Test of Variables of Attention®

SCREENING MANUAL

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The TOVA Company
Ed. No. 844 (February 20, 2008)

T.O.V.A.® Screening Manual

Test Of Variables of Attention Continuous Performance Test

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Printed in the United States of America.

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1. Introduction to the Screening Version

The T.O.V.A.s

The Tests of Variables of Attention are objective, standardized, and highly accurate continuous performance tests (CPTs) that are used to assess attention and impulsivity. The **T.O.V.A.®** is the visual version, and the **T.O.V.A.-A.®** is the auditory version. They are non-language based, sufficiently long (21.6 minutes) computerized tests that require no left-right discrimination or sequencing and have no appreciable practice effects. Responses are recorded with a specially designed, highly accurate (± 1 ms) electronic microswitch.

T.O.V.A.s:

- assess attention in neuropsychological and neuropsychiatric evaluations
- screen for disorders of attention
- are components in the diagnosis of disorders of attention
- predict medication response
- help medical professionals titrate medication dosage
- monitor treatment over time.

There are two forms of the T.O.V.A.s: the **screening** and the **clinical versions**. Although the tests are the same, the two different forms are used differently and produce different reports. The screening form is used by non-healthcare professionals and school personnel to screen children, teenagers and adults for possible attentional disorders to determine which cases to refer to a clinician for further assessment. In contrast, the clinical form is used by a clinician as part of the clinical assessment and treatment processes.

I. Terms and Concepts

A. "Off-task behavior" is a descriptive term with no specific etiologic or diagnostic implications. It is used in this manual to indicate that the person is not engaged in the appropriate or assigned task when it is reasonable to expect that they should be. They are not on-task for whatever reason or reasons that may have nothing to do with attention disorders.

B. The term, "Attention Deficit Disorders" (ADD), is used to indicate that attention is disordered (that is, abnormal or deviant from the norm). There are many different types of ADD, including but not limited to ADHD.

C. "Attention-Deficit Hyperactivity Disorder" (ADHD) refers to a specific symptom-complex, as defined by the current manual of diagnoses, DSM-IV.

II. Attention-Deficit Hyperactivity Disorder (ADHD), DSM IV

A. There are four sub-types of ADHD:

1. Predominantly Inattentive Type (314.00) - Must have six or more of the following symptoms: 1) Often fails to give close attention to details or makes careless mistakes in schoolwork, work, etc.; 2) Often has difficulty sustaining attention; 3) Often does not seem to listen to what is being said; 4) Often does not follow through on instructions and fails to finish school work, chores, or work (but not oppositional and not because of a failure to understand); 5) Often has difficulty organizing tasks and activities; 6) Often avoids or strongly dislikes tasks requiring sustained mental effort; 7) Often loses things necessary for tasks or activities; 8) Often easily distracted by extraneous stimuli; and 9) Often forgetful in daily activities.

2. Predominantly Hyperactive-Impulsive Type (314.01) - Must have four or more of the following symptoms: 1) Often fidgets with hands or feet or squirms in seat; 2) Often leaves seat in classroom; 3) Often runs about or climbs excessively (For teenagers and adults: may be limited to feelings of restlessness); 4) Often has difficulty playing quietly; 5) Often blurts out answers to questions too soon; 6) Often has difficulty waiting in line or waiting for turn.

3. Combined Type (314.01) - Both inattentive and hyperactive/impulsive symptoms are present.

4. ADHD Not Otherwise Specified, NOS (314.9) – Criteria for above types not met, but performance is affected by symptoms.

B. Requirements - To qualify for the diagnosis of ADHD, the following criteria must be met: 1) Onset of symptoms no later than seven years of age; 2) Symptoms must be present in two or more situations; 3) There must be clinically significant distress or impairment in social, academic, or occupational functioning; 4) Condition can not be exclusively part of a Pervasive Developmental Disorder, Schizophrenia, or other psychotic disorder, and is not better accounted for by a disorder of mood, anxiety, dissociation, or personality.

III. Causes of Off-Task Behavior

The role of the screener is to determine whether there are sufficient off-task problems to warrant referral for a clinical assessment. There are many different possible causes of off-task behavior, and all of them can be confused with ADHD. It is the role of the clinician to determine which cause or causes are important in a particular case and to design an appropriate treatment program. The different causes of off-task behavior include:

A. Normal ("active alert" children)
B. General medical problems, including hypothyroidism and anemia
C. Medications that sedate or slow the brain, including anticonvulsants and tranquilizers
D. Toxic conditions and illness
E. Sensory deficits and hypersensitivities
F. Neurologic problems, including Traumatic Brain Injury (TBI) and sleep disorders
G. Family chaos and disorganization
H. Lack of school readiness, difficult learning style, and poor motivation
I. Stress
J. Intellectual impairment and precocity
K. Learning disabilities
L. Psychiatric conditions
M. Substance use, abuse, and withdrawal, including caffeine, tobacco, and alcohol
N. Behavior disorder, impulsivity, and oppositional/defiant
O. Disorders of attention (ADD), including ADHD

These causes are not mutually exclusive. 30% of individuals with ADD (including adults) have a learning disability (and visa-versa), and between 40-65% of substance abusers have ADD. In addition, untreated individuals with ADD usually develop low self-esteem and depression.

IV. Screening for ADD

The possibility of ADD should be considered with underachieving students and adults, whether or not their behavior is disrupting or disrupted.

Screening procedures vary considerably, depending on the setting, but generally include:

A. A history to determine whether the person has ADD behaviors like inattention, etc.
B. A behavior rating generally by the classroom teacher or a self-rating by an adult (and/or significant other).
C. A visual T.O.V.A. and/or an auditory T.O.V.A.-A.

V. Diagnosis of ADD

A clinician decides which of the following components of a diagnostic workup for ADD to use: A. History, B. Physical and screening neurological exam, C. Psychological/neuropsychological evaluations, D. Evaluation of classroom/work place behavior and performance, E. Mental status examination/ personality assessment, F. Structured interviews, G. Behavior ratings, H. Self-ratings, I. Symptom behavior check lists (DSM IV) , and J. Continuous performance tests (CPTs): T.O.V.A. and T.O.V.A.-A..

Note: A comprehensive work-up that includes all or most of the components above is not feasible or cost-effective. Each clinician must decide which steps are needed and in what sequence.

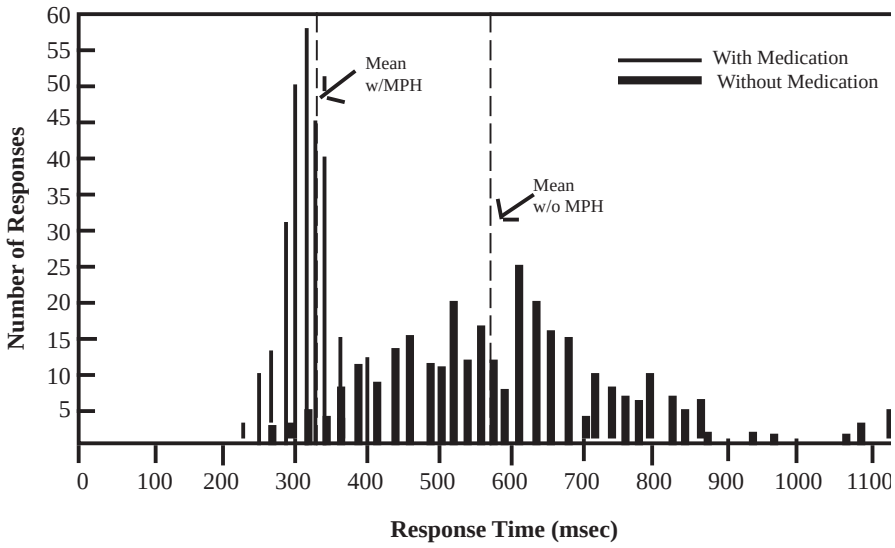
The T.O.V.A.s do not make diagnoses. Instead, they are tests that measure certain aspects of visual and auditory attention under very specific conditions. They measure attentional characteristics that can be affected by any number of contributing factors.

VI. Neurophysiological basis of Attention Deficits

The assumption that there is a neurological basis to that attentional disorder called ADHD is supported by many studies, including those with the T.O.V.A.s, that demonstrate a significant relationship between the diagnosis of ADHD and abnormal attentional processes.

Thus, we assume that ADHD, with or without hyperactivity, has a neurologically based attentional disorder.

The figure on the right illustrates the underlying neurophysiological problem in ADD, and illustrates the usefulness of the T.O.V.A.s in documenting response to medication.



The effects of 5 mg of methylphenidate (Ritalin or MPH) on the T.O.V.A.s of a physician with an attention deficit disorder (ADD) are represented. Shown are the mean response times (RT) or speed with which he correctly responded or reacted to the visual target. The mean RT of 580 $\pm$150 milliseconds in the test without medication (bold lines) is signifianctly slower than normal for an adult. Indeed, 580 msec is normal for six year old boys with average IQs. In contrast, the mean RT of 340 msec in the test given 1.5 hours after 5 mg of MPH (thin lines) is normal for an adult. Thus, a person with ADD can process infromation faster, more consistently, and more accurately with medication.

VII. The T.O.V.A.s

A. History

Rosvold introduced the CPT in the mid-50's. His CPT was a sequential, visual, language based A-X task in which the subject responded whenever they saw an "A" followed by a "X." Since that time, many CPTs have been created primarily for use in research projects, but only a few have been made available commercially for researchers,

schools, and clinicians. Only the T.O.V.A.s have been extensively normed and used.

The T.O.V.A. began as a large electronic rack with a tachistoscopic shutter in our first clinical study of what was then called the Hyperkinetic Reaction of Childhood in 1966. It was nicknamed "Herman" by one of the children. With an accuracy of ± 100 ms, the CPT results were significant and documented the efficacy of a psychostimulant (dextroamphetamine) in comparison with a tranquilizer (chlorpromazine) in the treatment of hyperkinetic children. It is noteworthy that the classroom behavior rating (the Conners' Parent-Teacher Questionaire) was not useful in discriminating medication effects. Perhaps the most important outcome of this initial study was the necessity to target inattention and hyperactivity separately and to develop appropriate tools to measure each.

With the advent of the Apple IIe in the late 70's, the current design (with two test conditions, see below) and the electronic microswitch were created and initially named the "MCA" (or Minnesota Computer Assessment). However, a potential copyright conflict arose, and the MCA became the Test Of Variables of Attention (T.O.V.A.) As the T.O.V.A., it was normed and used in a number of clinical trials before its release in the mid-80's.

Since then, we have continued to upgrade the test by making it more user friendly, collecting additional subjects to have year by year norms for children, and adding signal detection indices for a comparison ADHD Score. The School Intervention Report and Version 7.0 with an improved scoring and interpretation system were completed in 1996 when the T.O.V.A.-A., the auditory version, was released. The latest version (7.3) was released early in 2007.

B. T.O.V.A. Variables

Fourth generation CPTs, like the T.O.V.A.s, accurately measure far more significant variables of both auditory and visual information processing than the earlier CPTs. Length of the test (or subtest) makes a big difference since some individuals with ADD can "rise to the occasion" and do well enough for a short time. Different CPTs may label these variables somewhat differently, making comparisons difficult. It is also true that even when variables have the same labels, the characteristics of the different CPTs may be so different that they are actually measuring very different things. Of course, the variables also have different values within a CPT when there are two or more test conditions such as infrequent and frequent target presentation modes or when the interstimulus interval changes. In addition, we must keep in mind that labeling something doesn't mean that the variable is actually measuring what we think that it's measuring. The important CPT variables (all of which are in the T.O.V.A.s) are:

1. **Response Time Standard Deviation** is considered to be a measure of **variability** or **inconsistency** and is the standard deviation of correct response times. Individuals with ADD are inconsistent- they can perform within normal limits for a while, but they "lose it" much sooner than the non-impaired. As parents frequently note, a child with ADD can focus and stay on task some times, particularly when the task is very interesting and fast paced (like Saturday morning TV). Since this is the single most important measure of the T.O.V.A. s (accounting for 80% of the variance), the timing measurements must be very accurate; hence, the need for an electronic microswitch rather than rely on the significantly less accurate mouse button or keyboard.

2. **Correct Response Time** is the processing time (in ms) that it takes to respond correctly to a target. Counter-intuitively, individuals with ADD often have slower than normal response times, rather than faster ones. This measure is one of the more important ones in the T.O.V.A., especially in the first (or boring) half.
3. **d' or Response Sensitivity** (the ratio of hit rate to false alarm rate) is a measure derived from Signal Detection Theory. It is considered to be a measure or performance decrement, the rate of deterioration of performance over time. d' does help to distinguish non-impaired individuals from those with ADD.

4. **Errors of Commission** are considered to be a measure of **impulsivity** and/or **disinhibition** and occur when the subject incorrectly responds to the non-target; that is, the subject pushes the button

when they shouldn't have. In the T.O.V.A. s, commission errors are far more frequent in the second half (high response mode) even in non-impaired individuals. Since excessive errors of commission affect the other variables, they are also an important measure of test validity. Generally, excessive commission errors decrease omission errors, shorten response times, and increase variability.

5. **Errors of Omission** are considered to be a measure of **inattention** and occur when the subject does not respond to the designated target; that is, the subject omits pressing the button when a target appears. Because the T.O.V.A.s cover a broad age span (4-80+), omissions in the visual (but not auditory) version have a ceiling effect in adults. That is, the task is too easy for non-impaired adults who make no omission errors. On the other hand, omission errors are a sensitive measure in children, teenagers, and the elderly. Excessive omissions appear to indicate nonspecific neurological immaturity or dysfunction.

6. **Anticipatory Responses** are a measure of **guessing** which stimulus is presented or of a different **game strategy** in which the subject is trying to "kill" any stimulus as soon as possible. An anticipatory response is any response to a stimulus (target or non-target) that occurs within the 150 ms of the appearance of the stimulus (that is, before any one could distinguish target from non-target). Since these responses are guesses (even if they happen to be correct guesses), they are not included in the calculations of errors, response times, and variability. Since excessive anticipatory responses affect the other variables, they are also an important measure of test validity. Generally, excessive anticipatory responses decrease omission errors and commission errors, shorten response times, and increase variability. As will be noted later, some individuals process information and respond so much faster that they have excessive anticipatory responses but their responses are correct ones.

7. **Post-Commission Response Time** is the response time immediately following a commission error (mistakenly impulsively pressing the button when a non-target appears). Clinical observations (but not carefully conducted research) indicate the most people (including individuals with ADD and ADHD) recognize when they make a commission error, and slow down for the next response. It is noteworthy that a group of **conduct disordered** youngsters (without ADD) either did not slow down or actually responded faster than their average response time. Thus, this may be a way to distinguish individuals with ADD only from individuals with a conduct disorder only, but not the comorbid condition.

8. **Multiple Responses** are considered to be a reflection of **neurological status**. Excessive multiple responses (>20/test) do not alter or invalidate the other variables, but they do appear to indicate nonspecific neurological immaturity or dysfunction.

C. Significant T.O.V.A. Characteristics

1. Stimuli

a. Visual and auditory modes both need to be studied since there can be problems with auditory and/or visual information processing. (Most CPTs are only visual.)

b. Non-language based stimuli minimize the potential confounding of the results by learning, cultural effects, and co-existing learning disabilities.

c. Non-sequential or "go/no-go" design

1) The visual T.O.V.A. uses two geometric figures, one of which is the target and the other is the non-target:

Target Non-Target

2) The auditory T.O.V.A.-A. uses two tones: the higher tone (middle G, 392.0 H_z) is the target, the lower note (middle C, 261.6 H_z) is the nontarget.

2. Practice vs novelty effects

The more complex CPTs can have significant practice effects, limiting their use as repeated measures. In contrast, the T.O.V.A.s actually have a small novelty effect—there are non-significant commission error changes (increases) in the first half of the second test but not thereafter. Thus, the T.O.V.A.s can be used as serial measures even in the same morning.

3. Norms

a. The number of subjects per cell - The T.O.V.A. and T.O.V.A.-A. were normed with 1664 and 2680 individuals, respectively. In contrast, most other CPTs have been introduced with grossly inadequate or even no norms.

b. Sample characteristics - Unlike the T.O.V.A.s' very carefully selected controls with no co-morbidity, other CPTs tend to have inadequately defined and mixed samples.

c. Controlled variables

1) Age - Since attentional variables significantly change from birth to the late teens, year by year norms are necessary for accurate screening and diagnosis.

2) Gender - Since males and females generally have significantly different norms, it is necessary to have samples of each in the norms.

3) IQ - IQ may co-vary with CPT performance and is an especially important screening and diagnostic consideration since children with higher IQs may have "normal" T.O.V.A.s.

4) Test conditions - Time of day (mornings only for T.O.V.A. s), etc., are important variables that can significantly affect performance on a CPT.

d. The norms for T.O.V.A. and T.O.V.A.-A. are presented in Appendices C & D.

D. Sensitivity and specificity

1. The sensitivity of a test is its ability to correctly identify true cases (or, for the T.O.V.A.s, to identify ADHD); the higher the sensitivity, the fewer false negatives (missing cases of ADHD).

2. The specificity of a test is its ability to correctly identify normal individuals. The greater the specificity, there are fewer false positives (incorrectly concluding that a normal person has ADHD).

Classification By T.O.V.A. - Discriminant Analysis

Actual group	Normals	UADD
Normals (n = 29)	90%*	10%
UADD (n = 29)	21%	79%**

Overall Correctly Identified 84%

Actual group	Normals	ADHD
Normals (n = 73)	89%*	11%
ADHD (n = 73)	16%	84%**

Overall Correctly Identified 86%

(* = specificity, ** = sensitivity) (UADD = ADHD without hyperactivity)

The results, using Receiver Operator Characteristic analysis, a more conservative technique, are:

Sensitivity and Specificity of T.O.V.A.
Receiver Operator Characteristic Analysis

Sensitivity of 0.80	False negatives = 20%
Specificity of 0.80	False positives = 20%

Cut-off score of 1.8

Thus, there is an 80% chance that a T.O.V.A. (with no other information about the individual) is correct. Of course, with additional relevant data (such as behavior ratings and history), the "hit" rate improves significantly.

E. Test-Retest Reliability

Test-retest results for 33 randomly selected normal children, 40 children with ADHD, revealed no significant differences (paired t-test) in T.O.V.A. variables. There was a non-significant tendency for commission errors to increase (worsen) during the first half of the test from first test to second test but not for subsequent tests.

F. T.O.V.A. formulas

The following formulas are used to calculate T.O.V.A. variables:

1. Errors of Omission (or Inattention) = $\frac{\text{\# Omissions*}}{\text{\# Targets - \# Target A.R.**}}$ X 100

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

2. Errors of Commission (or Impulsivity/Disinhibition) = $\frac{\text{\# Commissions*}}{\quad}$ X 100

Nontargets - # Nontarget A.R.**

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

3. Response Time (msecs) = $\frac{\text{Raw Score* - Mean Score}^1}{\text{Standard Deviation}^1}$

4.Correct Response Time Standard Deviation (or Variability) = $\frac{\text{Raw Score* - Mean Score}^1}{\text{Standard Deviation}^1}$

* from protocol ** # Target or non target Anticipatory Responses from protocol [1]from norms table

5. Calculating D Prime (d')

A. 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).

B. Calculate the Hit Rate and the False Alarm Rate:

$$\text{Hit Rate} = 1 - \left(\frac{\text{Omission Percentage}}{100}\right)$$

$$\text{False Alarm Rate} = \left(\frac{\text{Commission Percentage}}{100}\right)$$

- 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

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

pHit Rate = 1 - (Hit Rate)
pFalse Alarm Rate = 1 - (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)

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

If you have access to a spread sheet or statistical program:

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

Otherwise (*Ref 1*),

$$\text{Let } T = \left[\sqrt{\ln\left(\frac{1}{(\text{pHit Rate})^2}\right)}\right]$$

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

$$\text{Let } T = \left[\sqrt{\ln\left(\frac{1}{(\text{pFalse Alarm Rate})^2} \right)} \right]$$

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

- 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

E. Calculate D Prime:

D Prime = 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)

6. Standard Score = 100 - (Standard Deviation x 15)

If Std Dev is 1.1, Std Score is 83.5
If Std Dev is -1.1, Std Score is 116.5

7. T Score = 50 + (Standard Deviation x 10)

If Std Dev is 1.1, T Score is 61

8. If you manually calculate the results and compare them to the results from the T.O.V.A. Interpretation Program, you may find some significant differences. The Interpretation Program calculates to the fourth place beyond the decimal point and includes all the values in the quarter, half or total that is being analyzed and compares those results to the norms. Thus, the half values are not simply the average of the two quarters.

G. Construction of the T.O.V.A.s

The T.O.V.A.s consist of two subtests with an abrupt transition between them.

1. In the first half of the test (the "Infrequent" or vigilance mode), the target appears randomly and infrequently with a target : nontarget ratio of 1:3.5 The person presses the button once in a while during this quickly boring half. Easily bored ("low arousal") persons do poorly during this half.

2. In the second half of the test (the "Frequent" or high response mode), the target appears frequently with a target : nontarget ratio of 3.5:1. The person is usually pressing the button and must inhibit the tendency to respond. Easily overstimulated ("high arousal") persons do poorly.

3. Length of each subtest- 10.8 minutes.

H. Administering the T.O.V.A.s

1. Training of both professionals and nonprofessionals to administer and monitor the test should follow the general outline of the instructions and include the use of the T.O.V.A Rating Form for recording observations that may be helpful to the clinician. In general, we want the subject to balance speed and errors- to be as fast as they can be, yet to minimize errors.

2. T.O.V.A.s should be administered in the mornings to match norms and to minimize diurnal variability which can significantly affect test performance. When comparing two tests it is

especially important that they have been given at the same time of day (that is, both in the morning or, if necessary, the afternoon.) If the T.O.V.A. is part of a battery of tests, it is important to administer it first- before the subject is fatigued or bored. If both T.O.V.A.s are to be administered, a sufficient time (more than 1.5 hours) should elapse between the tests to enable the subject to rest up.

3. The norms were obtained with an observer present at all times in the room with the subject. Research has shown that the observer's presence makes a significant difference even though they are not interacting with the subject. Test performances by children and adults can be significantly worse when the observer is not present.

4. When testing for the first time, the practice test should be given in its entirety. For subsequent testing, 30-90 seconds of practice should be sufficient to remember the task.

5. Although prompting is helpful in the practice test, it is not used during the actual testing unless necessary since prompting was not given for the norms.

6. The T.O.V.A Rating Form (Appendix B) can be used to record observations during testing. This form is not copyrighted so that it can be duplicated and used as needed.

2. Interpreting the Screening Report

I. IQ Considerations

IQ and CPT performance appear to co-vary. Although the research literature is not definitive, many clinicians factor in IQ when interpreting T.O.V.A. performance. In general, a person with an above average IQ would be expected to perform better than average on a CPT. Conversely, someone with a lower than average IQ would be expected to perform less than average on a CPT.

II. T.O.V.A. Report

The report contains six forms and the optional School and Home Intervention Reports. (Note: remarks specific for the case illustration [subject # 0020] are underlined.)

A. Cover page

1. A brief description of the T.O.V.A. is given for those who have not used it before.

2. A brief note is given to remind the reader that there are false positives and negatives, and that clinicians use more than just the T.O.V.A. for diagnosis and treatment.

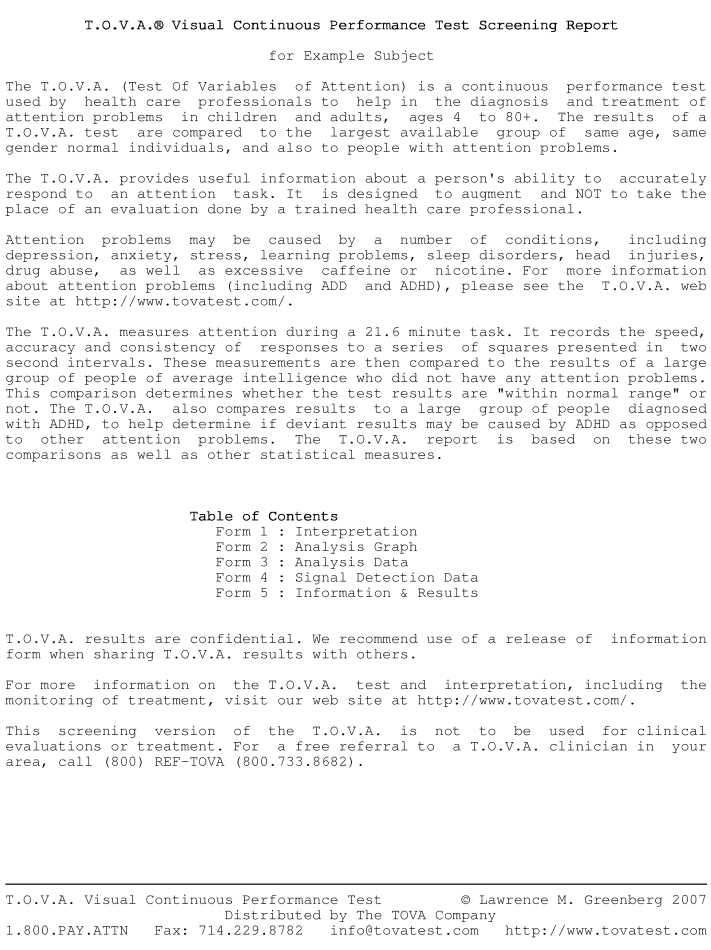
3. The table of contents is given to facilitate finding the necessary information.

4. The following two statements will appear:

This Screening Version of the T.O.V.A. is not to be used for clinical evaluations or treatment.

For a free referral to a T.O.V.A. clinician in your area, please call 800-REF-TOVA.

5. There is an advisory note: T.O.V.A. results are confidential. We recommend use of a release of information form when sharing T.O.V.A. results with others.



T.O.V.A.® Visual Continuous Performance Test Screening Report

for Example Subject

The T.O.V.A. (Test Of Variables of Attention) is a continuous performance test used by health care professionals to help in the diagnosis and treatment of attention problems in children and adults, ages 4 to 80+. The results of a T.O.V.A. test are compared to the largest available group of same age, same gender normal individuals, and also to people with attention problems.

The T.O.V.A. provides useful information about a person's ability to accurately respond to an attention task. It is designed to augment and NOT to take the place of an evaluation done by a trained health care professional.

Attention problems may be caused by a number of conditions, including depression, anxiety, stress, learning problems, sleep disorders, head injuries, drug abuse, as well as excessive caffeine or nicotine. For more information about attention problems (including ADD and ADHD), please see the T.O.V.A. web site at http://www.tovatest.com/.

The T.O.V.A. measures attention during a 21.6 minute task. It records the speed, accuracy and consistency of responses to a series of squares presented in two second intervals. These measurements are then compared to the results of a large group of people of average intelligence who did not have any attention problems. This comparison determines whether the test results are "within normal range" or not. The T.O.V.A. also compares results to a large group of people diagnosed with ADHD, to help determine if deviant results may be caused by ADHD as opposed to other attention problems. The T.O.V.A. report is based on these two comparisons as well as other statistical measures.

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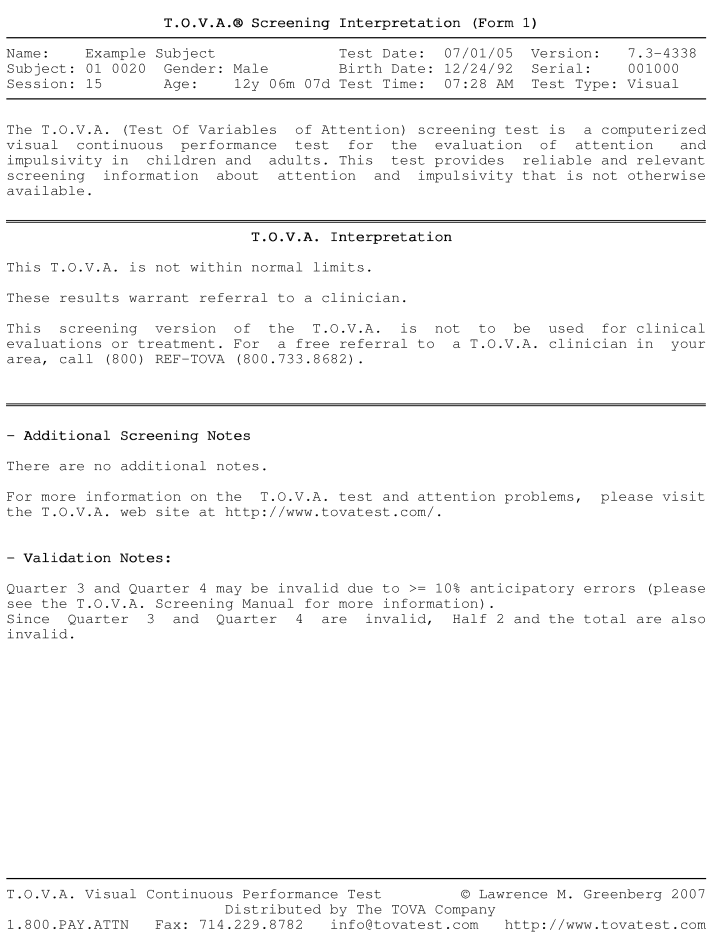
T.O.V.A. results are confidential. We recommend use of a release of information form when sharing T.O.V.A. results with others.

For more information on the T.O.V.A. test and interpretation, including the monitoring of treatment, visit our web site at http://www.tovatest.com/.

This screening version of the T.O.V.A. is not to be used for clinical evaluations or treatment. For a free referral to a T.O.V.A. clinician in your area, call (800) REF-TOVA (800.733.8682).

B. Form 1, T.O.V.A. Interpretation

This interpretation compares the subject's performance with the performances of normal individuals of average IQ, matched for age and gender. If the subject's performance is significantly deviant from the norm, it means that this person performed as though there were an attention problem. They were significantly off-task, impulsive, slow to respond, and/or inconsistent (variable speed of response), but there is no etiologic specificity to this interpretation. A poor performance could be the result of many very different factors as noted in Section 1, III.



T.O.V.A.® Screening Interpretation (Form 1)

Name: Example Subject Test Date: 07/01/05 Version: 7.3-4338
Subject: 01 0020 Gender: Male Birth Date: 12/24/92 Serial: 001000
Session: 15 Age: 12y 06m 07d Test Time: 07:28 AM Test Type: Visual

The T.O.V.A. (Test Of Variables of Attention) screening test is a computerized visual continuous performance test for the evaluation of attention and impulsivity in children and adults. This test provides reliable and relevant screening information about attention and impulsivity that is not otherwise available.

T.O.V.A. Interpretation

This T.O.V.A. is not within normal limits.

These results warrant referral to a clinician.

This screening version of the T.O.V.A. is not to be used for clinical evaluations or treatment. For a free referral to a T.O.V.A. clinician in your area, call (800) REF-TOVA (800.733.8682).

- Additional Screening Notes

There are no additional notes.

For more information on the T.O.V.A. test and attention problems, please visit the T.O.V.A. web site at http://www.tovatest.com/.

- Validation Notes:

Quarter 3 and Quarter 4 may be invalid due to >= 10% anticipatory errors (please see the T.O.V.A. Screening Manual for more information).
Since Quarter 3 and Quarter 4 are invalid, Half 2 and the total are also invalid.

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1.The top section contains the demographic data, including name, birth date, age, gender, subject #, session #, test date, test time, test serial #, test version #, form #, and tester. Note: only Test Forms #1 [IIFF] and #6 [IF] are standardized.

2. The T.O.V.A. Interpretation statement will be that:

The results are within normal limits.
or
Overall, this T.O.V.A. is suggestive of an attention problem.

The test results (see Form 3) are (or are not) within normal limits, and the ADHD Score (see Form 4) is (or is not) within normal limits.

The Screening Version is worded this way to avoid any diagnostic term or statement that could become a liability problem for non-clinicians, non-health care professionals, and schools using the T.O.V.A.

<u>For subject 0020, the ADHD Score could not be calculated because of invalid quarters.</u>

3. The Additional Interpretation Notes section may contain additional notes.

4. The Validation Notes section notes whether any of the quarters were invalid and why.

<u>For subject 0020, quarters 3 and 4 may be invalid due to ≥10% Anticipatory Error. As explained in C. 4. below, quarter 3 is invalid and quarter 4 is valid. Thus, we do not include the variables in quarter 3 in our interpretation of this protocol. Since quarter 3 is invalid, half 2 and the total are also invalid.</u>

5. Occasionally, when one or more quarters are invalid, the remaining (valid) quarters may be within normal limits. Thus, the protocol would be interpreted as within normal limits. When this happens, a statement will be made that the invalid quarter(s) may have been the result of an attention problem, and the interpretation should be viewed cautiously.

C. Form 3, T.O.V.A. Analyzed Data

1. The demographic data are presented first- name, birth date, age, gender, subject #, session #, test date, test time, test serial #, test version #, form #, tester.

2. The brief description of table that follows explains that the table contains the analyzed data, organized by quarters, halves, and total results, using standard scores and standard deviations.

3. The following interpretation codes are used in this table:

Interpretation Codes	
[ ] = invalid	* = significantly deviant result
! ! = excessive commission errors	b = borderline result

a. [ ] means that cell can not be assumed to be valid without checking Form 5.

Subject 0020 has brackets on all cells in quarters 3 and 4. Thus, quarters 3 and 4 must be interpreted cautiously. (See 4. c. below)

b. ! ! means that there were excessive Commission Errors in that cell, and that the other variables can not be considered valid although Commissions are valid.

Subject 0020 has no excessive Commission Errors.

c. * means that the results are valid and significant (compatible with an attention problem).

Subject 0020 has a number of cells with *, indicating that the protocol is not within normal limits and is compatible with an attention problem.

d. b means that the results are valid and borderline significant.

For subject 0020 there is one cell (commission errors in quarter 1) with a b in the protocol.

T.O.V.A.® Screening Analyzed Data (Form 3)

Name: Example Subject Test Date: 07/01/05 Version: 7.3-4338
Subject: 01 0020 Gender: Male Birth Date: 12/24/92 Serial: 001000
Session: 15 Age: 12y 06m 07d Test Time: 07:28 AM Test Type: Visual

These results, compared to the normal same-gender, same-age, and average intelligence group, are reported as standard deviations (std dev) and standard scores (std scores). The higher (more positive) the score, the better. Std devs and std scores indicate the deviance from the norm (e.g., the extent of a problem). Normal results for std devs are -1.00 or higher (more positive) and normal results for std scores are 85 or higher. Note: 1 std dev = 15 std score points.

Analysis Table	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Half 1	Half 2	Total
RT Variability msec	120	148*	[132]	[171]	138b	[156]	[154]
Std Deviation (Z)	-0.99	-1.39*	[-0.92]	[-1.54]	-1.23b	[-1.36]	[-1.37]
Standard Score	85	79*	[86]	[76]	81b	[79]	[79]
Response Time msec	369	442	[302]	[363]	401	[333]	[350]
Std Deviation (Z)	0.74	-0.10	[1.02]	[0.04]	0.35	[0.55]	[0.48]
Standard Score	111	98	[115]	[100]	105	[108]	[107]
d' (DPrime)	3.66	2.66	[1.69]	[1.27]	2.93	[1.45]	[2.46]
Std Deviation (Z)	-1.92	-2.60	[-2.16]	[-2.08]	-2.21	[-2.21]	[-2.21]
Standard Score	71	60	[67]	[68]	66	[66]	[66]
Commission Errors	3.97%b	2.38%*	[36.00%	[45.16%	3.17%*	[41.07%	[10.06%
Std Deviation (Z)	-1.11b	-1.62*	[-1.29]	[-1.51]	-1.45*	[-1.57]	[-1.31]
Standard Score	83b	75*	[80]	[77]	78*	[76]	[80]
Omission Errors	2.86%	25.00%*	[9.18%]	[12.62%	14.08%*	[10.95%	[11.76%
Std Deviation (Z)	-0.78	<-4*	[<4]	[<4]	<-4*	[<4]	[<4]
Standard Score	88	<40*	[<40]	[<40]	<40*	[<40]	[<40]

[ ] = Invalid b = Borderline result * = Significantly Deviant Result

The T.O.V.A. test results (below) are a quarter by quarter analysis of the test. These results, in combination with the ADHD Score (below and on Form 4) determine the T.O.V.A. Interpretation (see Form 1).

Test Results	B	*	*	*	*	*	*

Test Results Key: N = Within normal limits assuming average intelligence
* = Not within normal limits B = Borderline ? = Not interpretable

ADHD Score = [-3.23]
Note: The ADHD Score must be interpreted cautiously because of invalid quarters.

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4. The following are the Validity Measures:

a. Tests obtained after 1:00 pm

These tests are technically considered invalid because of possible diurnal effects on attention. However, for a minority of individuals with different diurnal patterns, afternoon testing would be valid.

b. User interrupts

The tester can interrupt the test and restart it at the same place should that be necessary. However, the remainder of an interrupted test would be considered invalid since the norms would not strictly apply.

c. Excessive Anticipatory Responses (≥10%/quarter)

These errors may invalidate all of the variables in that quarter since very rapid and responses tend to decrease Omissions and Response Time and increase Commissions and Variability.

To determine whether a quarter with excessive anticipatory responses is invalid, review the Results Table (Form 5).

In quarters 1 and 2, if the ratio of non targets to targets is >3.5, the quarter is considered invalid. (Conversely, if the ratio of non targets to targets is <3.5, the quarter is considered valid.

In quarters 3 and 4, if the ratio of non targets to targets is > 1:3.5, the quarter is considered invalid. (Conversely, if the ratio of non targets to targets is <1:3.5, the quarter is considered valid).

<u>For subject 0020, the ratio of non targets to targets in quarters 3 and 4 are 11:28 and 5:23, respectively. Therefore, we consider quarter 3 invalid and do not include the variables in our interpretation of the protocol. However, quarter 4 is valid, and we include the variables in our interpretation</u>.

T.O.V.A.® Screening Information and Results (Form 5)

Name: Example Subject Test Date: 07/01/05 Version: 7.3-4338
Subject: 01 0020 Gender: Male Birth Date: 12/24/92 Serial: 001000
Session: 15 Age: 12y 06m 07d Test Time: 07:28 AM Test Type: Visual

Medication	Dosage	Med-Test Interval
Challenge:	0.00 mg	0.0 hours
Med. #2:	0.00 mg	0.0 hours
Med. #3:	0.00 mg	0.0 hours

Weight: 0.0 lbs Height: 0 in.

Tester:
ISI: 2000 msec Ontime: 0200 msec Offtime: 0300 msec Anticipatory: 0150 msec
Test Format: 1(Std) Test Version: 7.2B9 Test Serial: 16295

Results Table (Tabulated Raw data)	Quarter 1	2	3	4	Half 1	2	Total
RT Variability msec	120	148	132	171	138	156	154
Response Time msec	369	442	302	363	401	333	350
D Prime	3.66	2.66	1.69	1.27	2.93	1.45	2.46
Commission Errors %	3.97%	2.38%	36.00%	45.16%	3.17%	41.07%	10.06%
(Impulsivity) #	5	3	9	14	8	23	31
Omission Errors %	2.86%	25.00%	9.18%	12.62%	14.08%	10.95%	11.76%
(Inattention) #	1	9	9	13	10	22	32
Anticipatory Resp.s %	0.62%	0.00%	24.07%	17.28%	0.31%	20.68%	10.49%
Nontargets #	0	0	11	5	0	16	16
Targets #	1	0	28	23	1	51	52
Multiple Responses #	0	0	9	3	0	12	12
Correct Responses #	34	27	89	90	61	179	240
Correct Nonresp.s #	121	123	16	17	244	33	277
Post-Commissions #	5	3	9	13	8	22	30
Response Time msec	326	409	297	349	357	328	336
Variability msec	59	47	123	116	68	122	111
User Interrupts	0	0	0	0	0	0	0
Hardware Errors	0	0	0	0	0	0	0

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d. Excessive Commission Errors

These errors may invalidate the other variables (but not Commissions) in that quarter since the rapid and additional responses tend to decrease Omissions and Response Time and increase Variability.

<u>Excessive Commission Errors</u>

<u>T.O.V.A. (Visual)</u>

Age	Quarters 1 or 2	Quarters 3 or 4
4-5 years old	≥20%	≥70%
6-12 years old	≥10%	≥60%
13+ years old	≥10%	≥50%

<u>T.O.V.A.-A. (Auditory)</u>

Age	Quarters 1 or 2	Quarters 3 or 4
6-7 years old	≥20%	≥60%
8-12 years old	≥10%	≥60%
13+ years old	≥10%	≥50%

e. Excessive Omission Errors (≥ 90%/quarter) These errors invalidate the entire quarter since there are too few responses to be a sufficient sample. Generally, it means that the subject stopped responding or, less commonly, that the Microswitch malfunctioned.

f. If Response Times = 0 ms
If this occurs, it means that there were no recorded correct responses. That quarter would be considered invalid.

Note: If any quarter is invalid, then the corresponding half and the total scores are also invalid.

6. Reading the Analysis Table

a. We first examine the totals for significant findings.

For subject 0020, the totals are invalid since quarter 3 is invalid.

b. We then examine and compare halves to determine whether there are significant findings and their implications.

1) Half 1 -

This is the more boring task, and the "under aroused" have difficulty maintaining attention and control. If this half is deviant, one should consider increasing toward-task stimulation, decreasing time on-task, introducing activity, etc.

2) Half 2

This is the active or high response task, and the "over stimulated" have difficulty. Of course, everyone (normals included) tends to be faster and make many more Commission Errors than in half 1. If this half is deviant, one should consider decreasing distractions and pace, etc.

3) If both half 1 and 2 are significantly deviant –

If the person has difficulty with both halves, one should consider interventions for both conditions.

T.O.V.A.® Analyzed Data (Form 3)

Name: Example Subject Test Date: 07/01/05 Version: 7.3-4338
Subject: 01 0020 Gender: Female Birth Date: 12/24/92 Serial: N/A
Session: 15 Age: 12y 06m 07d Test Time: 07:28 AM Test Type: Visual

These results, compared to the normal same-gender, same-age, and average intelligence group, are reported as standard deviations (std dev) and standard scores (std scores). The higher (more positive) the score, the better. Std devs and std scores indicate the deviance from the norm (e.g., the extent of a problem). Normal results for std devs are -1.00 or higher (more positive) and normal results for std scores are 85 or higher. Note: 1 std dev = 15 std score points.

Analysis Table	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Half 1	Half 2	Total
RT Variability msec	120	148*	[132]	[171]	138b	[156]	[154]
Std Deviation (Z)	-0.99	-1.39*	[-0.92]	[-1.54]	-1.23b	[-1.36]	[-1.37]
Standard Score	85	79*	[86]	[76]	81b	[79]	[79]
Response Time msec	369	442	[302]	[363]	401	[333]	[350]
Std Deviation (Z)	0.74	-0.10	[1.02]	[0.04]	0.35	[0.55]	[0.48]
Standard Score	111	98	[115]	[100]	105	[108]	[107]
d' (DPrime)	3.66	2.66	[1.69]	[1.27]	2.93	[1.45]	[2.46]
Std Deviation (Z)	-1.92	-2.60	[-2.16]	[-2.08]	-2.21	[-2.21]	[-2.21]
Standard Score	71	60	[67]	[68]	66	[66]	[66]
Commission Errors	3.97%b	2.38%*	[36.00%	[45.16%	3.17%*	[41.07%	[10.06%
Std Deviation (Z)	-1.11b	-1.62*	[-1.29]	[-1.51]	-1.45*	[-1.57]	[-1.31]
Standard Score	83b	75*	[80]	[77]	78*	[76]	[80]
Omission Errors	2.86%	25.00%*	[9.18%]	[12.62%	14.08%*	[10.95%	[11.76%
Std Deviation (Z)	-0.78	<-4*	[<4]	[<4]	<-4*	[<4]	[<4]
Standard Score	88	<40*	[<40]	[<40]	<40*	[<40]	[<40]

[ ] = Invalid b = Borderline result * = Significantly Deviant Result

The T.O.V.A. test results (below) are a quarter by quarter analysis of the test. These results, in combination with the ADHD Score (below and on Form 4) determine the T.O.V.A. Interpretation (see Form 1).

Test Results	B	*	*	*	*	*	*

Test Results Key: N = Within normal limits assuming average intelligence
* = Not within normal limits B = Borderline ? = Not interpretable

ADHD Score = [-3.23]
Note: The ADHD Score must be interpreted cautiously because of invalid quarters.

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For Subject 0020, half 1 is deviant from the norm with significantly high commissions and omissions. Half 2 is invalid since quarter 3 is invalid.

c. We then compare quarters within and across halves.

1) If there is a significant change (worsening) within a half, we should consider the possibility of a short (5-6 minute) attention span in that kind of task or possibly a 12-15 minute attention span overall if the change is between quarters 3 and 4.

For Subject 0020, V, RT, d', C, and O all worsen from quarter 1 to quarter 2. V, d', C, and O become significantly deviant in quarter 2. After analyzing anticipatory errors and determining that quarter 4 is valid, we note that V, d', C, and O are all significantly deviant in quarter 4.

2) If it appears that quarter 3 is worse than quarter 4, look for a change-of-set problem at the beginning of quarter 3 by examining response by response option. This could be indicative of excessive obsessive-compulsive traits or anxiety.

3) If quarter 1 is worse than quarter 2, it could be indicative of excessive anxiety.

4) Look for game (or test taking) strategy influences or changes

For some individuals being fast is more important than making fewer errors, and visa-versa. Some persons will dramatically slow down to reduce errors in half 2 while others may speed up as if losing control.

5) If there is an absence of an apparent test taking strategy
Sometimes the protocol looks disorganized with no discernable consistency or pattern. It looks "crazy". It may reflect the presence of a significant mental illness or the performance of a strategist who changes strategy frequently to "beat" the test. It would be helpful to debrief the subject.

7. The Test Results are summarized below the results table.
N = normal * = deviant from normal B = borderline ? = not interpretable

For subject 0020, all cells but quarter 1 are either deviant or invalid.

8. The ADHD Score is then presented.

For subject 0020, the ADHD Score is [-3.23], and there is a note that the ADHD Score must be interpreted cautiously (since quarter 3 was invalid). If the ADHD Score was not invalidated, it would be interpreted as indicative of an attention problem.

D. Form 2, T.O.V.A. Analysis Graph

The analyzed data from Form 3 are presented in graphs.

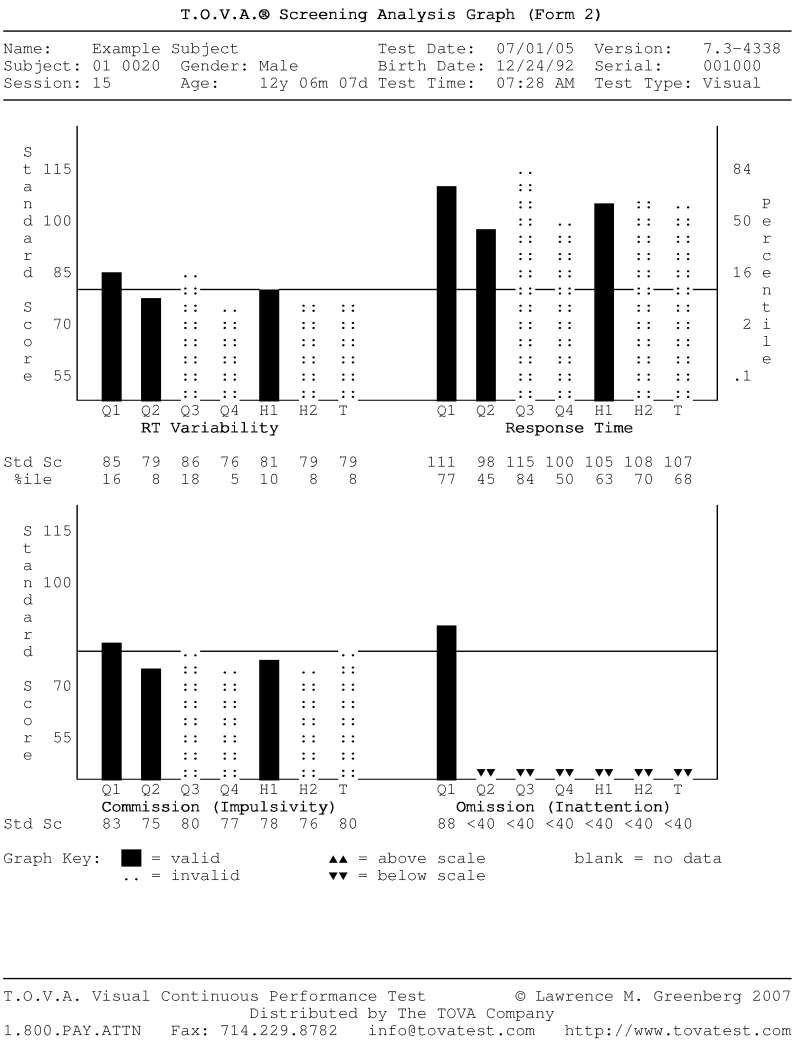
1. The top section contains the demographic data.

2. The graph presents T.O.V.A. results using standard scores and percentiles for Response Time Variability and Response Time, and standard scores for Commissions and Omissions. If the standard score is below the horizontal axis, it would not be displayed in the graph.

3. The "X" axis of the graph will be changed (up or down) automatically as necessary to allow sufficient room.

4. The normal range for standard score is 85-115, and any result below 80 (indicated by the dotted line) is considered significantly deviant, assuming average intelligence.

For Subject 0020, quarters 3 and 4, half 2, and total are labeled invalid. V, C, and O are significantly deviant in quarter 2 and half 1.



5. The results of four tests can be displayed side-by-side for comparisons of baseline (no medication) and on-medication tests, follow-up tests with previous tests, etc.

E. Form 4, T.O.V.A. Signal Detection Data

1. The first section contains the demographic data.

2. D Prime (d') is a measure of performance deterioration over time.

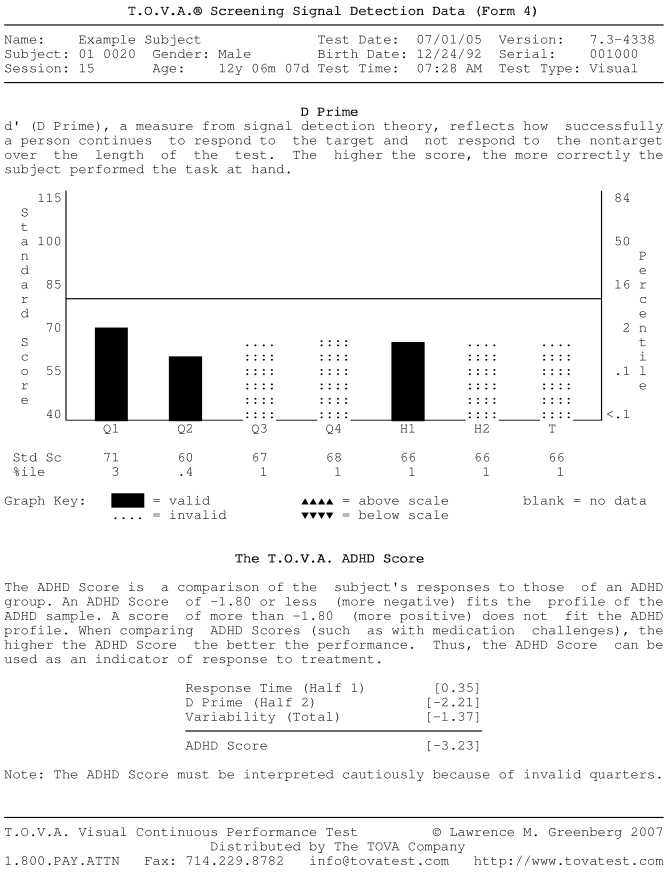
3. The Graph of D Prime is printed with standard scores and percentiles

As noted above, a standard score <80 is considered deviant from the norm, assuming average intelligence. If the standard score is below the horizontal axis, it would not be displayed on the graph.

<u>For subject 0020, d' is significantly deviant in quarters 1, 2, and 4 and half 1 and invalid in quarter 3, half 2, and total.</u>

4. The TOVA ADHD Score is then explained as a comparison of the subject's performance with an ADHD diagnosed group of individuals. Unlike the Interpretation (Form 1) that compares the subject's performance to a group of non-ADHD individuals by determining the degree of deviance from the norm, the ADHD Score describes how similar this subject's performance is to a group with ADHD.

5. The ADHD Score is determined as follows:



T.O.V.A.® Screening Signal Detection Data (Form 4)

Name: Example Subject Test Date: 07/01/05 Version: 7.3-4338
Subject: 01 0020 Gender: Male Birth Date: 12/24/92 Serial: 001000
Session: 15 Age: 12y 06m 07d Test Time: 07:28 AM Test Type: Visual

D Prime

d' (D Prime), a measure from signal detection theory, reflects how successfully a person continues to respond to the target and not respond to the nontarget over the length of the test. The higher the score, the more correctly the subject performed the task at hand.

	Q1	Q2	Q3	Q4	H1	H2	T
Std Sc	71	60	67	68	66	66	66
%ile	3	.4	1	1	1	1	1

Graph Key: ■ = valid .... = invalid ▲▲▲▲ = above scale ▼▼▼▼ = below scale blank = no data

The T.O.V.A. ADHD Score

The ADHD Score is a comparison of the subject's responses to those of an ADHD group. An ADHD Score of -1.80 or less (more negative) fits the profile of the ADHD sample. A score of more than -1.80 (more positive) does not fit the ADHD profile. When comparing ADHD Scores (such as with medication challenges), the higher the ADHD Score the better the performance. Thus, the ADHD Score can be used as an indicator of response to treatment.

Response Time (Half 1)	[0.35]
D Prime (Half 2)	[-2.21]
Variability (Total)	[-1.37]
ADHD Score	[-3.23]

Note: The ADHD Score must be interpreted cautiously because of invalid quarters.

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ADHD Score Formula

Z Score Response Time $_{\text{Half 1}}$
+ D' Z Score$_{\text{Half 2}}$
+<u>Z Score Variability</u>$_{\text{Total}}$
ADHD Score

5. Z Score = [Raw Score- Mean (norm group)]/ std dev (norm group).

6. **An ADHD Score -1.80 or less is not within normal limits. A score more than -1.80 is within normal limits.**

a. Less than -1.80 means -1.81 or a more negative number (like -1.89).

b. More than -1.80 means -1.79 or a more positive number (like -1.60 or 1.2).

<u>For Subject 0020, the ADHD Score of -3.23 is more negative than -1.80 and is not within normal limits. However, the ADHD Score is not valid since quarter 3, half 2 and total are invalid, making d' (half 2) and V (total) also invalid.</u>

Note: An ADHD Score more positive than -1.80 (like -1.60 or 1.2) is considered <u>inconclusive</u> and is not interpreted to mean that the subject does not have ADHD.

If the Interpretation (Form 1) is not within normal limits (that is, is deviant from the norm), and ADHD Score is not within normal limits, there is a high probability that the person has an attention problem.

If the Interpretation and the ADHD Score are within normal limits, there is a high probability that the person does not have an attention problem.

If the Interpretation is that the performance was deviant from the norm, but the ADHD Score was not significant, there is a high probability that the person has an attention problem.

Finally, if the Interpretation is that the performance was within normal limits, but the ADHD Score was significant, there is a high probability that the T.O.V.A. Interpretation represents a false negative, and that the person does have an attention problem. There are many reasons for a false negative result, including high IQ or the presence of an auditory rather than a visual attention problem and visa versa.

F. Form 5, T.O.V.A. Information and Results

This table contains the raw data, medication information (if any), and all of the validity measures.

1. The first section contains the demographic data.

2. Test data- tester, test format (#1 is the standard IIFF format for ages 6+; #6 is the IF format for 4-5 year olds), test version #, test serial #, ISI or InterStimulus Interval (2 seconds), (signal) On-Time (200 ms), (signal) Off-time (300 ms), and anticipatory response time (150 ms).

3. Medication data
The name of each medication, dosage, and med-test interval (the time between administering the medication and testing) are recorded for up to three medications.

T.O.V.A.® Screening Information and Results (Form 5)

Name: Example Subject Test Date: 07/01/05 Version: 7.3-4338
Subject: 01 0020 Gender: Male Birth Date: 12/24/92 Serial: 001000
Session: 15 Age: 12y 06m 07d Test Time: 07:28 AM Test Type: Visual

Medication	Dosage	Med-Test Interval
Challenge:	0.00 mg	0.0 hours
Med. #2:	0.00 mg	0.0 hours
Med. #3:	0.00 mg	0.0 hours

Weight: 0.0 lbs Height: 0 in.

Tester:
ISI: 2000 msec Ontime: 0200 msec Offtime: 0300 msec Anticipatory: 0150 msec
Test Format: 1(Std) Test Version: 7.2B9 Test Serial: 16295

Results Table (Tabulated Raw data)		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Half 1	Half 2	Total
RT Variability	msec	120	148	132	171	138	156	154
Response Time	msec	369	442	302	363	401	333	350
D Prime		3.66	2.66	1.69	1.27	2.93	1.45	2.46
Commission Errors	%	3.97%	2.38%	36.00%	45.16%	3.17%	41.07%	10.06%
(Impulsivity)	#	5	3	9	14	8	23	31
Omission Errors	%	2.86%	25.00%	9.18%	12.62%	14.08%	10.95%	11.76%
(Inattention)	#	1	9	9	13	10	22	32
Anticipatory Resp.s	%	0.62%	0.00%	24.07%	17.28%	0.31%	20.68%	10.49%
Nontargets	#	0	0	11	5	0	16	16
Targets	#	1	0	28	23	1	51	52
Multiple Responses	#	0	0	9	3	0	12	12
Correct Responses	#	34	27	89	90	61	179	240
Correct Nonresp.s	#	121	123	16	17	244	33	277
Post-Commissions	#	5	3	9	13	8	22	30
Response Time	msec	326	409	297	349	357	328	336
Variability	msec	59	47	123	116	68	122	111
User Interrupts		0	0	0	0	0	0	0
Hardware Errors		0	0	0	0	0	0	0

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a. Challenge medicine
Subject 0020 was not given a challenge medication.
Leave blank if not conducting a challenge test. If not left blank, the report will have medication notations on several pages even if the recorded medication is "none".

b. Med #2 and #3 : Subject 0020 was not taking any medication.
Although these spaces are generally for a psychoactive medication (that is, a medication that has an effect on the brain and on attention [and, therefore, on the T.O.V.A.]), other medications, like antibiotics, can also be entered here.

A clinician will need to determine what effects the medication(s) may have had on the T.O.V.A. results.

4. Weight and height are optional.
5. Results Table

The reported variables for each quarter, half and total are: Response Time Variability (ms), Response Time (ms), d prime, Commissions (%,#), Omissions (%,#), Correct Responses (%,#), Anticipatory Responses (%, # non targets and # targets), Multiple Responses (#), User Interrupts (#), Hardware Errors, and Post-Commission Response Time (#).

6. The Interpretation Program checks each validity measure to determine whether the quarters, halves and total are valid.

Validity Measures
Time of test
Test version
Omission %/quarter
Commission %/quarter
Response Time (ms)/quarter
Anticipatory Responses %/quarter
User Interrupt
Hardware Error

G. Response by Response Option.

1. This option allows the examination of each response throughout the test. It can be viewed on screen or printed out as needed.

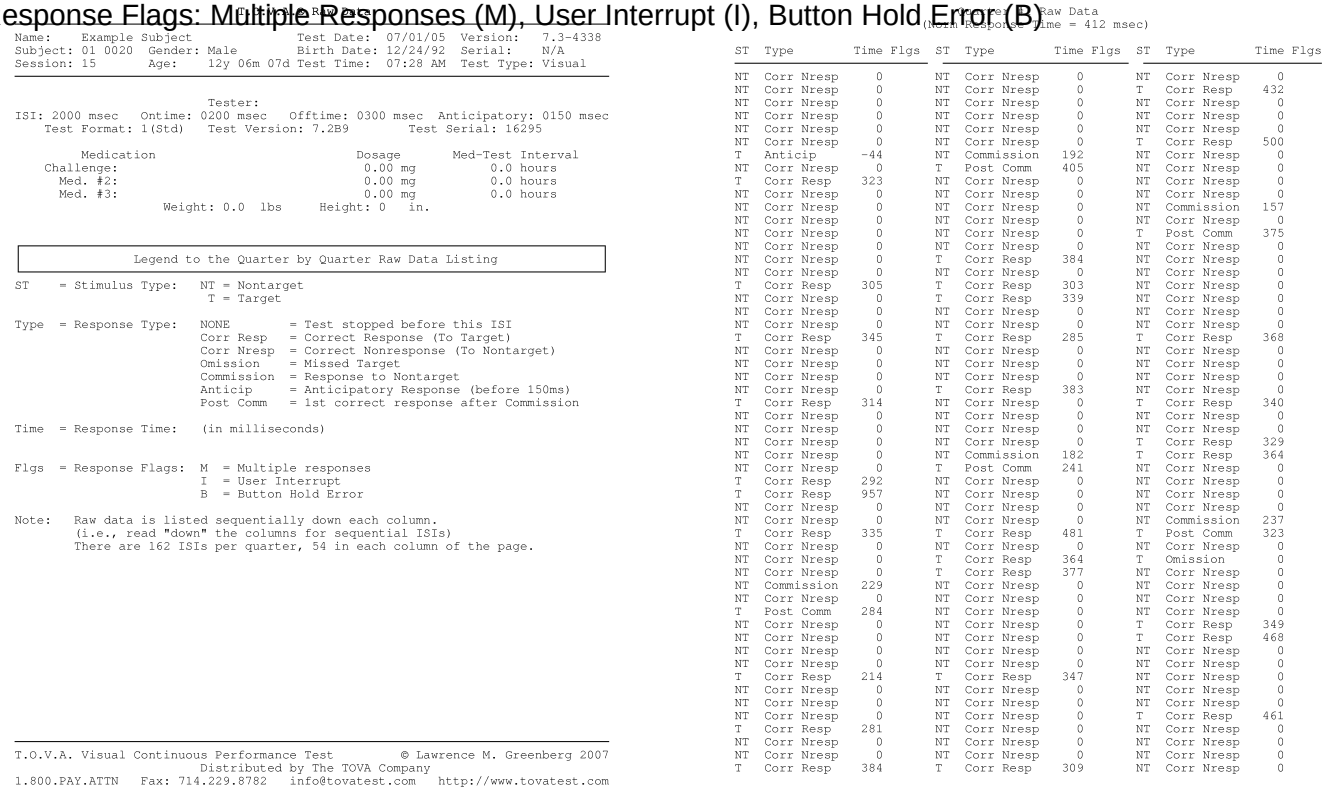
2. The four columns of information are:

a) Stimulus Type: Target (T) or non-target (NT)

b) Response Type: None, Correct Response (Corr Resp), Correct Non-Response (Corr Nresp), Omission, Commission, Anticipatory Response (Anticip), and Post-Commission Response (Post Comm)

c) Response Time (ms)

d) Response Flags: Multiple Responses (M), User Interrupt (I), Button Hold Error (B)



Example Raw Data

```
Name:    Example Subject              Test Date:  07/01/05  Version:   7.3-4338
Subject: 01 0020  Gender: Male        Birth Date: 12/24/92  Serial:    N/A
Session: 15       Age:    12y 06m 07d Test Time:  07:28 AM  Test Type: Visual

                          Tester:
ISI: 2000 msec   Ontime: 0200 msec   Offtime: 0300 msec  Anticipatory: 0150 msec
    Test Format: 1(Std)   Test Version: 7.2B9        Test Serial: 16295

        Medication                              Dosage       Med-Test Interval
    Challenge:                                   0.00 mg          0.0 hours
      Med. #2:                                   0.00 mg          0.0 hours
      Med. #3:                                   0.00 mg          0.0 hours
                  Weight: 0.0  lbs     Height: 0   in.
```

Legend to the Quarter by Quarter Raw Data Listing

```
ST    = Stimulus Type:   NT = Nontarget
                         T = Target

Type  = Response Type:   NONE        = Test stopped before this ISI
                         Corr Resp   = Correct Response (To Target)
                         Corr Nresp  = Correct Nonresponse (To Nontarget)
                         Omission    = Missed Target
                         Commission  = Response to Nontarget
                         Anticip     = Anticipatory Response (before 150ms)
                         Post Comm   = 1st correct response after Commission

Time  = Response Time:   (in milliseconds)

Flgs  = Response Flags:  M  = Multiple responses
                         I  = User Interrupt
                         B  = Button Hold Error

Note:   Raw data is listed sequentially down each column.
        (i.e., read "down" the columns for sequential ISIs)
        There are 162 ISIs per quarter, 54 in each column of the page.
```

```
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```

Example Raw Data
(Mean Response Time = 412 msec)

ST	Type	Time	Flgs	ST	Type	Time	Flgs	ST	Type	Time	Flgs
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Corr Resp	432	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Corr Resp	500	
T	Anticip	-44		NT	Commission	192		NT	Corr Nresp	0	
NT	Corr Nresp	0		T	Post Comm	405		NT	Corr Nresp	0	
T	Corr Resp	323		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Commission	157	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Post Comm	375	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		T	Corr Resp	384		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
T	Corr Resp	305		T	Corr Resp	303		NT	Corr Nresp	0	
NT	Corr Nresp	0		T	Corr Resp	339		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
T	Corr Resp	345		T	Corr Resp	285		T	Corr Resp	368	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		T	Corr Resp	383		NT	Corr Nresp	0	
T	Corr Resp	314		NT	Corr Nresp	0		T	Corr Resp	340	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Corr Resp	329	
NT	Corr Nresp	0		NT	Commission	182		T	Corr Resp	364	
NT	Corr Nresp	0		T	Post Comm	241		NT	Corr Nresp	0	
T	Corr Resp	292		NT	Corr Nresp	0		NT	Corr Nresp	0	
T	Corr Resp	957		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Commission	237	
T	Corr Resp	335		T	Corr Resp	481		T	Post Comm	323	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		T	Corr Resp	364		T	Omission	0	
NT	Corr Nresp	0		T	Corr Resp	377		NT	Corr Nresp	0	
NT	Commission	229		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
T	Post Comm	284		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Corr Resp	349	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Corr Resp	468	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
T	Corr Resp	214		T	Corr Resp	347		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		T	Corr Resp	461	
T	Corr Resp	281		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
NT	Corr Nresp	0		NT	Corr Nresp	0		NT	Corr Nresp	0	
T	Corr Resp	384		T	Corr Resp	309		NT	Corr Nresp	0	

III. School Intervention Report

T.O.V.A. Interpretation Service

This is a "504" plan based on T.O.V.A. results and additional clinical information that the clinician and/or school have.

A. Features

1. It can be personalized by adding the person's name to the appropriate space. The name will then be used in several of the paragraphs. If no name is used, the paragraphs will be constructed in a generic fashion.

2. The tester can choose (by typing an "X" in the appropriate box) and/or edit the paragraphs as needed.

3. The tester can export the report to a word processing program for other changes.

B. There are five categories that the report addresses.

1. Increasing focus on tasks (decreasing distractibility).
2. Improving social skills and managing social deficits.
3. Increasing thinking before action and decreasing impulsivity.
4. Effective behavioral interventions.
5. Promoting consistency in school performance (decreasing variability).

C. Confidentiality- The School Intervention Report (and the T.O.V.A. Interpretation Report) are confidential- a signed release is needed to send them to the school and other professionals.

T.O.V.A.® School Intervention Report

01/31/07

When attempting to intervene in the student's classroom, it is important to become familiar with the classroom dynamics and culture. This is best accomplished through active observation in the classroom and discussions with the classroom teachers. Interventions need to accommodate to the classroom culture and teacher style as well as meeting the student's needs. Ideas that can be utilized beyond one student or for the entire classroom have a greater chance of success. Understanding the teacher's belief system and preferred method of practice is vital in having any changes occur for the long-term. Collaborative development of intervention plans is needed to better serve all the students.

One of the hallmarks of attentional problems is the difficulty with sustaining attention on tasks over time. Students with attentional problems may need different levels of external/internal stimulation to enhance task focus. If a student performs better on the first half of the T.O.V.A., we may conclude that they will do better in environments in which there is less external stimulation and fewer frequent responses needed. In contrast, improved performance on the second half of the T.O.V.A. (with the first half being suggestive of ADD) may indicate improved performance in high stimulation settings with a greater frequency of response. In order to enhance the classroom environment for optimal concentration, the following conditions should be present.

Students with attentional problems do better in classrooms with four walls than in an "open pod" arrangement. Open pods allow too many visual and auditory distracters throughout the day.

The student's desk should be near the teacher (for prompting and redirection), away from other challenging students, and not touching others' desks. However, if the student is very auditorily distractible, they may benefit from being seated near the rear of the classroom. This eliminates the need for them to constantly look around to identify the sources of the distracting sounds. Experiment with seat location in the front of the classroom (near the board) and instructional area if the student is more visually distracted.

The student will function better when able to anticipate times requiring increased concentration. A visual representation of the day's schedule will provide another opportunity to internalize classroom routine.

A small student to teacher ratio enables an increased amount of feedback during prime times of difficulty. Attempt to involve parent volunteers, paraprofessionals, or support staff in this capacity.

The student will respond better to situations that they can find stimulating and engaging. Varying the instructional medium and pace will help sustain their interest. The student would probably find lessons that emphasize "hands-on" activities highly engaging. Keeping the time required for sustained attention on task balanced with more active learning will improve their performance. Changes in instructor's voice level and variation in word-pacing will also increase their attention during instruction.

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T.O.V.A.® School Intervention Report - Continued

Some students now take a small dose of their medication when they come home from school to aid in studying/homework completion. Check with the doctor about the time period of maximum medication effectiveness to help set-up a sensible homework schedule.

Quite often, variability in work performance will be related to the teacher's style and the student's temperament. Teachers tend to instruct using their own preferential learning style. Sequential teachers may help by providing more structure for them but the teacher may become frustrated with their disorganization and behavior. Random teachers, while not providing external structure, may be more likely to utilize flexibility in adjusting to their needs. Attempt to place the student with teachers who have similar styles that have proven effective for their particular needs. Some teachers have received training in dealing with students with attentional problems that would make them a particularly effective resource.

One of the simplest interventions with the most power is to have an extra set of textbooks at home to minimize the problem of not having the necessary homework materials.

Since fine motor activities and spelling can be a problem, consider a major emphasis on using a word processor at an early age. Software to practice keyboarding should have stimulating graphics to motivate their use. Using a "spell check" program is critical.

Along with the "executive process" of organizing for homework at the end of the day, a daily check-in time at the beginning of the school day can be helpful in preparing for a successful day. Checking the previous night's homework, highlighting changes in the daily schedule, and even pre-teaching some of the lessons for the day can ease stress.

The student should have a regularly scheduled time for cleaning their desk at least once a week. This will improve their ability to find their materials. It may, however, require the assistance/instruction of an adult to make this a successful experience.

Have someone actively monitoring the student during tests, especially multiple-choice, fill in the "bubble" tests. They can get off-track and fill in the wrong places or become so frustrated that they might answer at random to simply complete the test.

Emphasize that part of the work routine is to "check your work". Students tend to complete work and turn it in without checking it over. Give the student some instruction in how to check their work and practice it with them.

In assignments that require research reports and creative writing, have the student dictate the words to someone rather than writing it down. The student can then copy the words using the word processor. This technique will yield greater output on tasks requiring expressive written language skills by removing the written component.

Combine verbal directions with illustrations or demonstrations of the desired task. The use of multiple modes of instruction increases the probability of successful learning of the task.

After giving the student directions, have them paraphrase what the teacher has said. This will increase their comprehension and provide an opportunity to check for understanding.

The student may tend to want to be "the first one done" on assignments. Set reasonable accuracy goals with them and collect the entire group's work at once to reduce time pressures.

Since a characteristic of students with an attentional problem is the seeking of highly stimulating materials, computer-assisted instruction and drill can be highly successful and may also enhance keyboarding skills as well as fine-motor coordination.

Consider modifying the test environment for the student to accurately assess their ability/achievement on subject areas and standardized tests. Individual administration in a distraction-limited area with frequent breaks will give a more accurate assessment/evaluation than group administration.

Students with attentional problems experience many difficulties in the social area, especially with peer relationships. They tend to experience great difficulty picking up others' social cues, act impulsively, have limited self-awareness of their effect on others, display delayed role-taking ability, and over-personalize others' actions as being criticism, and tend not to recognize positive feedback. They tend to play better with younger or older children when their roles are clearly defined. These students tend to repeat self-defeating social behavior patterns and not learn from experience. Conversationally, they may ramble and say embarrassing things to peers. Areas and time-periods with less structure and less supervision, such as the playground and class parties, can be especially problematic.

Enlisting the support of peers in the classroom can greatly enhance the student's self-esteem. Students with good social awareness and who like to be helpful can be paired with them. This pairing can take the form of being a "study buddy", doing activities/projects, or playing on the playground. Cross-age tutoring with older or younger students can also have social benefits. Most successful pairing is done with adequate preparation of the paired student, planning meetings with the pair to set expectations, and with parental permission. Pairing expectations and time-commitments should be fairly limited in scope to increase the opportunity for success and lessen the constraints on the paired students.

Students with attentional problems tend to do well in the cooperative group instructional format. Small student groupings of three to five members, in which the students "sink or swim" together to complete assignments/projects, encourage students to share organizational ideas and responsibilities, and give an ideal setting for processing interpersonal skills on a regular basis.

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One of the characteristics of attentional problems is the variability of work performance across settings, tasks, and over time. Rather than take high performance on some tasks as an indicator that low performance on other tasks is due to low motivation and willfulness, it is important to understand this as the nature of attentional problems. The student will do better on tasks that are inherently interesting and stimulating to them. They will tend to do worse on tasks that required sustained attention and are more mundane. The student may have difficulty with tasks that require complex problem-solving strategies. There is continued difficulty with the "executive processes" (strategies that are used to organize and monitor thinking and action). They may tend to persist using strategies that have proven ineffective. Although the student may seem expansive in using oral language, they may be limited in producing ideas in written form. Assignments that require extensive fine motor skills are difficult.

Give seat work one sheet at a time, if possible. This will prevent the student from feeling overwhelmed. This is also a helpful technique in testing them.

Identifying the student's goals with their involvement is effective. Goals should begin by being simple and easy to understand. Two to three goals are sufficient to begin any goal attainment intervention. The criteria for success (or earning points) should be simple and clear. Successful goal attainment early in the process is critical. Ask the student to generate possible goal areas or have them choose from a menu that the teacher has created. The larger the role played in identifying the goals, the greater investment they will have in reaching them.

Completing school work and maintaining behavior during the school day can be exhausting experiences. Large homework loads on a regular basis can become discouraging for them and very stressful for the parent involved. Attempt to have homework reduced, if possible, and limited to guided practice on material that they has begun to master. Attempt to break down long-term assignments into steps to lessen the student's feeling overwhelmed. Consider having the student complete every third problem, instead of answering each one. Emphasize practice and assignment completion on the word processor to lower the frustration many students feel with written work.

The student should be encouraged to utilize assignment sheets, broken down by day and subject. They or their teachers can record assignments at the completion of each task. An organizing time at the end of each day can be helpful to gather the necessary materials for the assignments and develop a plan of action for completion. This will greatly aid the development of the "executive processes".

The student can become overwhelmed with floods of paper and be unable to find the needed materials. It is often helpful to carry only two work folders, one that contains work to be completed and one with work to be filed. Reviewing these work folders should become a regular part of the daily routine, with irrelevant work removed.

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Students with attentional problems can benefit greatly from behavioral interventions that are sensitive to their processing style. An individualized plan that emphasizes stimulating reinforcers on a consistent basis has a good chance of success. Consequences and reinforcement should be as immediate as possible. Changing the reward periodically is usually necessary. A major consideration in forming an effective behavioral plan is assessing what is workable for the classroom teacher on a regular basis. Some plans that require extensive charting do not succeed because the teacher can not follow through effectively within the context of the daily classroom demands. Keeping the plan simple and flexible is the key to success.

Students with attentional problems generally respond poorly to institution-wide/classroom behavioral systems. Programs such as Assertive Discipline usually provide difficulty in that rewards/consequences are delayed and not tailored to the individual student's needs. Whether or not there is a formal behavioral program for all students, The student will benefit from an individualized approach, in which target behaviors are specifically identified and rewards/consequences are fairly immediate.

Rewards and verbal praise on a continual basis will change the attentional problem the most effectively. One suggested system is the "point system". Feedback that is delayed or variable is problematic in that the student may have difficulty in correlating delay and gratification. The student may begin to make faulty behavioral connections in these situations.

Students respond well to rewards that they experience as highly-stimulating. Computer games, artistic media, and action-based play (sports or other physical activity), building sets, and activities outside of the school setting, can be effective. Ask the student what they would like to earn. The student is the best source of identifying the reward. Rewards should be changed frequently to maintain their "novelty power".

An effective system for immediate reinforcement and highly stimulating rewards is a "point system". Students earn points for accomplishments such as: 1) achieving prearranged goals that have been discussed and agreed to by the student, teacher, and parent, and 2) any valued activity or behavior that occurs spontaneously during the school day. Point values are assigned to various tasks/behaviors. Teachers have the flexibility of increasing point values or giving any assignment/activity a point value. Points are accumulated and "cashed in" on a reward menu. Points can be added on a continuing basis for a running total kept with the teacher/student. This menu can be a hierarchy of reward activities, such as extra computer or playground time, to out of school activities, such as lunch or bowling, for an accumulation of many points. The student is in charge as to when to "spend" their points. This system is designed to enhance the delay of gratification for students. It is important in any behavioral system that the student finds early success to "buy in" to the program.

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Research suggests that response/cost can be successfully combined with a point system. Response/cost means that the student would lose points they has accumulated as a consequence for certain behaviors. Make sure that when using response/cost that the student has "bought-in" to the point system with success and that the number of points deducted for consequences is less than the ones earned for accomplishing the same task/behavior.

It is important that behavior systems have a method for "keeping track" of points and goal attainment. Charts should be attractively produced on a computer. Punch cards, on which the teacher punches the student's reward card when a goal is met, can be a vehicle for immediate reinforcement. Various games can be represented on the punch card, such as rounding bases to get to home plate, rounding a track to cross a finish line, or crossing a soccer field to score a goal.

It is often helpful to group students who are charting/earning points for a small amount of time each day. This "Goal Group" can provide opportunities for peer support, become a time for positive modeling, and provide a basis for a group reward. By having the group earn a group reward, in addition to individual rewards, more support and encouragement result.

Encouraging the student to monitor their own behavior has many benefits. It can provide an opportunity for discussion when the student and the teacher agree/disagree on the ratings. It also prompts movement toward the student's internal frame of reference in evaluating their behavior.

It is important to pair verbal praise with a reward. This will facilitate "weaning" from a concrete reward structure to an internalized system. Encourage the student to also write or say self-affirmations. A simple nod, wink, smile, or touch on the shoulder can carry tremendous recognition power.

Instead of confronting the student continually on activities/behaviors that are inappropriate, point out the alternative choices that are available. This will make the expectations clearer to them and avoid the negativity inherent in what they would perceive as criticism.

Some students respond to a prearranged cueing system with the teacher. In this system, the teacher gives a visual signal (touching the ear) or verbal phrase ("Remember, I'm looking for good listeners") when a targeted inappropriate behavior occurs. The cue can remind the student to correct behavior without direct confrontation or loss of self-esteem. It can involve the classroom teacher or any support personnel available to the student.

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One of the hallmarks of children with attention deficits is the tendency to act impulsively (acting before thinking through the ramifications of behavior). Behaviorally, this manifests itself in a lack of understanding of cause and effect. Research also suggests that these students can often verbalize the rules in place for behavior but have difficulty internalizing them and translating them into thoughtful behavior. Difficulties in delaying gratification also add to the impulsivity. Some clinicians believe that this behavioral disinhibition (poor regulation and inhibition of behavior), rather than their ability to pay attention, is the primary manifestation of attention deficits and is more likely to discriminate these children from others.

By having students think "out loud" when they are problem-solving, the teacher will gain insights into their reasoning style and the process will slow them down before they respond impulsively. This will provide information about how they "see the world" and enable the teacher to begin to restructure inaccurate perceptions. Train the student's teachers and other adults how to do this to provide an on-going technique in the classroom setting, where critical incidents often occur.

Quite often, students will continue to have difficulty with certain types of interactions on a regular basis; difficulty in taking turns, over-interpreting others' remarks as hostile, personalizing others' actions excessively, and misreading social cues. With the help of the student, their teacher, and their trusted peers, common problematic themes can be identified. Role-play hypothetical interactions involving these behaviors, preferably with supportive peers, identifying and practicing positive alternative responses. Have the student practice these responses during the school day and have them and others give feedback on their success. Identifying critical incidents that occur during the day will provide insights for program planning.

The technique of "Stop-Think-Talk-Do" is central to many cognitive-behavioral interventions for students with attentional problems. It is a system that teaches the student how to "stop" before acting impulsively, "think" about the cause-and-effect relationships of their intended behavior, "say" or verbalize to themselves or others what they will do, and "do" the chosen behavior. Again, the purpose of the technique is to slow down response.

It is important to help the student identify a "support network" of peers and adults that can help give them hints about when to "slow down". This group can also practice the "slow down" techniques mentioned in this section. Peers and adults in this "network" may best be served by having some background in attentional problems and practicing the procedure with a professional skilled in the technique.

Encourage thoughtful responding and decrease impulsivity by waiting 10 to 15 seconds to receive responses during whole group instruction. "Calling on" the first few students who raise their hands will increase impulsivity in responses of students or will discourage the student because they are not able to organize and verbalize as efficiently as other students.

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Along with breaking up the need for sustaining attention for a long period, the student would do better when allowed frequent breaks to move around inside and outside the classroom. This may vary from a daily outside walk, doing errands around the building, to classroom stretching exercises.

The student tends to lose focus and their activity-level may increase during the day. Therefore, schedule the most demanding attentional tasks in the morning.

To provide an engaging classroom for students, try to be aware of the auditory and visual distracters present. Attempt to place the student where these would have the least effect.

Many students often bring their own distracters (toys) from home. Try to make a classroom rule about appropriate time/place to share them with classmates and limit their appearance in the classroom and on the desks. Establishing certain categories for classroom sharing on certain days can limit the number and type of items brought to school and make it more successful for all students.

The student may need a place to unwind and reduce stress during the school day. Often times this can be as simple as providing a place for sitting alone, using the computer, taking a short walk, drawing, or modeling with clay. After ten to fifteen minutes, the student will likely be able to access the energy needed to attend to the classroom.

Students using medication to treat attentional problems will have their optimal attention effects for methylphenidate 45 minutes to 2 1/2 hours after medication. Other medications differ, and it is best to check with the physician about the time of maximum medication effects. If possible, it is best to schedule the most attention-demanding tasks for the student during this medication window.

Tasks can also be modified to improve opportunities for optimal attention.

The student may get overwhelmed with large assignments. Their attention may wander after guided practice on similar tasks. Adjust the assignment down to smaller intervals. Give the assignment one sheet at a time. Assign every third problem, rather than every one, for completion to reflect mastery level. Cut apart single worksheets into strips. Tailor guided practice to occur during those time periods. Schedule breaks after this optimum attention time period and then return to the assignment.

Seat work is often extremely difficult. This can become compounded when the teacher is instructing another small group. Check on the student as much as possible or have them check-in with the teacher. Consider using a point system.

Make sure that the student establishes eye contact when receiving direction/instruction. This will improve their understanding and follow-through on the task.

The student will be more successful when given directions one step at a time. When a series of instructions are given, retention beyond the first direction is difficult.

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Small "play groups" of two to four students can help the student to develop more effective social skills. These groups are most effective if socially competent peers are willingly included in the group. The group should be focused on activities that stress interaction and cooperation. Board games, building projects, and sessions that promote frequent verbal interactions provide the greatest opportunity for learning appropriate social skills and controlling impulsivity. The student would benefit most when the target social skills are identified and practiced with their prior to the activity and processed after the activity.

Many students lack friends to be with outside of the school-setting. It can be beneficial to strategize with the student and their parent on developing a "friendship plan" for the home setting. Sometimes the goal of establishing one special friendship is ambitious and sufficient. This could include steps of identifying friend possibilities that might be available/accepting, practice in making arrangements using the phone, planning an activity or sleep-over that is structured/predictable, and tips on how to maintain friendships over time.

A subtle way for the student to learn social skills is through the use of guided observation of their peers on the playground. Accompany their on to the playground and point out the way other students initiate activities, cooperate in a game, respond to rejection, deal with being alone, etc. After some practice, the student can go out on their own and report back on some similar observations. Willing playground supervisors can often provide this function on a periodic basis.

For many students, thirty minutes on the playground is beyond their capability to maintain peer relationships successfully. If necessary, break-up the recess into ten minutes of activity, a ten minute check-in with the teacher/playground supervisor, then another ten minute activity period. Restricting the area available for the student during recess can increase the contact with adult supervision and lessen the complexity of social decision-making. This can be done privately with the student prior to recess. Many students welcome this manner of simplifying their social interactions during this period of low structure.

It is helpful to meet with the student prior to their lunchroom/playground period to review their plan for recess activity and with whom they will sit during lunch. Have them ask peers in advance of the recess block to do a certain activity with them. Process the activity with the student after recess and make suggestions for the following day.

Holding classroom meetings on a regular basis can help promote an atmosphere of respect and understanding. Concerns over assignments, activities, and interpersonal relationships can be dealt with in the context of acceptance and understanding.

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IV. Home Intervention Report - T.O.V.A.® Interpretation Service

This is a home intervention report based on T.O.V.A. results that the subjects and/or parents can be given to assist with attention behaviors.

A. Features

1. It can be personalized by adding the person's name in the appropriate space. The name will then be used in several of the paragraphs. If no name is used, the paragraphs will be constructed in a generic fashion.

2. The writer can choose (by typing an "X" in the appropriate box) and/or edit the paragraphs as needed.

3. The writer can export the Program to a word processing program for other changes.

4. There are many areas that the Program addresses.

B. Confidentiality- The Home Intervention Report (like the T.O.V.A. Interpretation Report) is confidential- a signed release is needed to send them to the school and other professionals.

- Effects of family modeling
- Enclosed homework areas
- Posted Daily Schedule
- Preemptive preparation for the morning routine
- Limiting choices
- Planned movement during study periods
- Plan attention-needed activities in the morning
- Making optimal use of medication
- Task modification
- Frequent monitoring/feedback
- Eye contact
- Single step instructions
- Provide examples
- Paraphrase
- Stay there until it starts
- Plan for transitions
- Use of a timer
- Avoid Spontaneity (when focused attention is necessary)
- Limit over-stimulation
- Avoid fatigue
- When/then statements
- Hands on tasks
- Pairing

- One friend at a time
- Pre-plan activities prior to visits
- Social goal-setting in play groups
- Encourage friendship development outside of school
- Detailed observations
- Verbalize mental processing
- Identify/rehearse/practice
- Stop-Think-Talk-Do
- Identify support people
- Individualize
- Frequent feedback
- High stimulation reward
- Point systems/reward menu
- Response/cost
- Charting/Punch cards
- Verbal/Non-verbal encouragement
- Redirection
- Cues
- Stop the flood
- After-school medications
- Variations in parenting style/temperament
- Individual daily organization
- Clean backpacks
- Accompany oral with written directions
- Monthly calendar with dates
- Message Center
- Posting of household rules

The following pages illustrate a generic Home Intervention Report with all categories included.

When/then statements

Statements such as "When you are done with your math worksheet, then you may watch television." provide a clear and direct statement of cause and effect. Keeping directions simple and to the point increases the probability of successful performance.

Hands on tasks

Individuals with ADHD do best when tasks have a hands on component rather than a task that is only cognitive or thought about. Actual hands on activities help to focus attention and understanding.

Individuals with ADHD experience many social difficulties, especially with peer relationships. They tend to experience difficulty picking up social cues, act impulsively, have limited self-awareness of their effect on others, display delayed role-taking ability, over-personalize others' actions as being criticism, and tend not to recognize positive feedback. They tend to get along better with younger or older peers when their roles are clearly defined. Individuals with ADHD tend to repeat self-defeating social behavior patterns and not learn from experience. Conversationally, they may ramble and say embarrassing things with peers. Times and places with less structure and less supervision, such as the playground or parties, can be especially problematic.

Pairing

Enlisting the support of peers in the classroom and neighborhood can greatly enhance self esteem. Others with good social awareness and who like to be helpful can often be successfully paired with individuals with ADHD. This pairing can take the form of being a "study buddy", doing activities/projects, or playing on the playground. Cross-age tutoring with older or younger individuals can also have social benefits. Pairing expectations and time commitments should be fairly limited in scope to increase the opportunity for success and lessen the constraints on the pair.

One friend at a time

Since understanding social cues can be a significant problem for individuals with ADHD, they are more likely to have a successful social experience if their interactions can focus on one friend at a time. The greater the number of social interactions to interpret, the greater chance a problem will occur.

Pre-plan activities prior to visits

It can be very helpful to pre-plan a friend's visit by discussing and listing their possible activities (games, computer use, outside play) prior to the friend's arrival. Help the individual choose activities that would promote the friendship, promote cooperation rather than competition, and identify a logical sequence of events.

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When attempting to intervene in the individual's home setting, it is important to become familiar with the dynamics and culture of the home. This is best accomplished through active observation in the home and discussions with all family members. Interventions need to accommodate to the family culture and style as well as meeting the individual's needs. Ideas that can be utilized for the entire family have a greater chance of success. Understanding the parent's belief system and preferred method of practice is vital in having any changes occur for the long-term. Collaborative development of intervention plans best serves the family.

One of the hallmarks of Attentional Deficit Hyperactivity Disorder (ADHD) is the difficulty with sustaining attention on tasks over time. The T.O.V.A. results can provide excellent clues about the level of external/internal stimulation that will enhance task focus. If the individual performs better on the first half of the T.O.V.A. (with the second half being suggestive of ADHD), we would expect that environments with less external stimulation and fewer needed responses would be best. In contrast, stimulating settings with a greater frequency of needed responses would be better for those who perform best on the second half of the T.O.V.A. (with the first half being suggestive of ADHD). In order to enhance the home environment for optimal concentration, the following conditions should be present.

Effects of family modeling

Family members can be made aware that their lifestyle has a large impact on the choice of coping skills. Families with a random organizational style often do not teach or model strategies such as prioritizing, using lists, budgeting time effectively, and breaking larger tasks into smaller units. Impulsivity and the inability to delay gratification may be frequent and not particularly bothersome to the others in the family. Family members can benefit by also receiving instruction and training in these areas.

Quiet homework areas

Individuals with ADHD more often complete their homework when they are able to work in an area with few visual and auditory distractions. Completing homework in front of the television or at the kitchen table is very difficult for them, particularly those who do poorly on the second half of the T.O.V.A. In contrast, some actually attend to task better with some unobtrusive background sound and action. Described as "white noise", repetitious background sound can mask or cover up potentially distracting noises like the dog barking or the telephone ringing.

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Social goal-setting in play groups

Small "play groups" of two to four peers can help the individual develop more effective social skills. These groups are most effective if socially competent peers are willingly included in the group. The group should be focused on activities that stress interaction and cooperation. Board games, building projects, and sessions that promote frequent verbal interactions provide the greatest opportunity for learning appropriate social skills and controlling impulsivity. The individual will benefit most when the target social skills are identified and practiced with them prior to the activity and processed after the activity.

Encourage friendship development outside of school

Many individuals lack friends to be with outside of the school-setting. It can be beneficial to strategize with the individual to develop a "friendship plan" for the home setting. Sometimes the goal of establishing one special friendship is ambitious and sufficient. This could include steps of identifying possible friends who might be available/accepting, practice in making arrangements using the phone, planning an activity or sleep-over that is structured/predictable, and tips on how to maintain friendships over time.

Observational detail

A subtle way for the individual to learn social skills is through guided observation of their peers on the playground. Accompany them to the playground and point out the way other children initiate activities, cooperate in a game, respond to rejection, deal with being alone, etc. After some practice, children can go out on their own and report back on some similar observations.

One of the hallmarks of ADHD is the tendency to act impulsively - acting before thinking through the ramifications of behavior. Behaviorally, this manifests itself in a lack of understanding of cause and effect. Individuals with ADHD can often verbalize the rules in place for behavior but have difficulty internalizing them and translating them into thoughtful behavior. Difficulties in delaying gratification also add to impulsivity. Behavioral disinhibition (poor regulation and inhibition of behavior) may be a primary manifestation of ADHD and may be even more important than their ability to pay attention.

Verbalize mental processing

By having individuals think "out loud" when problem-solving, you will gain insights into their reasoning style and slow them down before they respond impulsively. This will provide data for you about how they "see the world" and enable you to begin to restructure inaccurate perceptions. Train their teacher and other adults how to do this to provide an on-going technique in the classroom setting, where critical incidents often occur.

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Frequent feedback

Rewards and verbal praise on a continual basis will be most effective at changing behavior. One suggested system to follow is the "point system". Feedback that is delayed or variable is problematic because of the difficulty in delaying gratification and anticipating consequences. The individual may begin to make faulty behavioral connections in these situations.

High stimulation reward

Individuals respond well to rewards that they experience as stimulating. Computer games, art, and action-based play (sports or other physical activity), building sets, and activities outside of the home can be effective. Ask the individual for preferred rewards; they will often be the best source of identifying the reward. Rewards should be changed frequently, or rotated, to maintain their "novelty power."

Point systems

An effective system for immediate reinforcement and highly stimulating rewards is a "point system". Individuals earn points for a variety of accomplishments such as achieving prearranged goals that have been discussed and agreed to by the individual or for any valued activity or behavior that occurs spontaneously during the day. Point values are assigned to various tasks/behaviors with some flexibility to increase points or give any assignment or activity a point value. Points are accumulated and "cashed in" on a reward menu. Points can be added on a continuous basis for a running total kept in a central area. This menu can be a hierarchy of reward activities such as computer time or a small toy for a smaller number of points to activities, such as lunch at a restaurant, a movie, a moderately priced toy, or bowling, for an accumulation of many points. The individual can decide when to "spend" their points. This system is designed to enhance the delay of gratification for the individual. It is important in any behavioral system that there be early success to "buy in" to the program. It is sometimes helpful to establish a quota about the minimum number of points that must be given during the first week to ensure that the individual invests in the plan.

Response/cost

Response/cost can be successfully combined with a point system. Response/cost means that the individual will lose points that have been accumulated as a consequence for certain behaviors. Make sure that when using response/cost that "buy-in" to the point system has occurred, and that the number of points deducted for consequences is less than those earned for accomplishing the same task/behavior. It is sometimes helpful to target high risk behaviors, such as lying, stealing, hurting, and destroying property as behaviors that would cause the individual to lose points.

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Task modification

Long and multi-step tasks like cleaning a room, paying bills, or completing a lengthy homework project are often overwhelming. When a series of instructions is given, retention beyond the first direction is difficult. After providing instruction on how to complete the task, it would be helpful to break the task into smaller parts. For example, instead of the perceived overwhelming task of room cleaning, ask the individual to simply remove articles from the floor or focus on cleaning their desk. Then move on to the next one or two steps. And so on. It is helpful to do projects together and to prioritize the tasks that need to be completed. Individuals with ADHD will often misjudge the importance of certain tasks or try to complete everything at once and finish nothing at all. Utilize the T.O.V.A. results that identify the length of the individual's attention span and fit attention demanding tasks as indicated. Schedule brief breaks after the optimum attention time period.

Frequent monitoring/feedback

Homework is often a very difficult task, and it can become even more difficult when fatigued. Check on them during homework as much as possible or have them check with you. Establish a point system (see below).

Eye contact

Make sure that the individual establishes eye contact when receiving direction/instruction. This will improve understanding and follow-through on the task.

Single step instructions

The individual will be more successful when given directions one step at a time. When a series of instructions is given, retention beyond the first direction is difficult.

Provide examples

Combine verbal directions with illustrations or demonstrations of the desired task. The use of multiple modes of instruction increases the probability of successful learning of the task. Showing the individual how to do a chore and illustrating the desired outcome increases the likelihood of success.

Paraphrase

After giving directions, have them paraphrase those instructions. This will increase comprehension and ensure that the individual understands what steps need to be completed.

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Stay there until it starts

Individuals with ADHD often get distracted and do not begin a task, even after receiving and seemingly understanding directions. Staying with the individual until the task has begun will increase the likelihood that the task will be completed.

Plan for transitions

Changes in the predictable routine are often upsetting for individuals with ADHD and can cause increased anxiety and impulsivity. Individuals with ADHD perform better when warned in advance of transitions. When a change in an activity is going to occur, warn the individual a few minutes in advance of the up-coming change.

Use of a timer

Managing and regulating time can be extremely difficult for an individual with ADHD. They often think that they have more time than they really do. They have great difficulty in waiting, and have a very limited "time horizon" in which to anticipate the need for planning for up-coming events. Using timers can often help them stay on task and more accurately gauge the time to allot to complete various tasks. Egg timers and digital timers provide visual reminders.

Avoid Spontaneity (when focused attention is necessary)

Changes in the predictable routine are often upsetting for ADHD individuals and can cause increased anxiety and impulsivity. When possible, avoid spontaneous changes in routine. If it is possible to predict and warn the individual of the new changes in plans, accompanying worry and acting out behaviors may be avoided.

Limit over-stimulation

Visual, auditory, tactile, and/or olfactory channels can over-stimulate individuals with ADHD. If over-stimulated, ADHD symptoms and impulsive behaviors ("acting out") may worsen.

Avoid fatigue

The concept that our behavior and performance worsens as we get tired is true for many of us, but it is especially true for the individual with ADHD. They often return home after a long work day and do not feel motivated to respond to many demands. It is important to analyze the individual's energy levels during the day and attempt to have them do their work and other responsibilities before they becomes fatigued.

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Charting/Punch cards

It is important that behavior systems have a method for "keeping track" of points and goal attainment. Charts should be attractively produced. Punch cards, on which the parent punches a reward card when a goal is met, can be a vehicle for immediate reinforcement. Various games can be represented on the punch card, such as rounding bases to get to home plate, rounding a track to cross a finish line, or crossing a soccer field to score a goal.

Verbal/Non-verbal encouragement

It is important to pair verbal praise within any reward. This will facilitate "weaning" from a concrete reward structure to an internalized system. Encourage the individual to also write or say self-affirmations. A simple nod, wink, smile, or touch on the shoulder can carry tremendous recognition power.

Redirection

Instead of confronting individuals continually on activities and behaviors that are inappropriate, point out the alternative choices that are available. This will make the expectations clearer to the individual and avoid the negativity inherent in what might be perceived as criticism.

Cues

Some individuals respond to a prearranged cuing system. In this system, the parent gives a visual signal (for example, touching the ear) or verbal phrase ("Remember, I'm looking for good following of directions") when a targeted inappropriate behavior occurs. The cue can remind the individual to correct behavior without direct confrontation or loss of self-esteem.

One of the characteristics of ADHD is the variability of performance across settings, tasks, and over time. Do not assume that since there is high performance on some tasks that low performance on other tasks is due to low motivation and willfulness. Individuals with ADHD do better on tasks they find inherently interesting and stimulating. They tend to do worse on tasks that require sustained attention and are more mundane to them. Individuals with ADHD often have difficulty with tasks that require complex problem-solving strategies. There is continued difficulty with "executive processes" - strategies that are used to organize and monitor thinking and action. They tend to persist using strategies that have proven ineffective. Although they may seem expansive in using oral language, they may be limited in producing ideas in written form. Tasks that require extensive fine motor skills are also difficult.

Stop the flood

Assign tasks one at a time, if possible. This will prevent the individual from feeling overwhelmed. Individuals with ADHD have a great difficulty in sequencing a number of tasks/directions.

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Identify/rehearse/practice

Quite often, individuals will continue to have difficulty with certain types of interactions on a regular basis. Difficulty in taking turns, over-interpreting others' remarks as hostile, personalizing others' actions excessively, and misreading social cues are common difficulties. With the help of the individual, teacher, and trusted peers, common, problematic themes can be identified. Role-play hypothetical interactions involving these behaviors, preferably with supportive peers, while identifying and practicing positive alternative responses. Have the individual practice these responses during the school day and have them give feedback on the results. Identifying critical incidents that occur will provide insights for program planning.

Stop-Think-Talk-Do

This technique is central to many cognitive-behavioral interventions for ADHD. It is a system that teaches an individual how to "stop" before acting impulsively, "think" about the cause-and-effect relationships of the intended behavior, "say" or verbalize to themselves or others what they will do, and "do" the chosen behavior. Again, the purpose of the technique is to slow down responses.

Identify support people

It is important to help the individual identify a "support network" of peers who can help give them hints about when to "slow down". This group can also practice the "slow down" techniques mentioned in this section. Peers and adults in this "network" may best be served by having some background in ADHD and practicing the procedure with a professional skilled in the technique.

ADHD individuals can benefit greatly from behavioral interventions that are sensitive to their processing style. An individualized plan that emphasizes stimulating reinforcers on a consistent basis has a good chance of success. Consequences and reinforcement should be as immediate as possible. Changing the reward frequently is usually necessary. A major consideration in forming an effective behavioral plan is assessing what is workable on a regular basis. Some plans that require extensive charting do not succeed because of the difficulty of following through effectively within a busy daily routine. Keeping the plan simple and flexible are the keys to success.

Individualized

Individuals with ADHD benefit from an individualized approach, in which target behaviors are specifically identified and rewards/consequences are fairly immediate.

(continued on next page)

Posted Daily Schedule

Individuals with ADHD can better anticipate and plan for activities that require increased concentration when they have a posted schedule of daily activities. A visual representation will provide another opportunity to internalize home routines. This will include important daily routines such as meal time and homework schedules, as well as necessary self-care routines, such as showers, and bedtimes.

Preemptive preparation for the morning routine

Mornings are particularly difficult for families with someone who has the typical structural and organizational problems associated with ADHD. It is helpful to plan the morning routine in the evening before; clothes can be selected and laid out, back packs checked and left in the same place by the front door, jackets and boots found, permission slips signed, etc. Leaving fifteen to thirty minutes of extra time in the morning schedule can also relieve pressure. A tight schedule leaves little room for error and provides many opportunities for frustration. As much as it might be tempting, "sleeping in" should be avoided, since it results in a delayed schedule, with tension and stress becoming an almost certainty.

Limiting choices

Individuals with ADHD are often easily overwhelmed by the quantity of their possessions, especially clothes and toys. When making selections of clothes, it is important to simplify the process (and leave the room less cluttered) by removing out of season clothing from drawers and closets. This same process applies to toys, games and other objects. By rotating these items and putting some away for a period of time, there is less clutter and more interest when the objects are switched.

Planned movement during study periods

Along with breaking up tasks, frequent breaks for a brief walk, a snack, a chore or stretching exercises are helpful.

Plan attention-needed activities in the morning

Many individuals with ADHD have increasing problems focusing and controlling their activity-level as the day progresses. Therefore, schedule the most demanding attention tasks in the morning.

Making optimal use of medication

The different medications used to treat ADHD have different peaks and durations of effectiveness. For example, attention usually improves 45 minutes after taking methylphenidate, and the effects last for 2 1/2 hours. Other medications are different, and it is best to check with the doctor to determine the time of maximum medication effects. If possible, it is best to schedule the most attention-demanding tasks during this medication window.

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Posting of household rules

Limited, visible reminders are useful. It is helpful to post a few important rules of the house in areas where they can be easily seen. Keep the rule statements short and to the point, for example, "If you use it, clean it" and "We respect each other" are examples of "buzzwords" that can be used in a variety of settings.

After-school medications

Some students now take a small dose of medication when they come home from school to aid in studying/homework completion. Check with the doctor about the time period of maximum medication effectiveness to help set-up a sensible homework schedule.

Variations in parenting style/temperament

Quite often, variability in behavior will be related to the parental style and temperament experienced by the individual. Parents utilize their own preferential learning style. "Sequential" parents may help by providing more structure for the individual but may become frustrated with the disorganization and behavioral components of the behavior. "Random" parents, while not providing external structure, may be more likely to utilize flexibility in adjusting to individual needs. Strategically using the many parental strengths in situations that require different parental approaches will improve performance and create greater harmony.

Individual daily organization

Along with the "executive process" of organizing for homework at the end of the day at school, a daily check-in time at home to review assignments, organize materials, and mutual problem solving for future school demands will improve performance.

Clean backpacks

There should be a regularly scheduled time for cleaning out backpacks at least once a week. This will improve their ability to find their materials. It may, however, require the assistance/instruction of an adult to make this a successful experience.

Accompany oral with written directions

When possible, accompany oral directions with written directions and/or visual representations on the message board or refrigerator. Using both visual and auditory channels can improve the consistency of assignments.

Display monthly calendar with important dates

Display a monthly calendar on the refrigerator with important dates (project due dates, exams, games, appointments) noted in some colorful fashion. Cross out days that have already passed to help the individual track the current day's commitments.

Message Center

It can be helpful to establish a family "message center" where notes, phone calls, and other communications can be stored and later found. In a similar vein, "Caller ID" (where names and phone numbers of incoming calls are recorded) can provide an invaluable service in making sure necessary communications take place.

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V. T.O.V.A. Protocols

Selected protocols are presented and reviewed to illustrate the T.O.V.A. s and their uses.

Protocol	Subject
006	High Omission Errors (adult)
004	Invalid quarters- Excessive Commission Errors
007	Invalid quarters- Excessive Anticipatory Responses
008	Adult ADD pattern
002	"Acquired" ADHD, secondary to a head injury
020	Neurological pattern- lapse seizures

006 High Omission Errors (adult)

Protocol 006 38 year old female with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF		TOTAL
		1	2	3	4	1	2	
Omission Errors	%	3*	0	2*	0	1*	1*	1
Standard Dev		-2.8*	.17	>-4*	0	>-4*	>-4*	-.83
Standard Score		58*	102	<40*	100	<40*	<40*	87
Commission	%	1	1	8%	17*	1	12*	3
Errors		0	-.05	-.46	-2.5*	-.44	-1.6*	-.75
Standard Dev		100	99	93	61*	93	76*	88
Standard Score								
Response Time	ms	448	460	463	385	454	424	430
Standard Dev		-.05	-.1	-.89	-.01	-.08	-.47	-.38
Standard Score		99	98	86	99	98	92	94
RT Variability	ms	124*	53	116*	89	95b	110*	108b
Standard Dev		-2.0*	.56	-1.7*	-.58	-1.2b	-1.6*	-1.2b
Standard Score		70*	108	73*	91	81b	76*	81b

□ = Invalid Quarter * = Significantly Deviant Result
!! = Excessive Commission Quarter b = Borderline Result

1. Significantly high omissions in both halves 1 and 2 and in quarters 1 and 3.

2. If there were only one error, it would not be clinically significant, and the analysis and interpretation would disregard it.

3. Significantly high commissions in half 2 and quarter 4 and high variability in half 2 and in quarters 1 and 3.

4. Results are not within normal limits and warrant a referral to clinician.

5. Note that the deviant omission errors and variability occur in the same two quarters. It's as though the two were related. In fact, inspection of response by response option reveals that almost all of the deviant variability scores were during and after two consecutive omission errors in quarters 1 and 3. We will attribute the deviant variability to the cause of the omission errors - a possible neurological problem such as narcolepsy or a seizure disorder that resulted in brief (2-4 sec) unconsciousness.

Problems in the beginning of the two halves may result from difficulty adjusting to the test situation at the onset and when the test conditions changes without warning (between quarters 2 and 3 when infrequent target mode switches to frequent target mode). In such cases, we might consider interference by personality factors such as obsessive-compulsive traits and/or anxiety.

6. Subsequent evaluation revealed narcolepsy for which she was prescribed methylphenidate (the treatment for her attention disorder as well).

7. The high commission errors in quarter 4 might be indicative of difficulty inhibiting responses after 5 minutes in a high response test situation. If so, we would consider suggesting that she alter her work situation accordingly and reduce distractions.

004 Invalid quarters- Excessive Commission Errors

Protocol 004 8 year old male with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF		TOTAL
		1	2	3	4	1	2	
Omission Errors	%	56*	58*	!9!	!11!	57*	!10!	!20!
Standard Dev		>-4*	>-4*	!-.4!	!-.58!	-4.9*	!-.53!	!-1.5!
Standard Score		38*	<40*	!93!	!91!	26*	!92!	!78!
Commission	%	6	8b	75*	86*	7	81*	23*
Errors		-.45	-1.2b	-2.6*	-2.3*	-.86	-2.5*	-2.0*
Standard Dev		93	81b	61*	65*	87	62*	70*
Standard Score								
Response Time	ms	521	749*	!381!	!342!	631b	!361!	!394!
Standard Dev		.02	-2.4*	!.76!	!.98!	-1.2b	!.91!	!.86!
Standard Score		100	63*	!111!	!114!	81b	!113!	!112!
RT Variability	ms	172	429*	!187!	!193!	342*	!191!	!232!
Standard Dev		-.92	>-4*	!.74!	!-.39!	>-4*	!-.53!	!-1.5!
Standard Score		86	<40*	!88!	!88!	<40*	!92!	!77!

□ = Invalid Quarter
!! = Excessive Commission Quarter
* = Significantly Deviant Result
b = Borderline Result

1. Excessive commission errors (≥60%) could invalidate all other variables in quarters 3 and 4.

2. We can use all commission scores but omissions, response time and variability from quarters 1 and 2 only.

3. Commissions in half 2 (and quarters 3 and 4) and O, RT, and V significantly deviant from norm in half 1.

4. Results are not within normal limits and warrant a referral to clinician.

5. RT, and V all worsen significantly (≥.5 std dev or ≥7.5 std score) from quarter 1 to 2, suggesting a 5 minute attention span (or 5 minute ability to inhibit) during a boring task.

6. Intervention should take #5 into account by breaking up long, boring tasks.

7. The intervention should also take into account the excessive C in half 2 by reducing excessive stimulation and distractions.

007 Invalid quarters- Excessive Anticipatory Responses

Protocol 007 9 year old male with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF		TOTAL
		1	2	3	4	1	2	
Omission Errors	%	[17]	!3!	[58]	[53]	[9]	[55]	[40]
Standard Dev		[-1.1]	!0!	[>-4]	[-4.1]	[-.55]	[>-4]	[-3.1]
Standard Score		[83]	!100!	[37]	[39]	[91]	[<40]	[53]
Commission Errors	%	[22]	20*	[40]	[41]	[21]	[41]	[24]
Standard Dev		[-3.5]	>-4*	[-.59]	[-.02]	[>-4]	[-.31]	[-2]
Standard Score		[47]	<40*	[91]	[99]	[<40]	[95]	[69]
Response Time	ms	[302]	!324!	[954]	[1619]	[315]	[1294]	[780]
Standard Dev		[3.1]	!3!	[>-4]	[>-4]	[3.2]	[>-4]	[-3.7]
Standard Score		[146]	!145!	[<40]	[<40]	[147]	[<40]	[44]
RT Variability	ms	[83]	!71!	[808]	[618]	[77]	[790]	[738]
Standard Dev		[.93]	!1.6!	[>-4]	[>-4]	[1.5]	[>-4]	[>-4]
Standard Score		[113]	!123!	[<40]	[<40]	[122]	[<40]	[<40]
Anticipatory Responses	%	[12%]	4%	[35%]	[32%]	8%	[33%]	[21%]

□ = Invalid Quarter
!! = Excessive Commission Quarter
* = Significantly Deviant Result
b = Borderline Result

1. Excessive Anticipatory Responses (≥10%/quarter) in quarters 1, 2, and 3 may invalidate all variables in these quarters. The ratios of non targets to targets in these quarters invalidated them.

2. High Anticipatory Responses are generally seen in two cases: a) when the person has changed the rules and wants “to kill “ the stimulus as quickly as possible, or b) in someone with ADHD. The observer should ask the person about their “game plan”.

3. Excessive Commission Errors (≥10%) in quarter 2 invalidate all other variable in that quarter.

4. This protocol is uninterpretable except for significant impulsitivity in quarter 2 which would be compatible with a behavior problem and/or an attention problem. This finding would raise concerns about impulse control after 5 minutes in a boring task.

5. We would be inclined to retest with special instruction rather than rely on a single valid quarter.

008 Adult ADHD pattern

Protocol 008 16 year old female with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF		TOTAL
		1	2	3	4	1	2	
Omission Errors	%	0	6*	!4!	!2!	3	!3!	!3!
Standard Dev		.32	-2.7*	!-2.7!	!-.76!	-.99	!-2.0!	!1.8!
Standard Score		104	60*	!59!	!88!	85	!70!	!72!
Commission	%	2	0	58*	64*	1	61*	14*
Errors		-.99	.5	>-4*	>-4*	-.42	-4.1*	-3.6*
Standard Dev		85	107	<40*	<40*	93	39*	45*
Standard Score								
Response Time	ms	435	449	!352!	!351!	442	!352!	!372!
Standard Dev		-.49	-.46	!.22!	!.27!	-.49	!.18!	!.13!
Standard Score		92	93	!103!	!104!	92	!105!	!101!
RT Variability	ms	78	72	!116!	!96!	76	!106!	!107!
Standard Dev		.02	-.03	!-.92!	!.04!	.07	!-.33!	!-.35!
Standard Score		100	99	!86!	!100!	101	!95!	!94!

□ = Invalid Quarter
!! = Excessive Commission Quarter
* = Significantly Deviant Result
b = Borderline Result

1. Excessive (≥50%) commissions may invalidate the other variables in quarter 3 and 4.

2. Commission Errors are compatible with adult pattern attention deficit.

3. Omissions are significantly high in quarter 2. In addition, we'd expect Omissions to be decreased when Commissions are excessive as in quarters 3 and 4. However, Omissions are still significantly high in quarter 3 although technically invalid.

4. Note increase of Omissions from quarter 1 and quarter 2 that may be indicative of a 5 minute attention span in a boring task.

002 "Acquired" ADHD, secondary to a head injury

Protocol 002

11 year old boy tested in 1988 as part of norming study. He was tested again in 1990, as part of a neuropsychological assessment, six months after a serious auto accident and a long period of unconsciousness. Since the accident, his behavior has deteriorated dramatically, and he now meets criteria for ADHD.

	1988	1990
Omissions		
Standard Dev	0	-1.8*
Standard Score	100	73*
Commissions		
Standard Dev	.7	.3
Standard Score	111	105
Response Time		
Standard Dev	.3	-1.7*
Standard Score	105	75*
RT Variability		
Standard Dev	-.1	-2.1*
Standard Score	99	69*

□ = Invalid Quarter
!! = Excessive Commission Quarter
* = Significantly Deviant Result
b = Borderline Result

1. 1988 all variables are within normal limits.

2. 1990 - Omissions, Response Time, and Variability are all significantly deviant.

020 Neurological pattern- lapse seizures

Protocol 020 10 year old male with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF		TOTAL
Omission Errors	%							
Standard Dev		-2.2*	-3.6*	-.77	>-4*	-3.1*	-2.0*	-2.3*
Standard Score		66*	46*	88	<40*	53*	70*	65*
Commission Errors	%	.16	-2.6*	.03	.8	-1.1	.43	-.09
Standard Dev		102	60*	100	112	83	106	98
Standard Score								
Response Time	ms							
Standard Dev		-2.8*	-3.3*	-2.5*	-2.9*	-3.1*	-2.8*	-2.9*
Standard Score		58*	50*	62*	56*	53*	58*	55*
RT Variability	ms							
Standard Dev		-.94	-2.7*	-3.4*	-3*	-2.3*	-3.2*	-3.3*
Standard Score		85	58*	48*	55*	65*	51*	50*

□ = Invalid Quarter
!! = Excessive Commission Quarter
* = Significantly Deviant Result
b = Borderline Result

1. Total, halves and quarter scores significantly deviant from norms.

2. All variables worsen from quarter 1 to 2 suggesting a 5 minute attention span in boring task.

3. Response by response review revealed groupings of omissions.

4. Lapse seizures were subsequently diagnosed.

VI. Appendices

A. Testing Instructions

B. T.O.V.A. Observer Rating Form

C. Visual Norms

Summary
Omissions
Commissions
Response Time
Variability
D Prime

D. Auditory Norms

Summary
Omissions
Commissions
Response Time
Variability
D Prime

Appendix A.
TESTING INSTRUCTIONS

As with other assessment tools, it is important for the subject and the test user to have developed sufficient interpersonal rapport prior to test administration to facilitate administration. Further, the computer and /or monitor on which the test is being operated should be directly in front of the subject, at a comfortable position, easily seen by the subject.

Lighting must not produce glare on the monitor. Seating and environment must be comfortable and appropriate for the approximate half hour testing session.

Outside or environmental distractions, such as intercoms, telephones, and the like should be avoided during the test administration. Headphones may be used instead of speakers or to minimize auditory distractions.

The T.O.V.A. was normed with test administrations performed in the morning, prior to 1 p.m., to avoid diurnal variations. It was the first test administered to the norming subjects; however, test order use has not been studied independently. The recommended testing procedure for sequential T.O.V.A. testing in the same day is that there be at least 1 1/2 hours in between tests to minimize the effects of fatigue. If there is less than one hour between tests, the second test is considered technically invalid, and it is recommend that it be repeated on a different day.

Also, the norms were obtained with an observer present at all times during the testing. Even though the observer (test administrator) was not interactive during the testing, the observer was physically present. We recommend that the test administrator maintain physical presence throughout the testing. If behavioral cues are needed to assist the subject in staying on task, please note the cues and frequency to add to the behavioral information during the testing session.

Prompting is permitted during the practice test, but not during the actual testing (unless absolutely necessary). This was the format used for the test normalization. Encouragement of cooperation may be helpful in some younger subjects.

Please note interactions and frequencies to add to the behavioral information during the testing session. A "T.O.V.A. Observer Behavior Rating Form" is provided in the appendices.

The test administrator should be familiar with the test administration instructions prior to the use of the test. To properly utilize the interpreted T.O.V.A. test profile, the professional should be thoroughly familiar with the test scores and their meaning. Knowledge of attentional processes, impulse control, cognitive processes, childhood development, medical disorders, psychiatric disorders and neuropsychological functioning is essential to the utilization of the test data.

Since the tests are not language dependent, instructions may be given in the subject's native language.

Administration of the Test

Overview

The T.O.V.A. is the visual stimulus based CPT. The subjects are presented with visually presented targets and nontargets. (See Figure 1, Chapter 1.) The subjects are instructed to press the microswitch as quickly as possible after seeing the target stimulus. They are instructed to not press the switch (i.e., do nothing) when they see the nontarget. The targets and nontargets are pre-designed to appear in two different conditions, stimulus infrequent and stimulus frequent. Stimulus infrequent is defined by 36 targets and 126 nontargets per quarter in quarters 1 and 2. Stimulus frequent is defined by 126 targets and 36 nontargets per quarter in quarters 3 and 4. The test is internally timed to last for 21.6 minutes. Testing is usually scheduled for a half hour for a complete session.

The T.O.V.A.-A. is the auditory stimulus based CPT. The subjects are presented with auditory targets and nontargets. The auditory target sound is G above middle C, and the nontarget sound is *middle C*. Like the visual stimulus based test, the test has two conditions, stimulus infrequent and stimulus frequent. The subjects are instructed to press the microswitch as quickly as possible after they hear the target stimulus. They are instructed to not press the switch (i.e., do nothing) when they hear the nontarget. The targets and nontargets are pre-designed to

sound in two different conditions, stimulus infrequent and stimulus frequent. Stimulus infrequent is defined by 36 targets and 126 nontargets per quarter in quarters 1 and 2. Stimulus frequent is defined by 126 targets, 36 nontargets per quarter in quarters, 3 and 4. The test is internally timed to last for 21.6 minutes. Testing is usually scheduled for a half hour for a complete session.

We recommend that the computer and monitor be turned on with the appropriate test program "booted up" and tested prior to the subject entering the test room. The test examiner must enter the necessary demographic information needed to run the test (See T.O.V.A. Clinical Manual for additional assistance).

INSTRUCTIONS FOR ADMINISTERING THE T.O.V.A.

Administration of Practice Test for the Visual T.O.V.A.

The visual T.O.V.A. and the auditory T.O.V.A.-A., both, offer practice tests to insure that the subject understands the testing conditions and instructions. The subject is to be fast AND accurate so as not to sacrifice speed for accuracy or vice versa.

Since a practice test (3 minutes) was administered before the T.O.V.A. and T.O.V.A.-A. norming data were obtained, it is recommended that it be administered before testing a subject for the first time. A quick verification of the practice summary data also ensures that the program is operating correctly before the subject starts a full session.

Slowly read (or paraphrase) the following:

> "This test measures your ability to pay attention. Two different kinds of squares will flash on this computer screen. The squares will differ only in that one of them will have a small hole near the top (indicate with a picture or use DISPLAY STIMULI on screen), and one will have the hole near the bottom (indicate). We want you to press this button (indicate) every time you see the square with the hole near the top (indicate). (Find out which hand they use for writing.) I want you to hold this button in your writing hand with your thumb resting lightly on top, like this (indicate). Here... take the button. Let up when you hear the click; don't hold the button down very long. Push it down only once for each correct picture.
>
> "Now we are going to flash the squares on the screen, and your job is to press the button AS FAST AS YOU CAN every time you see a square with a hole near the top (indicate). But the trick is that you are NOT to press the button when the hole is near the bottom (indicate). Remember to press the button as fast as you can but only for the square with the hole near the top. The whole idea of this test is for you to be as fast, but also as accurate as you can. Try not to make any mistakes. But, if you do make a mistake...don't get upset, don't worry. Everyone can make a mistake on this test. Try and press the button as fast as you can but only for the square with the hole in the top. Don't be too fast -- take enough time to see which picture it is. Don't guess. Once you've pressed the button, let up. Don't press it more than once when you see the correct signal. Any questions...?
>
> "Now we are going to have a short practice. After I press the button, you are going to see a dot appear in the middle of the screen. That's where the squares are going to appear. After the dot appears, the numbers 3...2...1... are going to appear and then the first square will flash on the screen. Remember, the whole idea is to be as fast AND accurate as you can be. Any questions...?"

Starting the Practice Test

Start the practice. The practice test lasts 3 minutes. Observe to be sure the subject is doing it correctly and give prompts freely early in the practice test. Instruct again if necessary. Rerun practice if necessary until subject understands.

Check practice results to ensure the proper recording and that the subject understands the task. If errors are excessive, repeat the practice test with special instructions/reinforcement to be fast AND accurate.

Keep notes of observations of distractibility, attentiveness, mood, compliance, activity level, style of performance, medications and dosages taken in last 12 hours, etc. A form is provided in the Appendices. These observations provide behavioral information to go with the data provided in the TOVA report

Administering a Practice Test After the First Test

In subsequent tests with the same subject, you may run partial practice tests to remind the subject of the task and to reinforce the goals of speed AND accuracy. However, always look at the summary scores of the practice test to ensure the test is recording correctly before continuing to the full test. The recommended testing procedure for sequential T.O.V.A. testing in the same day is that there be at least 1 1/2 hours in between tests to minimize the effects of fatigue.

Administering the T.O.V.A.

After practice is over, slowly read the following:

> "OK, now we are going to do the test for about 20 minutes. Do the best job you can. Also, you should know that your eyes are probably going to get a little tired. Even so, try and do the best job you can... press the button as quickly as you can but only for the square with the hole in the top.
>
> "I'll be staying here while you do the test, but I can't talk to you once the test starts. Do you have any questions before we begin?
>
> "Ready, here we go... start watching the screen." Start the test.

Observe and record if the subject is on task, and how the subject is reacting to the test. Do not prompt unless absolutely necessary; i.e., only if results will be invalid without prompting. Record if prompted. A behavioral observation form is provided in the Appendices.

Observe for multiple responses to stimuli. This can be done by paying attention to the sound of the microswitch. While the test automatically records multiple responses, observation of the phenomenon for clinical correlation is advised.

When testing is completed the data will be saved. You will be returned to the Homepage and ready for scoring/interpreting.

INSTRUCTIONS FOR ADMINISTERING AUDITORY T.O.V.A.-A.

Administration of Practice Test for the T.O.V.A.-A.

Slowly read (or paraphrase) the following:

> "This test measures your ability to pay attention. Two different kinds of notes will be heard. The notes will differ only in that one of them will be higher in pitch (DEMONSTRATE TARGET NOTE) than the other (DEMONSTRATE NONTARGET NOTE). I want you to press this button (indicate) every time you hear this sound (DEMONSTRATE TARGET SOUND)." Find out which hand they use for writing. Then continue: "I want you to hold this button in your writing hand with your thumb resting lightly on top, like this (indicate). Here... take the button. Let up when you hear the click; don't hold the button down very long. Push it down only once for each correct note.
>
> "Now we are going to play the notes, and your job is to press the button AS FAST AS YOU CAN every time you hear the high note (DEMONSTRATE). But the trick is that you are NOT to press the button when the low note is heard (DEMONSTRATE). Remember to press the button as fast as you can but only for the high note. The whole idea of this test is for you to be as fast, but also as accurate as you can. Try not to make any mistakes. But, if you do make a mistake...don't get upset, don't worry. Everyone can make a mistake on this test. Try and press the button as fast as you can but only for the high note (DEMONSTRATE). Don't be too fast -- take enough time to hear which note it is. Don't guess. Once you've pressed the button, let up. Don't press it more than once when you hear the correct note. Any questions...?
>
> "Now we are going to have a short practice. When I press a key on the computer, the notes will begin. After I press the key, the numbers 3...2...1... are going to appear and then the first note will be heard. Remember, the whole idea is to be as fast AND accurate as you can be. Any questions...?"

Starting the Practice Test

Start the practice. The practice test lasts 3 minutes. Observe to be sure the subject is doing it correctly and use prompts freely early in the practice test. Instruct again if necessary. Rerun practice if necessary until subject

demonstrates an understanding of the test instructions. If you wish, you can check practice results. If errors are excessive, repeat practice after discussing the instructions with the subject.

Keep notes of observations of distractibility, attentiveness, mood, compliance, activity level, style of performance, medications and dosages taken in last 12 hours, etc. A form is provided in the Appendices. These observations provide behavioral information to go with the data provided in the TOVA report.

Administering a Practice Test After the First Test

The visual T.O.V.A. and the auditory T.O.V.A.-A., both, offer practice tests to insure that the subject understands the testing conditions and instructions. The subject is to be fast AND accurate so as not to sacrifice speed for accuracy or vice versa.

Since a practice test (3 minutes) was administered before the T.O.V.A. and T.O.V.A.-A. norming data were obtained, it is recommended that it be administered before testing a subject for the first time. A quick verification of the practice summary data also ensures that the program is operating correctly before the subject starts a full session.

Administering the T.O.V.A.-A.

After practice is over (3 minutes), slowly read the following:

> “OK, now we are going to do the test for about 20 minutes. Do the best job you can. Also, you should know that you will probably get a little tired. Even so, try and do the best job you can... press the button as quickly as you can but only for the high note.
>
> "I'll be staying here while you do the test, but I can't talk to you once the test starts. Do you have any questions before we begin?
>
> "Ready, here we go... start listening " Start the test.

Observe and record if the subject is on task, and how the subject is reacting to the test. Do <u>not</u> prompt unless absolutely necessary; i.e., only if results will be invalid without prompting. Record if prompted. A behavioral observation form is provided in the Appendices.

Observe for multiple responses to stimuli. This can be done by paying attention to the sound of the microswitch. While the test automatically records multiple responses, observation of the phenomenon for clinical correlation is advised.

When testing is completed the data will be saved. You will be returned to the Homepage and ready for scoring/interpreting.

Appendix B.

T.O.V.A. Observer Rating Form

Subject's name: _____ ***Date of test*** _____

Please rate the subject's behavior for each quarter while taking the T.O.V.A., using a scale of 1 (not at all) to 5 (very much)

	Quarter 1 (0-5.4')	2	3 (10.8-16.2Ó)	4
Distractible-in general	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Visual	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Auditory	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

(Please check here if there were no auditory/visual distractions during test _____)

Overactive	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Inattentive	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Becomes frustrated	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Uncooperative or oppositional	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Changes hands	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Tics (vocal or motor)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Staring, falls asleep	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Tires, wears out	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Complaining	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Talking	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Prompting needed	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Not trying hard/doesn't care attitude	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

How many hours did subject sleep last night?

Medications? (please list and record dosage and number of hours since last dose)

Please record substance use (and hours since last use):

	How much per day in last 2 wks	How much today
Cigarettes?		
Caffeinated beverages?		
Alcohol?		
Other?		

Appendix C.

Visual Norms - Summary

Years of Age	Omission Errors (%): Inattention [Mean ± SD]	Commission Errors (%): Impulsivity [Mean ± SD]	Response Time (ms) [Mean ± SD]	Variability (SD, ms) [Mean ± SD]	D PRIME: Hit Rate/ False Alarm Rate [Mean ± 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±.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±1.26	6.65±4.16	412.80±71.07	130.95±34.36	5.06±1.17
Age 12					
Male (N=37)	.68±1.15	6.34±3.82	389.92±73.81	125.05±37.09	4.97±1.15
Female (N=49)	.53±.92	4.59±4.16	410.29±80.96	122.33±40.89	5.34±1.26
Age 13					
Male (N=66)	.67±1.44	4.93±3.93	379.74±60.77	108.35±33.71	5.16±1.22
Female (N=69)	.55±1.39	3.81±2.85	379.71±56.85	103.09±29.61	5.14±1.14
Age 14					
Male (N=46)	.31±.47	3.97±3.31	383.43±65.82	104.70±35.07	5.32±1.05
Female (N=36)	.27[10]±.65	2.95±2.60	383.36±62.93	100.39±34.64	5.71±1.12
Age 15					
Male (N=61)	.69±1.31	3.64±2.82	361.15±53.54	96.59±27.34	5.25±1.19
Female (N=58)	.41±.82	3.45±3.39	374.41±61.85	90.93±22.71	5.63±1.42

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.

Visual Norms - Summary

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)	$.07^{10}$±$.18^{10}$	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)	$.00^{10}$±$.01^{10}$	1.62±1.05	355.25±72.94	64.00±12.83	6.49±0.36
Female (N=22)	$.14^{10}$±$.25^{10}$	1.77±1.56	369.77±53.53	81.36±24.57	6.05±0.96
Age 40 - 49					
Male (N=14)	$.02^{10}$±$.08^{10}$	2.76±1.80	331.93±31.25	66.14±11.60	6.29±0.84
Female (N=19)	$.06^{10}$±$.13^{10}$	1.88±2.01	405.32±66.85	81.89±21.06	6.21±0.85
Age 50 - 59					
Male (N=8)	$.19^{10}$±$.28^{10}$	2.16±1.22	442.88±46.85	75.38±11.55	5.71±1.02
Female (N=16)	$.15^{10}$±$.32^{10}$	1.85±2.33	432.06±41.57	79.56±17.37	6.20±1.22
Age 60 - 69					
Male (N=12)	$.10^{10}$±$.24^{10}$	1.95±2.22	447.17±35.92	86.50±22.93	6.19±0.91
Female (N=24)	$.22^{10}$±$.31^{10}$	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

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).*

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Visual Norms - Omissions (%)

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^{4}±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^{4}±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)	$.65^{4}$±2.00^{4}	$.76^{4}$±2.10	$.41^{2}$±$.78^{2}$	$.68^{2}$±1.01	.71±1.71	$.41^{6}$±$.78^{6}$	.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	$.52^{6}$±1.03^{6}	.68±1.26
Age 12							
Male (N=37)	$.53^{4}$±1.95^{4}	$.98^{4}$±1.83	$.58^{2}$±.88	.93±1.71	.70±1.54	$.72^{6}$±1.24^{6}	.68±1.15
Female (N=49)	$.61^{4}$±1.39^{4}	$.83^{4}$±1.61^{4}	$.44^{2}$±.85	$.57^{2}$±1.49	.72±1.27	$.50^{6}$±1.03^{6}	.53±.92
Age 13							
Male (N=66)	$.68^{4}$±1.97^{4}	$.76^{4}$±1.48^{4}	$.56^{2}$±1.43	.86±1.85	.71±1.50	$.67^{6}$±1.56^{6}	.67±1.44
Female (N=69)	$.33^{4}$±1.05^{4}	$.61^{4}$±2.02	$.57^{2}$±.92	$.63^{2}$±2.26	.47±1.43	$.56^{6}$±1.41^{6}	.55±1.39
Age 14							
Male (N=46)	$.37^{4}$±1.12^{4}	$.36^{4}$±$.95^{4}$	$.32^{2}$±.79	$.25^{2}$±$.53^{2}$	$.35^{8}$±.73	$.29^{6}$±$.53^{6}$	.31±.47
Female (N=36)	$.08^{4}$±$.46^{4}$	$.16^{4}$±$.67^{4}$	$.41^{2}$±1.03	$.30^{2}$±$.77^{2}$	$.10^{8}$±$.36^{8}$	$.31^{6}$±$.82^{6}$	$.27^{10}$±.65
Age 15							
Male (N=61)	$.47^{4}$±1.76^{4}	1.89^{4}±6.04	$.66^{2}$±1.07	$.39^{2}$±1.24	1.18±3.33	$.53^{6}$±1.02^{6}	.69±1.31
Female (N=58)	$.29^{4}$±1.00^{4}	$.58^{4}$±1.14^{4}	$.36^{2}$±$.72^{2}$	$.57^{2}$±1.58	.42±.78	$.40^{6}$±$.97^{6}$	.41±.82

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).*

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Visual Norms - Omissions (%)

Age 16 Male (N=22) Female (N=29)	$.63^{4}\pm1.19^{4}$ $.86^{4}\pm2.98$	$.63^{4}\pm1.70^{4}$ $.77^{4}\pm2.34^{4}$	$.76^{2}\pm1.26$ $.77^{2}\pm1.64$	$.87\pm2.27$ $.63^{2}\pm1.15$	$.63\pm1.11$ $.81\pm2.61$	$.81^{6}\pm1.69$ $.70^{6}\pm1.27^{6}$	$.77\pm1.42$ $.72\pm1.42$
Age 17 Male (N=18) Female (N=18)	$.46^{4}\pm1.07^{4}$ $.62^{4}\pm1.52^{4}$	$.00^{4}\pm.00^{4}$ $.15^{4}\pm.65^{4}$	$.35^{2}\pm.49^{2}$ $.13^{2}\pm.30^{2}$	$.22^{2}\pm.46^{2}$ $.62^{2}\pm1.55$	$.23^{8}\pm.53$ $.39\pm.80$	$.29^{6}\pm.30^{6}$ $.37^{6}\pm.90^{6}$	$.27^{10}\pm.30$ $.38\pm.75$
Age 18 Male (N=32) Female (N=66)	$.17^{4}\pm.68^{4}$ $.21^{4}\pm.74^{4}$	$.17^{4}\pm.68^{4}$ $.29^{4}\pm.99^{4}$	$.37^{2}\pm.49^{2}$ $.31^{2}\pm.60^{2}$	$.42^{2}\pm.75^{2}$ $.43^{2}\pm1.48$	$.17^{8}\pm.59$ $.25^{8}\pm.69$	$.40^{6}\pm.48^{6}$ $.37^{6}\pm.99^{6}$	$.35\pm.42$ $.35\pm.80$
Age 19 Male (N=25) Female (N=54)	$.00^{4}\pm.01^{4}$ $.21^{4}\pm.73^{4}$	$.11^{4}\pm.56^{4}$ $.62^{4}\pm1.84^{4}$	$.10^{2}\pm.26^{2}$ $.54^{2}\pm2.05$	$.06^{2}\pm.32^{2}$ $.71^{2}\pm2.47$	$.06^{8}\pm.28^{8}$ $.41\pm1.16$	$.08^{6}\pm.20^{6}$ $.62^{6}\pm2.23$	$.07^{10}\pm.18^{10}$ $.58\pm1.81$
Age 20 - 29 Male (N=19) Female (N=30)	$.29^{4}\pm.88^{4}$ $.56^{4}\pm1.85^{4}$	$.29^{4}\pm.88^{4}$ $.37^{4}\pm.96^{4}$	$.33^{2}\pm.97$ $.26^{2}\pm.82$	$.46^{2}\pm1.00$ $.87\pm2.14$	$.29^{8}\pm.58$ $.46\pm1.17$	$.40^{6}\pm.88^{6}$ $.57^{6}\pm1.34^{6}$	$.37\pm.72$ $.55\pm1.21$
Age 30 - 39 Male (N=4) Female (N=22)	$.00^{4}\pm.01^{4}$ $.25^{4}\pm.82^{4}$	$.00^{4}\pm.01^{4}$ $.13^{4}\pm.59^{4}$	$.00^{2}\pm.01^{2}$ $.11^{2}\pm.28^{2}$	$.00^{2}\pm.01^{2}$ $.14^{2}\pm.31^{2}$	$.00^{8}\pm.01^{8}$ $.19^{8}\pm.49$	$.00^{6}\pm.01^{6}$ $.13^{6}\pm.23^{6}$	$.00^{10}\pm.01^{10}$ $.14^{10}\pm.25^{10}$
Age 40 - 49 Male (N=14) Female (N=19)	$.00^{4}\pm.01^{4}$ $.00^{4}\pm.01^{4}$	$.00^{4}\pm.01^{4}$ $.15^{4}\pm.64^{4}$	$.06^{2}\pm.21^{2}$ $.13^{2}\pm.30^{2}$	$.00^{2}\pm.01^{2}$ $.00^{2}\pm.01^{2}$	$.00^{8}\pm.01^{8}$ $.07^{8}\pm.32^{8}$	$.03^{6}\pm.11^{6}$ $.06^{6}\pm.15^{6}$	$.02^{10}\pm.08^{10}$ $.06^{10}\pm.13^{10}$
Age 50 - 59 Male (N=8) Female (N=16)	$.35^{4}\pm.98^{4}$ $.17^{4}\pm.69^{4}$	$.35^{4}\pm.98^{4}$ $.00^{4}\pm.01^{4}$	$.10^{2}\pm.28^{2}$ $.25^{2}\pm.63^{2}$	$.20^{2}\pm.56^{2}$ $.10^{2}\pm.40^{2}$	$.35^{8}\pm.64$ $.09^{8}\pm.35^{8}$	$.15^{6}\pm.30^{6}$ $.17^{6}\pm.35^{6}$	$.19^{10}\pm.28^{10}$ $.15^{10}\pm.32$
Age 60 - 69 Male (N=12) Female (N=24)	$.00^{4}\pm.01^{4}$ $.35^{4}\pm.94^{4}$	$.00^{4}\pm.01^{4}$ $.23^{4}\pm.78^{4}$	$.20^{2}\pm.49^{2}$ $.33^{2}\pm.66^{2}$	$.07^{2}\pm.23^{2}$ $.07^{2}\pm.22^{2}$	$.00^{8}\pm.01^{8}$ $.29^{8}\pm.71$	$.13^{6}\pm.31^{6}$ $.20^{6}\pm.39^{6}$	$.10^{10}\pm.24^{10}$ $.22^{10}\pm.31$
Age 70 - 79 Male (N=12) Female (N=39)	$.23^{4}\pm.80^{4}$ $.21^{4}\pm.75^{4}$	$1.16^{4}\pm2.50^{4}$ $1.21^{4}\pm2.69^{4}$	1.19 ± 1.81 $.81\pm1.63$	2.18 ± 3.42 $.65^{2}\pm2.20$	$.69\pm1.26$ $.71\pm1.52$	1.69 ± 2.56 $.73^{6}\pm1.82$	1.47 ± 2.22 $.73\pm1.71$
Age 80 and up Male (N=8) Female (N=23)	3.13 ± 3.77 $1.57^{4}\pm3.63$	3.47 ± 4.39 $1.21^{4}\pm2.34^{4}$	2.58 ± 1.93 1.83 ± 3.11	1.88 ± 2.61 2.83 ± 5.82	3.30 ± 3.92 1.39 ± 2.78	2.23 ± 2.15 2.33 ± 3.73	2.47 ± 2.47 2.12 ± 3.11

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).*

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Visual Norms - Commissions (%)

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[5]±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[5]±.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[5]±.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[5]±.85[5]	15.35±12.81	3.97±3.31
Female (N=36)	.58[1]±1.01	.37[1]±.67[1]	10.98±9.18	12.48±11.78	.46[5]±.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[5]±.92[5]	14.56±10.74	3.64±2.82
Female (N-58)	.73[1]±1.08	.24[1]±.54[1]	13.38±14.04	14.89±13.89	.45[5]±.66[5]	14.12±13.41	3.45±3.39

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Visual Norms - Commissions (%)

Age 16							
Male (N=22)	1.19±1.76	.61[1]±.88	15.15±15.78	16.29±18.47	.90[5]±1.24[5]	15.72±16.58	4.19±4.54
Female (N=29)	.57[1]±.95	.36[1]±.62[1]	9.87±9.32	12.74±10.69	.47[5]±.75[5]	11.30±9.24	2.87±2.46
Age 17							
Male (N=18)	.71[1]±1.36	.26[1]±.54[1]	9.72±12.14	12.04±13.10	.49[5]±.90[5]	10.88±12.17	2.79±3.11
Female (N=18)	.62[1]±1.00	.31[1]±.48[1]	6.48±7.13	10.19±10.74	.46[5]±.64[5]	8.33±8.52	2.21±2.26
Age 18							
Male (N=32)	.55[1]±.74[1]	.69[1]±1.14	14.41±13.00	16.84±15.18	.62[5]±.64[5]	15.19±12.54	3.86±3.04
Female (N=66)	.48[1]±.68[1]	.44[1]±.79	12.16±12.50	13.43±12.82	.46[5]±.61[5]	12.82±12.15	3.21±2.87
Age 19							
Male (N=25)	.41[1]±.61[1]	.16[1]±.32[1]	8.33±5.50	9.22±8.44	.29[5]±.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[5]±.85[5]	14.63±13.38	3.73±3.38
Age 20 - 29							
Male (N=19)	.75[1]±.72[1]	.75[1]±.93	18.71±13.70	19.30±16.16	.75[5]±.66[5]	19.01±14.22	4.81±3.48
Female (N=30)	.37[1]±.74[1]	.40[1]±.93	9.26±10.43	8.70±11.60	.38[5]±.62[5]	8.98±10.58	2.29±2.66
Age 30 - 39							
Male (N=4)	.00[1]±.01[1]	.20[1]±.40[1]	6.94±4.81	6.94±5.78	.10[5]±.20[5]	6.94±4.39	1.62±1.05
Female (N=22)	.14[1]±.31[1]	.61[1]±1.75	5.18±5.24	8.08±7.90	.38[5]±.87[5]	6.63±5.84	1.77±1.56
Age 40 - 49							
Male (N=14)	.51[1]±.59[1]	.28[1]±.39[1]	9.33±7.11	12.70±9.42	.40[5]±.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[1]±.41[1]	6.25±5.51	10.07±6.95	.45[5]±.39[5]	8.16±5.11	2.16±1.22
Female (N=16)	.74[1]±1.80	.20[1]±.54[1]	5.73±6.21	7.64±8.70	.47[5]±1.12[5]	6.68±6.96	1.85±2.33
Age 60 - 69							
Male (N=12)	.60[1]±.96	.26[1]±.52[1]	7.41±10.14	7.18±7.05	.43[5]±.60[5]	7.29±8.27	1.95±2.22
Female (N=24)	.63[1]±.84	.33[1]±.57[1]	10.30±10.05	10.53±11.38	.48[5]±.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[1]±.72[1]	9.54±7.69	8.19±7.73	.74[5]±.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[5]±.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

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.

Visual Norms - Response Time (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

Visual Norms - Response Time (ms)

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

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

Visual Norms - Variability (ms)

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

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

Visual Norms - D Prime (Perceptual Sensitivity)

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

Appendix D.
Auditory Norms - Summary

Years of Age	Omission Errors (%): Inattention [Mean ± SD]	Commission Errors (%): Impulsivity [Mean ± SD]	Response Time (ms) [Mean ± SD]	Variability (SD, ms) [Mean ± SD]	D PRIME: Hit Rate/False Alarm Rate [Mean ± 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

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.

Auditory Norms - Omissions (%)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
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)	$.85^{4}$±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^{4}±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)	$.29^{4}$±1.18^{4}	$.46^{4}$±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)	$.73^{4}$±2.43^{4}	$.89^{4}$±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)	$.36^{4}$±1.80^{4}	$.77^{4}$±2.17^{4}	$.69^{2}$±1.38	.87±1.62	.56±1.76	$.79^{6}$±1.36^{6}	.74±1.36
Age 13							
Male (N=98)	$.65^{4}$±2.21^{4}	$.79^{4}$±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)	$.74^{4}$±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)	$.34^{4}$±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)	$.50^{4}$±2.28^{4}	$.63^{4}$±1.61^{4}	$.77^{2}$±1.54	$.66^{2}$±1.37	.57±1.68	$.72^{6}$±1.28^{6}	.69±1.18
Age 15							
Male (N=98)	$.31^{4}$±1.59^{4}	$.31^{4}$±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)	$.37^{4}$±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)	$.24^{4}$±$.89^{4}$	$.83^{4}$±2.11^{4}	$.58^{2}$±1.15	.96±2.39	.53±1.21	$.77^{6}$±1.64	.72±1.40
Female (N=87)	$.35^{4}$±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)	$.22^{4}$±1.03^{4}	$.45^{4}$±1.30^{4}	$.46^{2}$±.88	$.61^{2}$±2.14	$.34^{8}$±.85	$.54^{6}$±1.21^{6}	.49±.98
Female (N=107)	$.31^{4}$±1.17^{4}	$.60^{4}$±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)	$.25^{4}$±$.80^{4}$	$.36^{4}$±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)	$.17^{4}$±$.95^{4}$	$.30^{4}$±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)	$.00^{4}$±$.01^{4}$	$.13^{4}$±$.59^{4}$	$.76^{2}$±2.20	$.33^{2}$±$.64^{2}$	$.06^{8}$±$.30^{8}$	$.55^{6}$±1.33^{6}	.44±1.03
Female (N=10)	$.00^{4}$±$.01^{4}$	$.00^{4}$±$.01^{4}$	$.64^{2}$±1.19	$.24^{2}$±$.75^{2}$	$.00^{8}$±$.01^{8}$	$.44^{6}$±$.91^{6}$	.34±.71
Age 20-29							
Male (N=54)	$.51^{4}$± 2.02^{4}	$.41^{4}$±$.1.13^{4}$	$.76^{2}$±1.88	2.10±6.66	.46±1.40	1.43±1.10^{6}	1.22±3.26
Female (N=75)	1.26^{4}±1.13^{4}	$.78^{4}$±3.75	$.49^{2}$±1.06	$.66^{2}$±1.59	.52±2.17	$.57^{6}$±1.21^{6}	.56±1.20

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).*

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Auditory Norms - Commissions (%)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
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[1]±.42[1]	8.00±8.09	12.99±12.30	.46[5]±.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[5]±.92[5]	9.16±12.43	2.32±2.83
Female (N=107)	.42[1]±1.14	.10[1]±.29[1]	4.76±6.46	7.16±6.68	.26[5]±.59[5]	5.95±5.92	1.51±1.44
Age 11							
Male (N=96)	.45[1]±.68[1]	.15[1]±.33[1]	4.93±4.95	7.03±7.44	.30[5]±.40[5]	5.96±5.14	1.54±1.27
Female (N=104)	.21[1]±.46[1]	.15[1]±.37[1]	4.35±4.74	7.52±8.55	.18[5]±.34[5]	5.93±6.13	1.44±1.39
Age 12							
Male (N=87)	.40[1]±.70[1]	.24[1]±.74[1]	4.91±6.45	5.64±7.80	.32[5]±.66[5]	5.28±6.65	1.40±1.53
Female (N=94)	.29[1]±.67[1]	.11[1]±.30[1]	3.08±3.54	5.28±5.59	.20[5]±.38[5]	4.18±3.96	1.08±1.04
Age 13							
Male (N=98)	.31[1]±.70[1]	.11[1]±.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[1]±.55[1]	.12[1]±.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[1]±.59[1]	.28[1]±.82	4.22±7.29	4.99±8.05	.27[5]±.58[5]	4.60±7.34	1.20±1.69
Female (N=101)	.18[1]±.40[1]	.13[1]±.33[1]	2.83±4.34	3.76±4.83	.15[5]±.27[5]	3.30±3.98	.85±.97
Age 15							
Male (N=98)	.22[1]±.46[1]	.13[1]±.34[1]	3.22±4.18	3.54±4.31	.17[5]±.29[5]	3.38±3.67	.88±.93
Female (N=90)	.14[1]±.49[1]	.10[1]±.33[1]	3.98±9.18	5.36±11.70	.12[5]±.33[5]	4.67±10.23	1.13±2.35
Age 16							
Male (N=94)	.17[1]±.40[1]	.13[1]±.31[1]	2.65[3]±3.81	2.83±3.90	.15[5]±.25[5]	2.73±3.36	.71±.79
Female (N=87)	.20[1]±.81	.07[1]±.29[1]	2.11[3]±3.94	3.08±5.83	.14[5]±.44[5]	2.61±4.54	.68±1.16
Age 17							
Male (N=99)	.15[1]±.39[1]	.09[1]±.25[1]	2.52[3]±6.93	2.99±6.85	.12[5]±.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[1]±.32[1]	.05[1]±.20[1]	1.88[3]±3.19	2.25[3]±3.84	.09[5]±.19[5]	2.06±3.16	.52±.71
Female (N=101)	.07[1]±.30[1]	.03[1]±.15[1]	1.16[3]±2.53[3]	1.94[3]±2.89	.05[5]±.17[5]	1.55±2.29	.38±.53
Age 19							
Male (N=22)	.07[1]±.24[1]	.07[1]±.23[1]	2.08[3]±5.15	1.99[3]±3.78	.07[5]±.16[5]	2.03±4.17	.49±.90
Female (N=10)	.16[1]±.33[1]	.08[1]±.25[1]	2.32[3]±3.78	1.94[3]±2.94	.12[5]±.19[5]	2.12±3.27	.56±.76
Age 20-29							
Male (N=54)	.34[1]± .61[1]	.18[1]±.32[1]	6.26±7.34	6.39±7.35	.23[5]±.33[5]	6.63±6.74	1.57±1.59
Female (N=75)	.23[1]±1.14[1]	.78v±3.75	4.40±3.10	4.33±5.95	.18[5]±.59[5]	4.37±5.70	1.11±1.40

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.

Auditory Norms - Response Time (ms)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
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

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

Auditory Norms - D Prime (Perceptual Sensitivity)

Years of Age	Quarter				Half		Total
	1	2	3	4	1	2	
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