.4462	.4549	.1689	.1591	.2869	.314	.1703	.3156	.2704	.7131	.7512	.879
CRMH1	.5322	.5604	.4956	.4891	.5755	.5001	.5275	.2084	.2227	.3533	.3885	.2236	.3889	.3416	.9751	.9808	.8149
CRMH2	.4309	.4656	.5151	.5083	.4727	.5197	.5295	.1986	.2065	.3233	.3506	.2099	.3532	.3167	.7737	.8082	.975
CRMTOT	.4675	.5009	.504	.4968	.5104	.5083	.525	.2106	.2181	.3285	.3577	.2222	.3596	.3279	.85	.8788	.9668
CRVQ1	.5613	.5864	.5493	.5421	.6043	.5545	.5804	.3324	.3027	.4927	.5108	.3284	.5245	.4789	.7472	.6965	.6364
CRVQ2	.5172	.559	.5184	.5286	.5674	.5319	.5548	.3098	.3231	.4983	.5196	.3281	.5327	.4824	.6843	.7718	.6388
CRVQ3	.4977	.5375	.5775	.5661	.5459	.5809	.5945	.2864	.2808	.5437	.5616	.2937	.5781	.4803	.6591	.6823	.7564
CRVQ4	.437	.4746	.4947	.4998	.4811	.5047	.5167	.2184	.2016	.5194	.5651	.2178	.5693	.4239	.6193	.6523	.679
CRVH1	.5767	.6096	.5644	.5678	.6249	.5752	.6017	.3344	.3293	.5184	.541	.3435	.5543	.5035	.7577	.8026	.6892
CRVH2	.4955	.535	.5808	.5823	.5434	.5909	.603	.289	.2783	.5551	.5845	.2938	.5966	.4892	.6592	.6908	.7458
CRVTOT	.52	.5607	.57	.5729	.5699	.5806	.598	.3047	.2993	.5509	.5787	.3128	.5913	.4998	.695	.7323	.7625
D1QT	-.6866	-.6042	-.5707	-.5536	-.6745	-.5713	-.606	-.4739	-.4011	-.5393	-.5457	-.452	-.5667	-.5864	-.5097	-.4914	-.4733
D2QT	-.6038	-.7221	-.6054	-.5936	-.7024	-.6091	-.6434	-.4132	-.459	-.5698	-.5546	-.4523	-.5863	-.5954	-.5378	-.5434	-.4962
D3QT	-.4572	-.4903	-.5788	-.5524	-.4995	-.5744	-.5823	-.2898	-.2867	-.7193	-.6516	-.2986	-.7127	-.5489	-.4516	-.4493	-.471
D4QT	-.4361	-.4708	-.5443	-.574	-.4782	-.5682	-.5736	-.2662	-.262	-.6307	-.742	-.2735	-.7228	-.5363	-.4706	-.472	-.4792
D1HF	-.6214	-.6523	-.5746	-.5601	-.6709	-.5765	-.6098	-.4244	-.4007	-.5698	-.5801	-.427	-.6009	-.5847	-.5358	-.5395	-.5092
D2HF	-.4522	-.4864	-.5679	-.5708	-.4949	-.5784	-.5851	-.2828	-.2759	-.6725	-.7061	-.2892	-.7219	-.5468	-.475	-.4764	-.4928
DTOT	-.5041	-.5388	-.5896	-.5903	-.5497	-.5994	-.6121	-.3416	-.326	-.6463	-.6724	-.3455	-.6901	-.5711	-.5091	-.5147	-.5269

Table 82: Pearson Product Coefficients - Auditory All Variables, continued

	CRMQ4	CRMH1	CRMH2	CRMTOT	CRVQ1	CRVQ2	CRVQ3	CRVQ4	CRVH1	CRVH2	CRVTOT	D1QT	D2QT	D3QT	D4QT	D1HF	D2HF	DTOT
CRMQ4	0.1																	
CRMH1	0.7508	0.1																
CRMH2	0.9509	0.8093	0.1															
CRMTOT	0.9372	0.8845	0.9857	0.1														
CRVQ1	0.5988	0.7369	0.6431	0.6884	0.1													
CRVQ2	0.6158	0.7458	0.6509	0.694	0.7488	0.1												
CRVQ3	0.7146	0.6866	0.7587	0.7619	0.746	0.7683	0.1											
CRVQ4	0.7537	0.6521	0.7317	0.7412	0.7051	0.732	0.8654	0.1										
CRVH1	0.6551	0.7984	0.697	0.7445	0.9125	0.9462	0.8059	0.768	0.1									
CRVH2	0.7661	0.6914	0.7796	0.7804	0.7522	0.78	0.9632	0.9546	0.8176	0.1								
CRVTOT	0.7705	0.7306	0.7927	0.8061	0.8004	0.8275	0.9535	0.9436	0.8702	0.9875	0.1							
D1QT	-0.4339	-0.5103	-0.4719	-0.4949	-0.6428	-0.5904	-0.6015	-0.5473	-0.6485	-0.5994	-0.62	0.1						
D2QT	-0.4481	-0.5493	-0.4948	-0.5204	-0.6349	-0.6502	-0.6386	-0.5842	-0.6815	-0.6383	-0.6573	0.6347	0.1					
D3QT	-0.4537	-0.4589	-0.4845	-0.4868	-0.602	-0.603	-0.7088	-0.6601	-0.6358	-0.7115	-0.7062	0.5844	0.6018	0.1				
D4QT	-0.4684	-0.4804	-0.501	-0.5035	-0.6076	-0.6171	-0.6975	-0.6932	-0.6465	-0.7252	-0.7205	0.567	0.5893	0.7388	0.1			
D1HF	-0.4678	-0.5474	-0.5098	-0.5331	-0.6671	-0.662	-0.6689	-0.6161	-0.703	-0.6682	-0.6873	0.8727	0.8718	0.6413	0.6345	0.1		
D2HF	-0.4837	-0.485	-0.5121	-0.5145	-0.6263	-0.6369	-0.7366	-0.7104	-0.667	-0.7528	-0.7467	0.5845	0.6044	0.8869	0.9223	0.6504	0.1	
DTOT	-0.5115	-0.5218	-0.5432	-0.5498	-0.6607	-0.671	-0.7591	-0.7241	-0.7052	-0.7728	-0.7728	0.668	0.6801	0.8664	0.8926	0.7525	0.9655	0.1

Table 83: Auditory Correlation Coefficients Condition 1

	OMQ1	OMQ2	OMH1	OMT	CQ1	CQ2	CH1	CT	RTQ1	RTQ2	RTH1	RTT	VQ1	VQ2	VH1	VT
OMQ1	1															
OMQ2	0.8082	1														
OMH1	0.9416	0.9593	1													
OMT	0.7325	0.7896	0.8024	1												
CQ1	0.4108	0.3769	0.4117	0.4143	1											
CQ2	0.46	0.4135	0.4562	0.4203	0.8664	1										
CH1	0.4514	0.4099	0.45	0.4319	0.9635	0.9683	1									
CT	0.5481	0.5075	0.5523	0.57	0.8599	0.8841	0.9033	1								
RTQ1	0.5544	0.5661	0.5894	0.5289	0.2073	0.2258	0.2247	0.344	1							
RTQ2	0.4962	0.5449	0.5494	0.5137	0.2031	0.2198	0.2194	0.3313	0.9149	1						
RTH1	0.5322	0.5604	0.5755	0.5275	0.2084	0.2227	0.2236	0.3416	0.9751	0.9808	1					
RTT	0.4675	0.5009	0.5104	0.525	0.2106	0.2181	0.2222	0.3279	0.85	0.8788	0.8845	1				
VQ1	0.5613	0.5864	0.6043	0.5804	0.3324	0.3027	0.3284	0.4789	0.7472	0.6965	0.7369	0.6884	1			
VQ2	0.5172	0.559	0.5674	0.5548	0.3098	0.3231	0.3281	0.4824	0.6843	0.7718	0.7458	0.694	0.7488	1		
VH1	0.5767	0.6096	0.6249	0.6017	0.334	0.3293	0.3435	0.5035	0.7577	0.8026	0.7984	0.7445	0.9125	0.9462	1	
VT	0.52	0.5607	0.5699	0.598	0.3047	0.2993	0.3128	0.4998	0.695	0.7323	0.7306	0.8061	0.8004	0.8275	0.8702	1

Table 84: Auditory Correlation Coefficients Condition 2

	OMQ3	OMQ4	OMH2	OMT	COQ3	COQ4	COH2	COT	RTQ3	RTQ4	RTH2	RTT	VQ3	VQ4	VH2	VT
OMQ3	1															
OMQ4	0.9358	1														
OMH2	0.9834	0.9842	1													
OMT	0.9806	0.9769	0.9949	1												
COQ3	0.542	0.5592	0.5597	0.5685	1											
COQ4	0.4952	0.489	0.4996	0.5104	0.8299	1										
COH2	0.5391	0.5433	0.5498	0.56	0.9476	0.9645	1									
COT	0.5302	0.5476	0.5487	0.57	0.7778	0.7051	0.7701	1								
RTQ3	0.5259	0.5094	0.5257	0.5366	0.3115	0.3439	0.3438	0.3149	1							
RTQ4	0.4417	0.4377	0.4462	0.4549	0.2869	0.314	0.3156	0.2704	0.879	1						
RTH2	0.5151	0.5083	0.5197	0.5295	0.3233	0.3506	0.3532	0.3167	0.975	0.9509	1					
RTT	0.504	0.4968	0.5083	0.525	0.3285	0.3577	0.3596	0.3279	0.9668	0.9372	0.9857	1				
VQ3	0.5775	0.5661	0.5809	0.5945	0.5437	0.5616	0.5781	0.4803	0.7564	0.7146	0.7587	0.7619	1			
VQ4	0.4947	0.4998	0.5047	0.5167	0.5194	0.5651	0.5693	0.4239	0.679	0.7537	0.7317	0.7412	0.8654	1		
VH2	0.5808	0.5823	0.5909	0.603	0.5551	0.5845	0.5966	0.4892	0.7458	0.7661	0.7796	0.7804	0.9632	0.9546	1	
VTOT	0.57	0.5729	0.5806	0.598	0.5509	0.5787	0.5913	0.4998	0.7625	0.7705	0.7927	0.8061	0.9535	0.9436	0.9875	1