



**Test of Variables of Attention®**

## **CLINICAL MANUAL**

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The TOVA Company  
June 14, 2017

# T.O.V.A.<sup>®</sup> 9 Clinical Manual

Test Of Variables of Attention Continuous Performance Test

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Edition Number 9.0-94-gad4b915 (June 14, 2017) L5R2

T.O.V.A. release 9.0-77-g9146952

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Printed in the United States of America.

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## Part I

# Important Information

## 1 Indications

The Test of Variables of Attention (T.O.V.A.) provides healthcare professionals with objective measurements of attention and inhibitory control, which aid in the assessment of attention deficits, including attention-deficit/hyperactivity disorder (ADHD). T.O.V.A. results should only be interpreted by qualified healthcare professionals.

**CAUTION:** Federal law restricts this device to sale by or on the order of a qualified healthcare professional.

## 2 Contraindications

The T.O.V.A. microswitch and USB device should not be used in conjunction with an MRI.

## 3 Warnings and Precautions

**WARNING:** Repetitive flashing of display may cause eye strain, headaches or seizures. Please seek medical help if you experience any eye strain or headache.

T.O.V.A. results should be interpreted only by qualified healthcare professionals.

## 4 T.O.V.A. Description

The Test of Variables of Attention (T.O.V.A.) is an accurate and objective continuous performance test (CPT) that measures the key components of attention and inhibitory control. The T.O.V.A. is used by qualified healthcare professionals in the assessment of attention deficits, including attention-deficit/hyperactivity disorder (ADHD), in children and adults.

The T.O.V.A. is a culture- and language-free, sufficiently long computerized test that requires no left/right discrimination or sequencing. Responses to visual or auditory stimuli are recorded with a specially designed, highly accurate ( $\pm 1$  ms) microswitch. The T.O.V.A. calculates response time variability (consistency), response time (speed), commissions (impulsivity), and omissions (focus and vigilance). These calculations are then compared to a large age- and gender-matched normative sample (over 1,700 individuals for the visual test, and over 2,600 individuals for the auditory test), as well as to a sample population of individuals independently diagnosed with ADHD. These comparison results are used to create an immediately available, easy-to-read report.

The T.O.V.A. system includes:

- USB flash drive with software installer for Mac and Windows PCs.
- T.O.V.A. USB device
- T.O.V.A. microswitch
- Installation Guide
- User's Manual
- Clinical Manual
- Accessory cables (USB, VGA, and audio cables)

## Part II

# Introduction

## 5 Terms and Concepts Used in This manual

**Attention**, according to Merriam-Webster's dictionary is a) the act or state of applying the mind to something, and b) a condition of readiness for such attention involving especially a selective narrowing or focusing of consciousness or receptivity.

Attention is a mainstay of life and the ability to focus one's attention has a determination on one's success in school, at work, and in relationships.

**Inhibitory Control** can be defined as a range of mechanisms that allow the suppression of previously activated cognitions and inappropriate actions and resistance to interference from irrelevant stimuli (Bjorklund & Harnishfegar, 1995).

**Attention-Deficit/Hyperactivity Disorder (ADHD)** refers to a specific symptom complex defined in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013).



## 6 Attention-Deficit/Hyperactivity Disorder (ADHD)

### 6.1 ADHD and the *DSM-5*

To gain a full understanding of attention-deficit/hyperactivity disorder (ADHD) please read and understand the description, criteria, and related disorders and comorbidities in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013).

In summary, there are currently five different diagnoses under ADHD in the *DSM-5*. These are:

- 314.01 (F90.2) Combined presentation
- 314.00 (F90.0) Predominantly inattentive presentation
- 314.01 (F90.1) Predominantly hyperactive/impulsive presentation
- 314.01 (F90.8) Other Specified Attention-Deficit/Hyperactivity Disorder
- 314.01 (F90.9) Unspecified Attention-Deficit/Hyperactivity Disorder

Clinicians need to specify if in Partial Remission. Partial Remission is defined as when full criteria were previously met but fewer than full criteria are presently met.

Clinicians also need to specify the current severity, with the choices being mild (just enough symptoms to meet criteria), moderate (between mild and severe), or severe (many symptoms in excess of the minimum needed or several symptoms that are severe or cause impairment in social or occupational functioning). It is interesting to note that educational functioning is not mentioned.

#### 6.1.1 Sub-Types Criteria

**314.00 (F90.0) Predominantly inattentive presentation** – Must have six or more of the following symptoms for six months or more. If 17 or older, must have 5 or more.

- Often fails to give close attention to details or makes careless mistakes in schoolwork, work, and other activities
- Often has difficulty sustaining attention in tasks and play activities
- Often does not seem to listen when spoken to directly
- Often does not follow through on instructions and fails to finish school work, chores, or duties in the workplace (but not due to oppositional behavior and not because of a failure to understand)
- Often has difficulty organizing tasks and activities

- Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
- Often loses things necessary for tasks or activities (e.g. toys, school assignments, pencils, books, or tools)
- Often easily distracted by extraneous stimuli
- Often forgetful in daily activities

**314.01 (F90.1) Predominantly hyperactive/impulsive presentation** – Must have six or more of the following symptoms for 6 months or more. If 17 and older must have 5 or more.

- **Hyperactivity**

- Often fidgets with hands or feet or squirms in seat
- Often leaves seat in classroom or in other situations in which remaining seated is expected
- Often runs about or climbs excessively in situations in which remaining seated is expected (in adolescents and adults, may be limited to feelings of restlessness)
- Often has difficulty playing or engaging in leisure activities quietly
- Often “on the go” or often acts as if “driven by a motor”
- Often talks excessively

- **Impulsivity**

- Often blurts out answers before questions have been completed
- Often has difficulty awaiting turn
- Often interrupts or intrudes on others (e.g., butts into conversations or games)

**314.01 (F90.2) Combined Type** – Must meet criteria for both inattentive and hyperactive/impulsive types for six months or more.

**314.01 (F90.8) Other Specified ADHD** – Criteria for other subtypes are not met, but symptoms are judged to cause clinically significant distress or impairment in social, occupational, or other important areas of life. Clinicians should add the reason for using “Other specified” such as “insufficient inattention symptoms”.

**314.01 (F90.9) Unspecified ADHD** – Criteria are the same as ADHD Other Specified, but no reason is given to specify the reason for the diagnosis.

### 6.1.2 Requirements

To qualify for the diagnosis of ADHD, the following criteria must be met:

- Six symptoms present before 12 for children and 5 symptoms present for 17 and older.

- Symptoms present in two or more settings.
- Symptoms interfere with or reduce the quality of social, academic or occupational functioning.
- The condition can not be caused by another psychiatric illness like Schizophrenia, or other psychotic disorder of mood, anxiety, dissociative disorder, or personality disorder.
- Specify if in partial remission.
- Specify mild, moderate, or severe.

### 6.1.3 Issues

Conceptually, the diagnostic category, “ADHD”, has many limitations.

- The symptoms are subjective, unreliable, and culture-bound.
- ADHD is really a symptom complex, not a disorder (that, by definition, must have a single, common etiology and a predictable natural history and response to treatment).
- The assumption that hyperactivity and attention deficits are necessarily linked is misleading and an artifact of equating symptom complexes with disorders. (This isn’t the only example in psychiatry and psychology of a hypothetical construct being treated as though it had an independent existence in the real world.)
- The requirement that the onset be by twelve years of age ignores some critical factors. As examples, many non-hyperactive, inattentive children and children with strong external support systems are not symptomatic until later.
- Since behavior is situationally specific, attention deficits may not be apparent in more than one setting. Differences in setting (school, classroom, teacher, peers) may affect the presence of symptoms.
- Although the emphasis is on inattention, individuals with ADHD are highly variable in their attention over time, and can hyperfocus.
- Executive functions are not included.

## 6.2 Causes of Off-Task Behavior

Differential diagnosis for off-task behavior includes the following:

- **Normal behavior**

Age-appropriate behavior that is mislabeled, e.g., “active alert” children or unrealistic adult expectations of normal development.

- **General medical problems**

Such as anemia, hyperthyroidism, otitis media, and dietary inclusions/sensitivities.

- **Medications**

Such as anticonvulsants, antihistamines, and antidepressants that sedate or slow the brain.

- **Toxic conditions**

Such as environmental exposures, drugs, or an illness.

- **Sensory deficits and hypersensitivities**

Such as unrecognized hearing and visual impairments and any sensory (including olfactory and kinesthetic) hypersensitivity.

- **Neurologic problems (other than ADHD)**

Such as sleep disturbances (including apnea and narcolepsy), seizures, and mild and major neurocognitive disorders (such as Traumatic Brain Injury).

- **Family style and organization**

This may include social and cultural factors.

- **School readiness**

The younger children in primary grades have a higher incident of ADHD diagnosis due to level of development compared to the older children in the class.

- **Learning style and motivation**

Some children (including those with ADHD) have a hands-on rather than a listen and understand learning style and may lose motivation if they aren't successful or their learning style is frustrated.

- **Stress**

Resulting from physical, sexual or emotional trauma and overwhelming situations.

- **Intellectual impairment and precocity**

High and low IQ and boundary testing.

- **Learning disabilities**

One third of individuals with an attentional disorder also have a learning disability, and vice versa.

- **Psychiatric conditions**

Such as PTSD, psychosis, bipolar disorder, obsessive-compulsive traits/disorders, depression, ODD, dementia, conduct disorder, reactive attachment disorder and/or anxiety.

- **Medication**

Over and under dosing of medication and improper medication.

- **Substance use, abuse, and withdrawal**

Legal and illegal substances including alcohol, caffeine, and nicotine.

- **ADHD** (see below)

**Note:** These causes are not mutually exclusive. As noted above, 30% of individuals with ADHD (including adults) have a learning disability (and vice versa), and between 25-35% of substance abusers have ADHD. In addition, untreated individuals with ADHD often develop low self-esteem, depression, coping strategies and acting out which may obscure the underlying ADHD.

### 6.3 Diagnosis of ADHD

The components of a diagnostic workup for ADHD **may** include:

- **History:** Nothing replaces a detailed personal and family history.
- **Physical exam:** A recent exam by a primary care provider is important.
- **Psychological/neuropsychological assessment:** There should be emphasis on learning style, cognitive assets and liabilities, and CNS functioning.
- **Evaluation of classroom/workplace behavior and performance:** Direct observations or telephone interview of teacher or supervisor are very helpful, especially to prepare for recommendations.
- **Mental status examination/personality assessment:** This helps identify comorbid and/or other conditions (such as depression).
- **Behavior ratings for children**—including the Vanderbilt, ACTeRS, the ASEBA, and BASC 3—are especially useful. Behavior ratings for adults include the ASRS-v1.1, the BAARS-IV, the ASEBA, and the BAADS. While behavior ratings are an important part of the diagnostic process, they are best used in conjunction with objective measures like the T.O.V.A. to minimize the effects of rater bias and overemphasis of disruptive behaviors.
- **DSM-5 Symptom checklists:** These checklists help clinicians to thoroughly review all symptoms of ADHD.
- **T.O.V.A.:** The T.O.V.A. objectively measures response time variability, response time, inhibitory control, focus and vigilance, all of which can be affected by many factors; however, **the T.O.V.A. does not make a diagnosis.** The clinician needs to make use of the objective results in the context of the full clinical picture. There will be more about this in the review of sensitivity and specificity.

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

**sequence.**

## 7 Continuous Performance Tests (CPTs)

### 7.1 T.O.V.A. variables

Historically speaking, Continuous Performance Tests (CPTs) have focused on the error rates (false positives [commission errors] and false negatives [omission errors]) to their stimuli. While response time is often measured, it is de-emphasized because of the inaccuracy of the measurement. The T.O.V.A. accurately and precisely measures *all* of the significant variables of both auditory and visual information processing, including response time and response time variability, allowing the clinician to see the full picture of CPT response.

#### 7.1.1 Primary variables

The following variables are included in the T.O.V.A.:

##### **Response Time Variability**

Response Time Variability (“RTV”) is a measure of variability (consistency) of response time. RTV is the standard deviation of correct response times, and thus directly measures the spread of the subject’s fast and slow response times. Individuals with ADHD tend to have inconsistent response times on the 10 - 100 millisecond time scale, and thus have a wider RTV. RTV is the most sensitive measure of the T.O.V.A. Because changes in RTV are on the 10 - 100 millisecond time scales, timing measurements must be very accurate; hence, the need for accurate timing (the T.O.V.A. USB device), an accurate and repeatable subject input device (the T.O.V.A. microswitch), and the need to calibrate out delays and variability in the computer screen (the T.O.V.A. microswitch’s calibration photodiode).

##### **Correct Response Time**

Correct Response Time is the processing time (in milliseconds) taken to respond correctly to a target. Counter-intuitively, individuals with ADHD often have slower than normal response times as well as faster ones. This measure is one of the more important ones in the T.O.V.A., especially in the infrequent (“boring”) first half.

##### **$d'$ or Response Sensitivity**

$d'$  or Response Sensitivity (the ratio of hit rate to false alarm rate) is a measure derived from Receiver Operating Characteristics (ROC) which is part of Signal Detection Theory. It is a measure of performance decrement, the rate of deterioration of performance over time. Most individuals tend to fatigue over time, especially with a boring task. The performance of individuals with ADHD tends to deteriorate faster than others.

##### **Errors of Commission**

Errors of Commission are a measure of impulsivity and/or disinhibition and occur when the subject incorrectly responds to the nontarget; that is, the subject pushes the button when they shouldn’t have. In the T.O.V.A., commission errors are far more frequent in the second half (high response demand). Since excessive commission errors can 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. When a report states that the results are ‘invalid’ because of excessive commission scores, it means that we must interpret the results cautiously since the other variables may or may not be valid. Of course, impulsivity is a hallmark of ADHD.

### **Errors of Omission**

Errors of Omission are a measure of focus and vigilance and occur when the subject does not respond to a target stimulus; that is, the subject omits pressing the button when a target appears or is played. This may be due to inattention or distractibility. Omission errors are rare in adults, and long strings of omission errors should be investigated. Use the Observation Form (page 44) to record behaviors during the test to determine and record the reason(s) for Omission errors.

When evaluating omissions, always look at the absolute or raw numbers of omission errors on the Summary page and/or the Tabulated Data page. In some cases one or two errors reach statistical significance because of the lack of omission errors in especially older ages of the T.O.V.A. normative study, yet there may be little or no clinical significance to one or two errors. As an example, a single error early in quarter 1 may signify that the subject was surprised when the test began even though the practice session preceded the test. Always interpret standard score data alongside actual raw data to determine clinical significance of the results.

#### **7.1.2 Secondary variables**

These variables are not as sensitive for assessing attention and inhibitory control as the primary variables, but are important to understand as they describe the subject’s performance.

### **Anticipatory Responses**

Anticipatory Responses (AR) are responses to stimuli that occur before the subject could have possibly processed the visual or auditory information. An AR occurs whenever a subject responds (pressing the microswitch) 200 milliseconds (ms) before and 150 ms after any stimulus (target or non-target) appears, or in the case of the Auditory T.O.V.A., any stimulus is heard. Humans need more than 150 ms to hear, distinguish, and respond to a go/no-go (target and a nontarget) stimulus; hence, the use of the word “anticipatory”. ARs are considered impulsive responses, and often occur when the subject is not actually attending to the T.O.V.A. test, but rather attempting to “guess” which stimulus (target or nontarget) is going to be displayed, or trying to “hit” the target by pressing the microswitch as soon as the stimulus is displayed (without regards to which stimulus it is).

ARs are not included in the calculations of errors, response times, and variability. Since excessive anticipatory responses can affect the other variables, they are also an important measure of test validity. Generally, excessive anticipatory responses decrease omission errors, increase commission errors, shorten response times, and increase variability. The Session, Response and Performance Validity section on T.O.V.A. Interpretation Notes page flags quarters with excessive ARs (equal or exceeding 10%) as needing to be cautiously interpreted.

### **Post-Commission Response Time**

Post-Commission Response Time is the correct response time when a target immediately follows a commission error. Clinical observations (but not carefully conducted research) indicate that most people (including individuals with 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 ADHD) either did not slow down or actually responded faster than their average response time. Thus, this may be a way to distinguish



individuals with ADHD only from individuals with a conduct disorder only, but not the comorbid condition. Rarely, some highly motivated individuals increase their focus, speed up after a commission error, and become more accurate. A post T.O.V.A. interview with the subject may help to clarify the reason for fast post-commission response times and adds depth to the clinical picture.

### Multiple Responses

Multiple Responses are considered to be a reflection of neurological status. Excessive multiple responses (>20/test) do not alter or invalidate the other variables, and they may reflect hyperactivity or neurological dysfunction.

## 7.2 Significant features

The following design features significantly influence what is being measured by a CPT as well as its “hit rate”:

### 7.2.1 Stimuli

- Visual and auditory modes

Both visual and auditory modalities may need to be evaluated since there can be problems with auditory and/or visual information processing. Most individuals process visual and auditory information similarly. That is, without a visual or auditory disorder, they process visual and auditory information similarly in terms of speed, variability, and accuracy.

However, some individuals process one type of sensory input differently than the other. Thus, the Visual T.O.V.A. performance may be within normal limits, but the Auditory T.O.V.A. may not be normal and vice versa. The T.O.V.A. intentionally separates the auditory and visual tests to minimize distractions and/or stimulation so that specific auditory and visual processing strengths and difficulties can be identified.

- Non-sequential or sequential tasks

In the typical CPT sequential task, the instructions are to respond whenever an A is followed by a X. Most CPTs use the A-X format which is cognitively more complex and difficult than the T.O.V.A. that uses a “go/no go” design with single non-sequential stimuli.

- Non-language or language based

Non-language based stimuli (like in the T.O.V.A., see Figure 1) minimize the potential confounding of the results by language, culture, and/or a learning disability.

The Auditory T.O.V.A. uses two single tones. The target is G above middle C (392.0 Hz), and the non-target is “middle C” (261.6 Hz).

- Configuration

Simple stimuli (like in the Visual and Auditory T.O.V.A.) are easier to process than complex stimuli and have less associative value.

- Monochromatic vs. multicolored stimuli

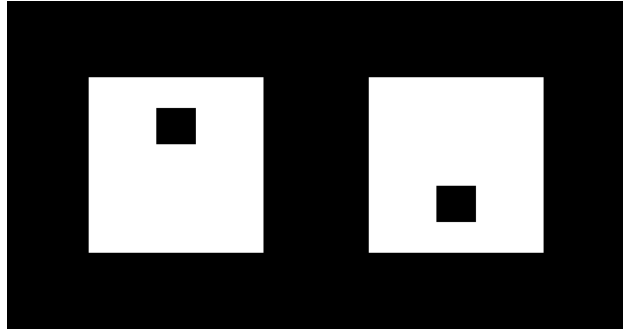


Figure 1: The T.O.V.A. visual stimuli.

Monochromatic stimuli (like in the T.O.V.A.) are simpler and less arousing than multicolored stimuli. The T.O.V.A. is designed to minimize the number of confounding variables that may affect a person's performance.

### 7.2.2 Presentation of stimuli

- **Infrequent and frequent target modes**
  - The infrequent target mode (or low response demand mode subtest) in quarters 1 and 2 is the more boring task and is the traditional form for measuring vigilance. Individuals with “low CNS arousal” tend to do poorly on this form.
  - The frequent target mode (or high response demand mode/high inhibition demand mode subtest) in quarters 3 and 4 is a more stimulating task during which individuals with “high CNS arousal” can become overstimulated, and individuals with “low CNS arousal” can “wake up”.
  - The T.O.V.A. for children 4 and 5 is a shorter test and consists of only quarter 1 (infrequent target mode subtest) and quarter 3 (frequent target mode subtest) to more appropriately match a normal attention span for their age.
- **Fixed or variable Inter-Stimulus Interval (ISI)**

A fixed ISI (the interval between the stimuli) minimizes stimulating/alerting changes while a variable ISI can be more arousing and/or difficult. The T.O.V.A. uses a two-second fixed ISI, which is generally accepted as the most discriminating interval.
- **Alerting signal**

The T.O.V.A. does not use alerting signals which would make the task easier and increase false negatives.
- **Stimulus presentation time**

The shorter the time the stimulus is “on”, the more difficult is the task. 100 ms (as in the T.O.V.A.) is the norm for CPTs.
- **Focal point**

Focal points (like in the T.O.V.A.) are frequently used in visual CPTs.

### **7.2.3 Practice vs. novelty effects**

The more complex CPTs can have significant practice effects, limiting their use as repeated measures. In contrast, the Visual T.O.V.A. actually has a small novelty effect. Thus, the Visual T.O.V.A. can be repeated even in the same day.

### **7.2.4 Length of test and subtests**

The longer the test, the harder it is to attend and inhibit. This is important when measuring vigilance, a key factor in attention disorders. The T.O.V.A. is a 21.6-minute test with two 10.8-minute subtests. For children ages 4 and 5, the T.O.V.A. is 10.8 minutes in length, and the two subtests are each 5.4 minutes each.

### **7.2.5 Distractions**

Few commercially available CPTs have distractors at this time. It is very difficult to control the novelty (arousing) effects of so-called distractions which may actually enhance or decrease performance in some cases. Some people come with their own built-in mechanisms (foot tapping, talking, chewing gum, etc) that may act to arouse the person and help them focus. This warrants being noted on the T.O.V.A. Observation Form (page [44](#)).

## 8 The T.O.V.A.

### 8.1 Construction of the T.O.V.A.

The T.O.V.A. consists of two subtests with no transition or warning between them.

In the **first half of the test** ( the “Infrequent” or vigilance mode), the target appears randomly and infrequently with a target : non-target ratio of 1:3.5. The person presses the microswitch infrequently and must stay on task while maintaining focus during this quickly boring half. There are 36 targets and 126 nontargets per quarter in quarters 1 and 2. Easily bored (“low arousal”) persons may do poorly during this half.

In the **second half of the test** (the “Frequent” or high response demand mode) the target appears randomly and frequently with a target : non-target ratio of 3.5:1. The person is frequently pressing the microswitch and must stay on task while inhibiting the tendency to respond. (There are 126 targets and 36 nontargets per quarter in quarters 3 and 4.) Easily overstimulated (“high arousal”) persons may do poorly.

Length of each subtest: 10.8 minutes.

For children **4 to 5.5 years of age**: The ratios of targets to non-targets remain the same; however, only quarters 1 and 3 are administered.

### 8.2 T.O.V.A. Intended Use

The Test of Variables of Attention (T.O.V.A.) provides healthcare professionals with objective measurements of attention and inhibitory control, which aid in the assessment of attention deficits, including attention-deficit/hyperactivity disorder (ADHD). T.O.V.A. results should only be interpreted by qualified healthcare professionals.

### 8.3 Administering the T.O.V.A.

**Training** to administer and monitor the test should follow the general outline of the instructions in the User’s Manual and include the use of the T.O.V.A. <sup>®</sup> Observation Form (page 44) for recording observations that may be helpful to the clinician. A thorough history and clinical interview can help determine whether to administer a Visual or Auditory T.O.V.A. session first. In general, the subject should balance speed and accuracy in order to be as fast as they can be, yet to minimize errors. Multimedia instructions are available in the T.O.V.A., and are available in eight languages.

#### 8.3.1 Pre-test Preparation

Preparing the subject is crucial, because it assures that the test is administered properly and replicates the same conditions as the T.O.V.A. norms.

1. Prior to testing, explain to the subject (or to caregivers) that no caffeinated beverages (e.g. coffee,

tea, cocoa, or soft drinks) should be ingested on the day of a test. Nor should the subject have smoked within 3-4 hours.

2. Setting: Testing should be done in a quiet, darkened room with a glare-free monitor screen. Clocks should not be visible or audible. It is best if the subject faces a neutral colored wall without distracting pictures. The keyboard should not be visible during the test.
3. The test administrator should be familiar with the test instructions and test administration prior to the test.
4. At test time:
  - Introduce yourself to the subject.
  - Ask if the subject needs to use the bathroom.
  - Determine whether they have glasses or hearing aid if needed.
  - Have subject remove his or her watch; mute all potential sources of noise including cell phones and place them out of line of vision.
  - Determine from subject or caregiver any and all medications taken in the last 24 hours, with dosage and interval since administered, and record them in the New Test Session window.
  - Determine whether the Auditory or Visual test is to be administered based on history and any previous test results. If in doubt, consider administering both practice tests to see which is the more challenging to the subject.
  - Position the subject and chair so he or she may sit with feet on the floor.
  - Position the monitor so the screen is at or near eye level.

## 8.4 Observation Form

The T.O.V.A. Observation Form (page 44) can be used by the test administrator to gather information before, during, and after the test. Behaviors that affect test performance can be noted to help determine the reason for test results. If the test is administered by a psychometrist or other staff member, the Observation Form should be given to the clinician along with the T.O.V.A. report.

## Part III

# Interpreting T.O.V.A. Reports

Familiarity with the scientific basis of the T.O.V.A. as well as the interpretation of the T.O.V.A. report will help establish the best use of the T.O.V.A. Clinical casework or reflections are not a recommendation for assessment or diagnosis.

## 9 Factors Affecting T.O.V.A. Performance

The T.O.V.A. performance can be significantly improved or worsened by anything that affects attention:

- Someone with ADHD could successfully self-medicate with nicotine and/or caffeinated beverages, assuming that excessive quantities are not ingested. A person with ADHD who has coffee, an energy drink, or cigarettes before testing may very well perform within normal limits on the T.O.V.A.
- On the other hand, acute caffeine and nicotine withdrawal can have adverse effects on attention. Thus, a person without ADHD can do poorly on the T.O.V.A. if they do not indulge in their habitual coffee in the morning.
- Any medication that can affect brain function can affect attention. Someone taking antihistamines for allergies can become sufficiently sedated so that the T.O.V.A. performance may not be within normal limits just as someone receiving lithium for a bipolar disorder may have slow response times.
- People with ADHD who have extensive video game experience and highly trained athletes may perform normally on the visual T.O.V.A. due to the hand-eye coordination training. The auditory T.O.V.A. is useful in these situations although musicians may do better on the auditory T.O.V.A.
- Sleep deprivation, anxiety, and depression, as well as a number of psychiatric conditions, can adversely affect performance whether comorbid with ADHD or not.
- Although the literature is not definitive, a person with an above average intelligence may perform better than average. Conversely, someone with a lower than average intelligence may perform less than average.

**It is important that the clinician obtain an adequate history and behavior ratings to be able to interpret T.O.V.A. results, taking the above factors into account.**

## 10 The standard T.O.V.A. Report

The following pages contain T.O.V.A. Reports and discussion of the forms and findings. When printing out a Report, you may select which pages you want printed and not print out the other pages. When

sending a Report to a clinician, we recommend sending the Introduction, Summary, Interpretation Notes, and Analyzed Data pages.

## **10.1 Introduction Page**

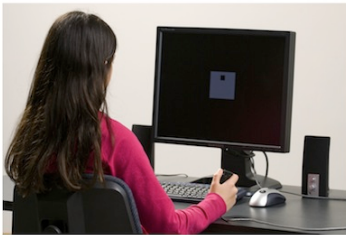
This page provides basic information about the T.O.V.A. and its uses. It can be given to persons unfamiliar with the T.O.V.A. as an overview of the test.

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

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



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



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



## 10.2 Summary Page

### 10.2.1 Demographic Information

This page, and the pages to follow, include demographic data about the subject in a light gray box. Demographic information includes the subject's name, gender, date of birth and age, as well as details on the T.O.V.A. session (Visual or Auditory test, T.O.V.A. software version, T.O.V.A. serial number, and the date and time of administration).

### 10.2.2 Session, Response and Performance Validity

This section summarizes whether there were any validity issues that might affect the test results, such as user interruptions, excessive errors, or unusual test results (regardless of ADHD diagnosis).

#### Validity Measures

- **User interrupts:** The user can interrupt a T.O.V.A. session by pressing the 'Esc' key. Once interrupted, the user can choose to resume the test session. However, an interrupted test must be interpreted cautiously since the norms did not contain such an interruption.
- **Hardware errors:** The test will be interrupted if the hardware is unplugged, or fails, during the test.
- **$\leq 25\%$  correct responses:** There were too few responses in a quarter to be a sufficient sample for that quarter. Generally, this means that the subject stopped attending to the T.O.V.A. test for some reason. For example, they could have been off task due to a distraction, or even fallen asleep.
- **Excessive Anticipatory Responses ( $\geq 10\%$  per quarter of responses were faster than 150 ms).** Quarters with excessive Anticipatory Responses (that are usually guesses) must be interpreted cautiously since most people do not process and respond correctly to information that quickly. Excessive guessing, a common finding in persons with attention problems, tends to increase Response Time Variability and Commission Errors, and to decrease Response Time and Omission Errors.
- **Performance Validity (PV) is a measure of unusual patterns of performance in the T.O.V.A. that are not typically seen in attention disorders. If the PV is 1 or higher, and secondary gain is a concern, consider the possibility of "faking bad". Other conditions that unusual performance may flag include cognitive impairment, drug use, psychiatric conditions, oppositional behavior, test maladaptation and/or very severe problems with attention. PV is only applicable for ages 17 and older and relevant when the overall performance is not within normal limits. PV criteria are:**
  - Total number of Omission Errors are  $> 30$ .
  - Half 1 Commission Errors are  $> 10$ .
  - Half 2 Response Time Skew is  $>150$  ms. Response Time Skew is the amount the distribution is "skewed" to the left or the right from a normal distribution. Skew is calculated as the mean minus the mode.
  - Half 2 Commission Error Response Time is  $> 75$  ms slower than Half 2 Correct Response Time.

Higher numbers of flags indicate increasingly unusual patterns of performance and warrant more caution

interpreting test performance. Only the clinician can determine the cause of the PV score. Malingering should be considered when the possibility of secondary gain exists.

In the sample protocol shown below, the Session, Response and Performance Validity statement is “This session meets session, response and performance validity criteria.”

### 10.2.3 T.O.V.A. Interpretation

The T.O.V.A. Interpretation summarizes the results of two different performance comparisons:

- The subject’s performance compared to the T.O.V.A. normative sample by age and gender, called the Comparison to the Normative Sample (CNS). The CNS compares the subject’s performance with individuals who do not have an attention problem.
- The Attention Comparison Score (ACS), which compares the subject’s performance with individuals who have been independently diagnosed with ADHD.

The interpretation statement will be one of the following:

- If the Comparison to the Normative Sample (CNS) and the Attention Comparison Score (ACS) are within normal limits, the interpretation statement is:

*The results of this T.O.V.A. are within normal limits.*

- If the CNS is within normal limits but the ACS is not within normal limits (below zero), the interpretation statement is:

*The results of this T.O.V.A. are within normal limits, but the Attention Comparison Score is below zero. In this situation, the T.O.V.A. Interpretation is considered not within normal limits, and may be suggestive of an attention deficit, including ADHD.*

- If the CNS is borderline and the ACS is above zero, the interpretation statement is:

*The results of this T.O.V.A. are borderline, but the Attention Comparison Score is above zero. In this situation, the T.O.V.A. Interpretation is considered borderline, and may be suggestive of an attention deficit, including ADHD.*

- If the CNS is borderline and the ACS is below zero, the interpretation statement is:

*The results of this T.O.V.A. are borderline and the Attention Comparison Score is below zero. In this situation, the T.O.V.A. Interpretation is considered not within normal limits, and may be suggestive of an attention deficit, including ADHD.*

- If the CNS is not within normal limits but the ACS is within normal limits, the interpretation statement is:

*The results of this T.O.V.A. are not within normal limits, but the the Attention Comparison Score is above zero. In this situation, the T.O.V.A. Interpretation is considered not within normal limits, and may be suggestive of an attention deficit, including ADHD.*

- If the CNS and the ACS are not within normal limits, the interpretation statement is:

*The results of this T.O.V.A. are not within normal limits, and may be suggestive of an attention deficit, including ADHD.*

On rare occasions the Quarter scores will be within normal limits while Half 1, Half 2 and/or the Total will be not within normal limits. If the T.O.V.A. Interpretation is not within normal limits and the Quarter scores on the Summary page are within normal limits, consult the Analyzed Data page Half and Total scores.

**Note: “Suggestive of an attention problem” does not mean that the subject has ADHD, but only that the *session results* were not within normal limits.**

In the sample protocol shown below, the CNS and the ACS were not within normal limits and the Interpretation is “The results of this T.O.V.A. are not within normal limits and are suggestive of an attention problem, including ADHD.”

#### 10.2.4 Treatment

Any current treatments, including any prescribed or over the counter medications (with dosages and medication-test interval), are printed here..

**Note: The clinician will need to determine what effects the treatment may have on the T.O.V.A. performance.**

In the sample protocol shown below, treatment shows “None was entered.”

#### 10.2.5 Comparison to the Normative Sample

The subject’s comparison to the T.O.V.A. normative study is shown as quarter-by-quarter standard scores illustrated by bar graphs. Response Time Variability (RTV) and Response Time (RT) show percentile rank below the standard score, while Commission and Omissions show the number of errors in that quarter below the standard score.

- Standard scores above 85 are within normal limits.
- Standard scores 80-85 are borderline.
- Standard scores below 80 are not within normal limits.
- If the standard score is below the limit of the vertical axis (<40), it would be noted as a downward facing red triangle.
- If the standard score is above the limit of the vertical axis (>120), it would be noted as an upward facing red triangle.

In the sample protocol shown below, the subject had results that were not within normal limits compared to the T.O.V.A. normative study for Response Time Variability (Quarters 2-4), Response Time (Quarters 1-2), and Omission Errors (Q3). Please see the Analyzed Data page for Half and Total scores.

### 10.2.6 Attention Comparison Score

The Attention Comparison Score (ACS) compares the subject's performance to a group of individuals that were independently diagnosed with ADHD. Scores below zero indicate performance more like the ADHD sample, and scores above zero indicate performance like the normative sample. A simple line graph is shown with the ACS score. A right or left facing triangle indicates ACS values that are past the limits of the graph.

In the sample protocol shown below, the subject's ACS is -2.62, which is consistent with the ADHD sample.

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

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

## Session, Response, and Performance Validity

This session meets session, response and performance validity criteria.

## T.O.V.A. Interpretation

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

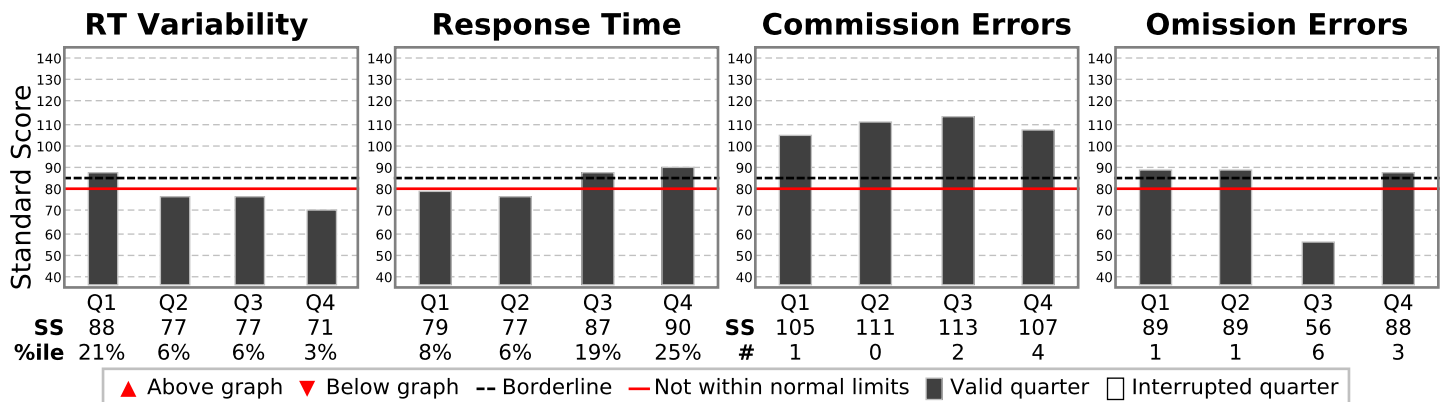
## Treatment

No treatments entered.

## Comparison to the Normative Sample

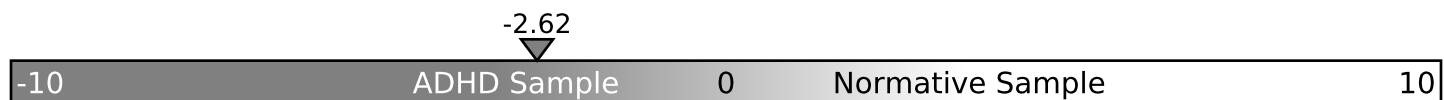
These scores compare this subject's performance to the performance of individuals of the same gender and age in the T.O.V.A. Normative Sample, a study of individuals who did not have attention problems.

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



## Attention Comparison Score

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



## **10.3 Interpretation Notes Page**

### **10.3.1 Comments**

Any comments entered by the test administrator regarding the subject or session are shown here.

### **10.3.2 Notes on the Comparison to the Normative Sample:**

This section summarizes the definition of each variable with a note in bold type on any Quarter, Half or Total that was not within normal limits.

This section also notes response patterns that may affect test interpretation. Examples are when 3 or more Omission Errors occur in a row, 15 or more multiple responses, and/or if some other response pattern is evident (e.g. fast response times and multiple commission errors or slow response times and few or no errors).

### **10.3.3 Other Notes**

This section may contain a note to consider administration of the Auditory T.O.V.A. for persons 6-29 or the Visual T.O.V.A. for persons 4-80+, if that test has not been administered.

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

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

## Session, Response, and Performance Validity

### Performance Validity

Performance Validity is applicable only to ages 17 or above.

## Notes on the Comparison to the Normative Sample

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

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

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

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

## Other Notes

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

## 10.4 Analyzed Data Page

### 10.4.1 Treatment

Like on the Summary page, this section shows any treatments that the subject may have had.

### 10.4.2 Comparison to the Normative Sample

After a brief description of standard scores, the analyzed data table displays standard scores, organized by quarters, halves, and total scores.

**Visual indicators** used in this table are:

- Scores with a dotted line around them means that the quarter may not be valid and must be interpreted cautiously; see the Session Validity information on the Interpretation Notes page for more information.
- Shaded scores mean that the results are not within normal limits, and may be suggestive of an attention disorder.
- Outlined (“boxed”) scores means that the results are borderline.

For example, in the sample protocol shown below, Response Variability is not within normal limits in Quarter 2,3,4, Half 2, and the Total, while it is borderline in H1. Similarly, Response Time is not within normal limits in Quarters 1 and 2, Half 1, and is borderline for the Total. Omission errors are not within normal limits in Quarter 3, Half 1 and 2, and the Total.

Note that even though Quarters 1 and 2 are within normal limits, Half 1 is not within normal limits. This is because Halves are not averages of Quarters, nor is the Total an average of the Halves or Quarters. Quarters, Halves and the Total are independent calculations. In this instance, the subject made two Omission Errors in Half 2, which, when compared to the Normative Sample, is not within normal limits, even though making one Omission Error in Quarter 1 and 2 is within normal limits.

### 10.4.3 Attention Comparison Score

A brief description of the Attention Comparison Score (ACS) is followed by the ACS score and formula.

In the sample protocol shown below, the ACS is -2.62.



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

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

### Treatment

No treatments entered.

### Comparison to the Normative Sample

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

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

Key: Borderline, Not within normal limits, Invalid

### Attention Comparison Score

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

The formula for calculating the ACS is:

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

## 10.5 Tabulated Data Page

The Tabulated Data page provides tabulated statistics on the subject's test results. The T.O.V.A. session parameters used for the test are also documented on this page. Tabulated data are listed by quarters, halves and total, and include:

- Response Time Variability (ms). RTV is the first standard deviation of response time, and is a measure of variance.
- Response Time (ms). Average response time to the target stimulus.
- Post-Commission Responses (#, Response Time in ms, Variability in ms). These are correct responses that occur directly after a Commission Error.
- Commission Errors (#, %, and Response time in ms). "False positive" responses. Commission Error Response Time is used as part of the embedded Performance Validity.
- Omission Errors (# and %). "False negative" responses.
- D Prime (Raw, Standard Score, and Beta). D prime is part of the Receiver Operator Characteristics (ROC) analysis used in the Attention Comparison Score (ACS).
- Anticipatory Responses (% , # To Nontargets, # To Targets). Responses to stimuli made before the subject could have possibly responded appropriately (200 ms before to 150 ms after the stimulus is displayed).
- Multiple Responses (#). Multiple presses of the button for one stimulus.
- Total Correct (#, # Correct Responses, # Correct Nonresponses).
- Skew (ms). Skew is a measure of response time histogram skew, and is used in the Performance Validity rules.
- User Interrupts (#). The number of test interruptions caused by the user pressing 'Esc'.
- Hardware Errors (#). The number of test Interruptions caused by hardware errors.

In the sample protocol shown below, the tabulated data table shows that:

- The subject's post-commission response time (454 ms) was slower than their average response time (417 ms), which is what is expected when a subject recognizes an error and immediately slows down (in this case, after a commission error).
- There were no user or hardware interrupts.

### Session Parameters, Session Information, and Hardware Information

This section contains technical details on the session's test parameters and hardware, including screen calibration.

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

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

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

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

Infrequent

Frequent

**Session parameters**

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

**Session information**

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

**Hardware information**

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

## 10.6 Raw Data Graphs

The Raw Data Graphs are the stimuli by stimuli responses of the subject for each Quarter. These graphs provide a fine grained picture of the subject's performance throughout the test. Quarters 1 and 2 are on the Raw Data Graphs page and Quarters 3 and 4 are on the Raw Data Graphs (continued).

Codes:

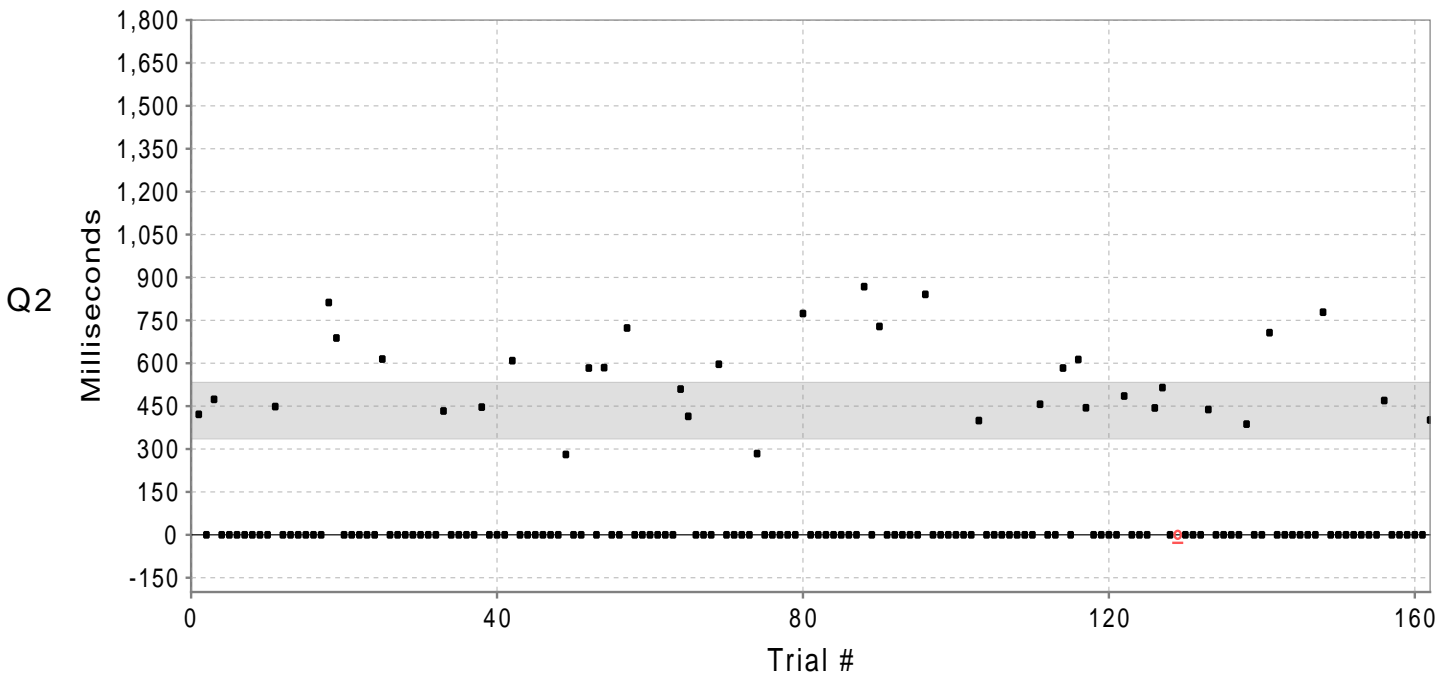
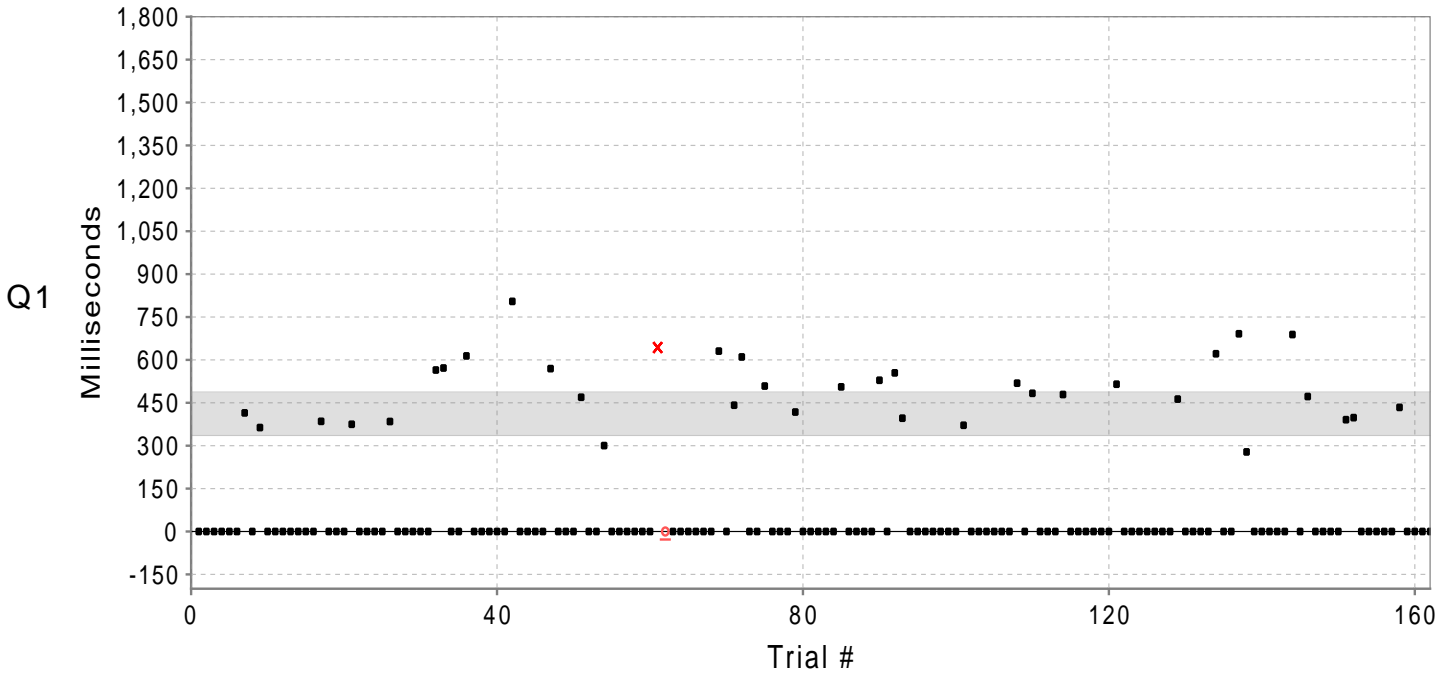
- ■ = Correct responses (black square at the time of the response)
- ■ = Correct non-responses (black square on the zero milliseconds line)
- × = Commission Errors (red X at the time of the error)
- o = Omission Error (red o at the zero milliseconds line)
- ■ = Anticipatory Error (red square between 200 ms before and 150 ms after the stimulus)
- ● = Post-Commission Error Correct Response (green dot at time of response)
- | = Interruption (red line at the time of the interruption)
- Light gray area = The response time range for the normative sample, matched for age and gender
- Commission errors and post-commission responses are linked by lines:
  - A positive slope ( / ) of a light gray line identifies a usual response (slowing down) after a commission error. (The person recognizes the mistake and slows down.)
  - A negative slope ( \ ) of a black line identifies an unusual response (speeding up) after a commission error. (The person may not recognize the error, may not care, or is impulsive. In some cases, especially in older teenagers and adults with few post-commission responses, they may have extra motivation and concentration on the task resulting in a faster correct response.)
- **3 10s** = The number of omissions (if 3 or more in a row) over the number of seconds between correct responses. (Strings of 3 or more omission errors are unusual, and may be caused by a neurological condition such as narcolepsy or a seizure disorder, oppositional behavior, distractibility, or, rarely, a hardware error.)

In the sample protocol shown below, the subject made one Commission Error in Quarter 1 (see red 'X') and one Omission Error in Quarter 2 (see red 'O'). There are two examples of a post-commission errors (green square) in Quarter 3, and one in Quarter 4.

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

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

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

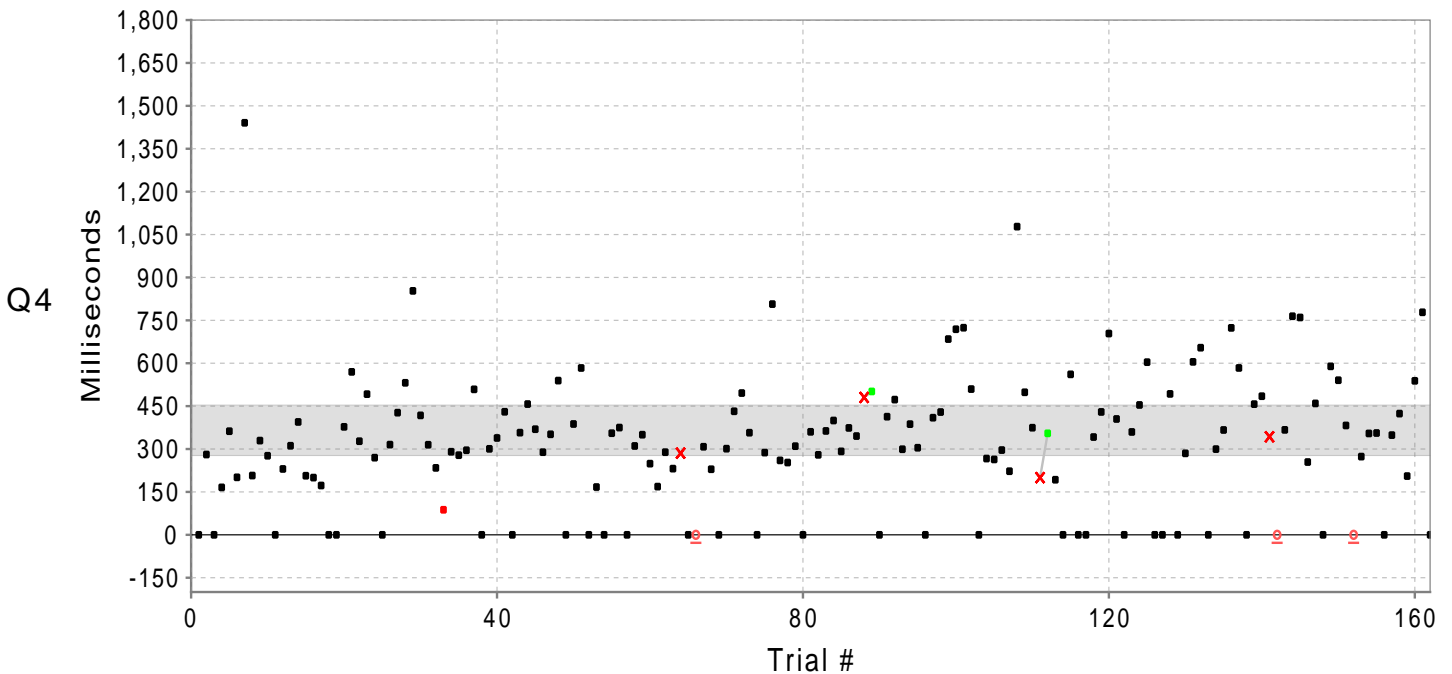
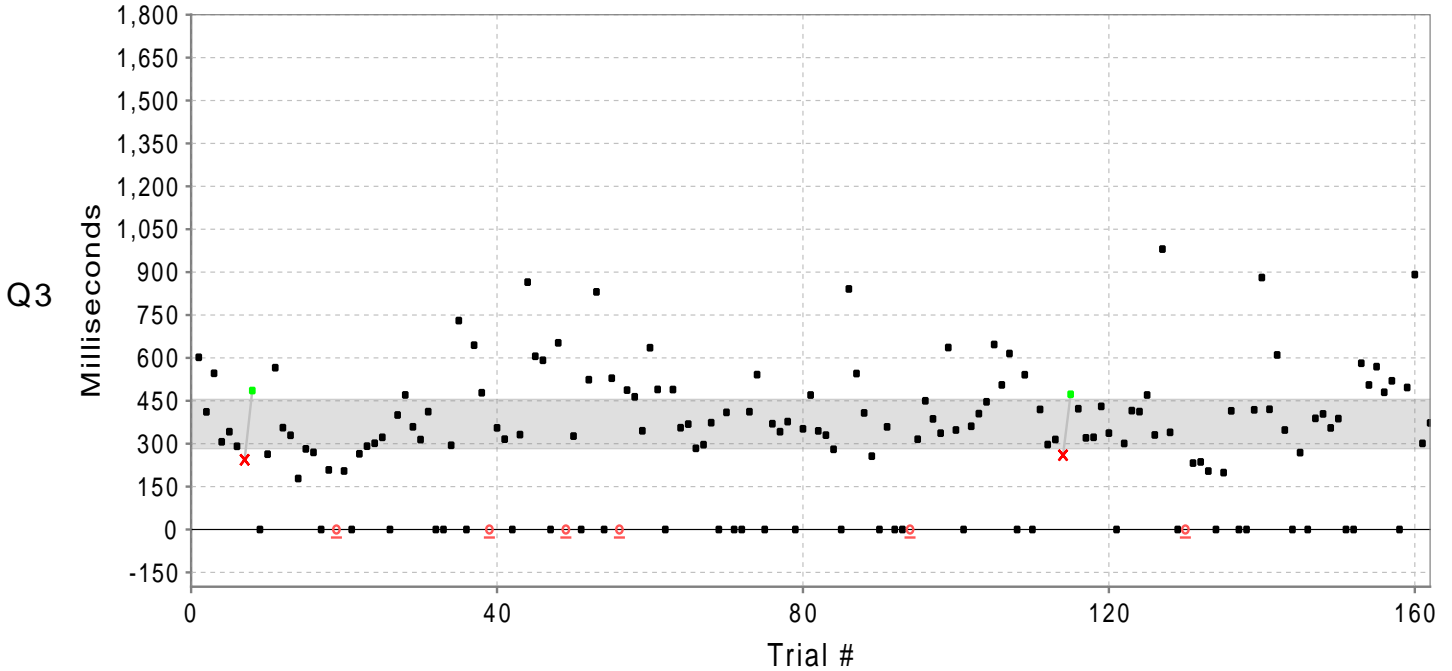


- Correct response    -▪ Correct non-response    ✕ Commission error    ○ Omission error    ▪ Anticipatory response
- Post-commission error correct response    / Slower post-commission RT    \ Faster post-commission RT
- ▲△ Off-scale resp./error    ■ Normative range    | Interruption    3 10s Response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

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

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

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



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

## 10.7 Raw Data Tables

These tables present the sequence of targets and non-targets with the subject's response to each one in a tabular format. Errors are shown in red, and response times are in ms. A negative response time indicates a response that was made before the stimulus was displayed.

The codes are:

T = target	N = nontarget	O = Omission Error
C = Commission Error	A = Anticipatory Response	M = Multiple Responses
Red = Error Responses	T = Post-Commission Error Response	
U = User Interrupt	H = Hardware Interrupt	

In the sample protocol shown below, the subject:

- In Quarter 1, made a slow Commission Error (643 ms as compared to an average response time of 492 ms in this quarter) immediately followed by an Omission Error.
- In Quarter 2, there was a fast commission error (243 ms) followed by a slowed down correct response (a post commission error responses, at 485 ms).
- In Quarter 2, there was a Multiple Response on a Target and an Omission Error later in the quarter.
- In Quarter 3, there was a fast Commission Error (243 ms) followed by a slowed down correct response (a Post Commission Error Response, at 485 ms). There were also 6 other Omission Errors, 1 Commission Error and 1 other Post Commission Error Response.
- In Quarter 4 there was 1 Non-Target Anticipatory Response (87 ms), 4 Commission Errors (one followed by a Post Commission Response and one by an Omission Error) and 2 other Omission Errors.



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

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

1-27	28-54	55-81	82-108	109-135	136-162	163-189	190-216	217-243	244-270	271-297	298-324
N	N	N	N	N	N	T 421	N	N	N	N	N
N	N	N	N	T 483	T 691	N	N	N	N	N	N
N	N	N	N	N	T 278	T 473	N	T 723	N	T 456	T 387
N	N	N	T 505	N	N	N	N	N	N	N	N
N	T 564	N	N	N	N	N	N	N	N	N	N
N	T 571	N	N	T 479	N	N	T 433	N	N	T 583	T 706
T 414	N	C 643	N	N	N	N	N	N	T 867	N	N
N	N	O	N	N	N	N	N	N	N	T 613	N
T 363	T 613	N	T 528	N	T 688	N	N	N	T 728	T 444	N
N	N	N	N	N	N	N	N	T 509	N	N	N
N	N	N	T 554	N	T 471	T 448	T 446	T 414	N	N	N
N	N	N	T 396	N	N	N	N	N	N	N	N
N	N	N	N	T 515	N	N	N	N	N	N	T 778
N	N	N	N	N	N	N	N	N	N	T 485	N
N	T 804	T 630	N	N	N	N	T 608	T 596	T 840	N	N
N	N	N	N	N	T 390	N	N	N	N	N	N
T 385	N	T 441	N	N	T 398	N	N	N	N	N	N
N	N	T 610	N	N	N	T 812	N	N	N	T 443	N
N	N	N	N	N	N	T 688	N	N	N	T 514	N
N	T 569	N	T 371	N	N	N	N	T 284	N	N	N
T 374	N	T 508	N	T 463	N	N	N	N	N	O	T 469
N	N	N	N	N	N	N	T 280	N	T 399	N	N
N	N	N	N	N	T 433	N	N	N	N	N	N
N	T 469	N	N	N	N	N	N	N	N	N	N
N	N	T 417	N	N	N	T 614	T 583M	N	N	T 438	N
T 384	N	N	N	T 621	N	N	N	T 773	N	N	N
N	T 300	N	T 518	N	N	N	T 584	N	N	N	T 401

325-351	352-378	379-405	406-432	433-459	460-486	487-513	514-540	541-567	568-594	595-621	622-648
T 602	T 470	T 529	T 344	T 541	T 414	N	T 531	T 355	T 279	T 498	T 723
T 411	T 359	O	T 329	N	N	T 280	T 853	T 375	T 363	T 374	T 583
T 546	T 314	T 487	T 280	T 419	N	N	T 417	N	T 399	C 199	N
T 306	T 412	T 464	N	T 297	T 418	T 165	T 314	T 310	T 291	T 354	T 457
T 342	N	T 345	T 841	T 314	T 881	T 362	T 234	T 350	T 373	T 192	T 484
T 290	N	T 635	T 545	C 259	T 420	T 201	NA 87	T 248	T 345	N	C 342
C 243	T 294	T 489	T 407	T 472	T 610	T 1440	T 290	T 168	C 480	T 561	O
T 485	T 730	N	T 256	T 422	T 347	T 207	T 278	T 288	T 501	N	T 367
N	N	T 489	N	T 320	N	T 329	T 295	T 231	N	N	T 764
T 263	T 644	T 355	T 358	T 322	T 268	T 276	T 508	C 285	T 413	T 341	T 760
T 565	T 478	T 368	N	T 430	N	N	N	N	T 472	T 429	T 254
T 356	O	T 283	N	T 337	T 388	T 230	T 300	O	T 299	T 703	T 459
T 329	T 355	T 296	O	N	T 404	T 311	T 338	T 307	T 387	T 405	N
T 178	T 315	T 373	T 315	T 300	T 355	T 394	T 430	T 229	T 304	N	T 589
T 281	N	N	T 450	T 415	T 387	T 206	N	N	N	T 359	T 540
T 269	T 331	T 409	T 386	T 412	N	T 200	T 357	T 301	T 409	T 454	T 382
N	T 864	N	T 336	T 470	N	T 172	T 457	T 431	T 429	T 603	O
T 208	T 605	N	T 636	T 330	T 581	N	T 369	T 495	T 684	N	T 273
O	T 591	T 411	T 347	T 980	T 505	N	T 289	T 357	T 718	N	T 354
T 204	N	T 541	N	T 339	T 569	T 377	T 351	N	T 724	T 492	T 356
N	T 652	N	T 361	N	T 479	T 569	T 539	T 287	T 509	N	N
T 264	O	T 369	T 405	O	T 519	T 327	N	T 806	N	T 284	T 348
T 291	T 326	T 342	T 446	T 232	N	T 491	T 387	T 260	T 266	T 604	T 423
T 301	N	T 377	T 646	T 236	T 496	T 269	T 583	T 252	T 263	T 654	T 205
T 322	T 523	N	T 505	T 204	T 891	N	N	T 310	T 296	N	T 538
N	T 830	T 352	T 615	N	T 301	T 315	T 167	N	T 222	T 299	T 778
T 400	N	T 470	N	T 199	T 372	T 427	N	T 360	T 1077	T 366	N

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

## 11 Visual Short Form Session (“Pre-School” Report)

Subjects aged 4.0 through 5.5 are given a shortened 11-minute version of the standard 22-minute T.O.V.A. test. The first quarter is the same in both the standard and short formats, but the second quarter of the short form is the 3rd quarter of the standard test. This essentially makes a two quarter, or two “Half” test. Thus in the Pre-School report there are two halves and a total score, but no quarters.

An example Summary page of a Pre-School report is attached below.

ID: 1 **Example Subject** (Apr 1, 2012)  
**Female - 5y 2m 0d**

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

## Session, Response, and Performance Validity

This session meets session, response and performance validity criteria.

## T.O.V.A. Interpretation

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

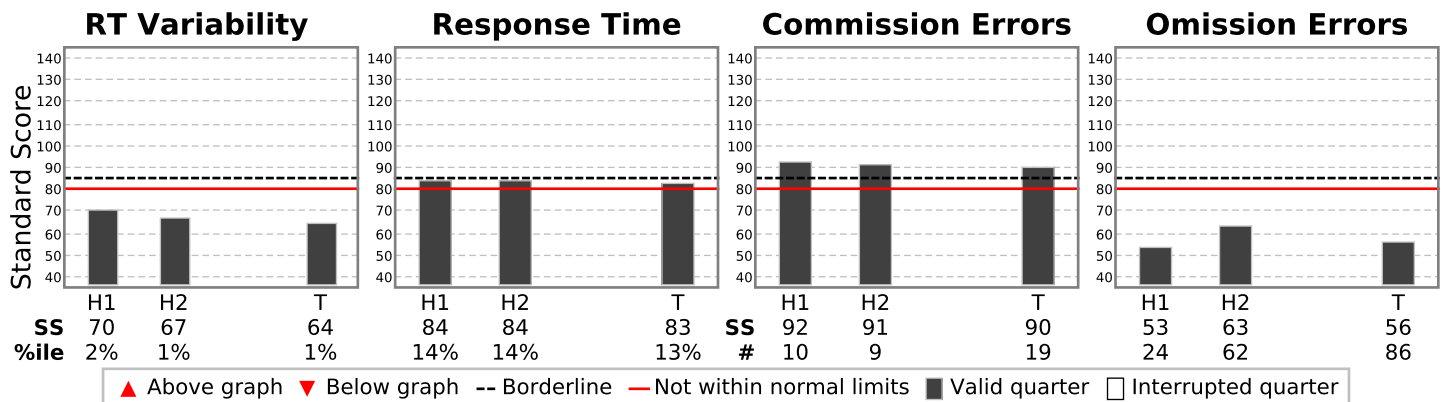
## Treatment

No treatments entered.

## Comparison to the Normative Sample

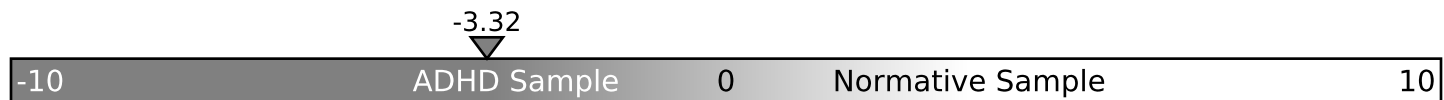
These scores compare this subject's performance to the performance of individuals of the same gender and age in the T.O.V.A. Normative Sample, a study of individuals who did not have attention problems.

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



## Attention Comparison Score

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



## 12 Performance Validity (“Adult” Report)

Subjects aged 17 to 80+ receive an “Adult” report which includes an embedded Performance Validity that flags unusual performance on the Visual test. If Performance Validity is flagged, this is noted in the Session, Response and Validity Section on the Summary Page, with details on the Interpretation Notes page.

An example Summary and Interpretation Notes page of an Adult report with flagged performance validity is attached below.

ID: 1 **Example Subject** (Jul 1, 1997)  
**Male - 19y 11m 0d**

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

### Session, Response, and Performance Validity

**CAUTION:** There are important performance validity issues that affect the interpretation of this test. Please see the Validity section of the Interpretation Notes page.

### T.O.V.A. Interpretation

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

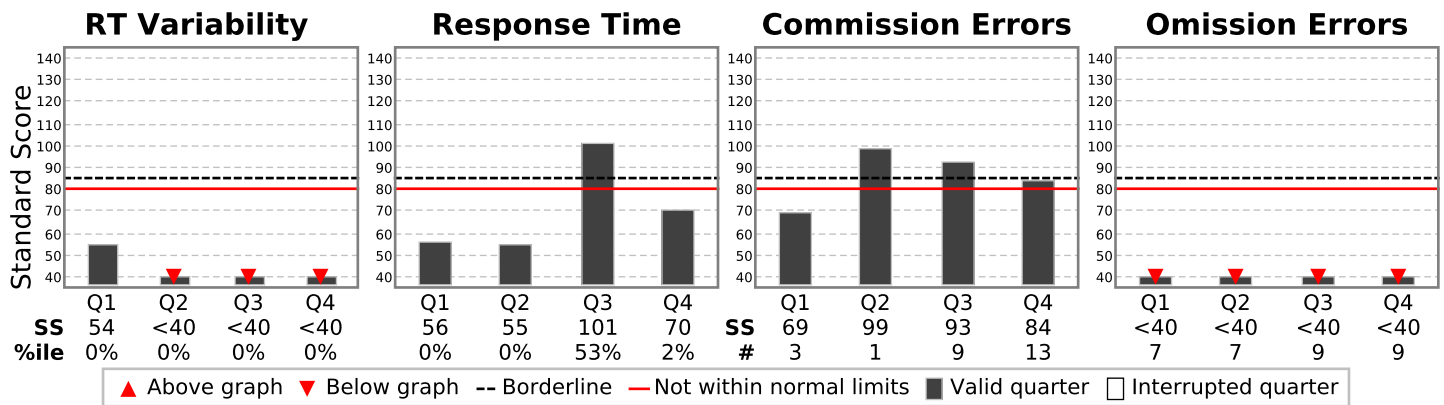
### Treatment

No treatments entered.

### Comparison to the Normative Sample

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

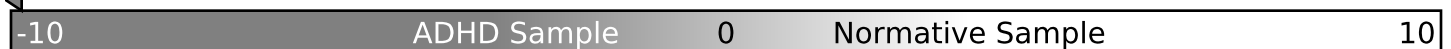
Results are reported as standard scores (average = 100 with a standard deviation of 15) and are compared to a large normative sample stratified by gender and age. Scores above 85 are within normal limits, 80-85 are borderline, and below 80 are not within normal limits. See the Interpretation Notes page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



### Attention Comparison Score

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

-10.63



ID: 1 **Example Subject** (Jul 1, 1997)  
**Male - 19y 11m 0d**

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

## Session, Response, and Performance Validity

### Performance Validity

**CAUTION:** 2 of 4 performance validity rules have been flagged.

Performance Validity is flagged when test results are more consistent with cases of poor effort, severe impairment, or malingering ("fake bad"). The Performance Validity is only applicable to ages 17 or older and when the overall test performance is not within normal limits. Higher numbers of flags indicate increasingly unusual patterns of performance and warrant more caution interpreting test performance. Only the clinician can determine if the test performance is consistent with an attention problem and/or the result of poor effort, severe impairment, or malingering. Malingering should be considered especially when the possibility of secondary gain exists.

Rule	Results	Flagged
Total omission errors greater than 30	32	1
Half 1 commission errors (CE) greater than 10	4	0
Half 2 response time (RT) skew greater than +150 ms	+241 ms	1
Half 2 CE RT minus RT greater than +75 ms	-137 ms	0
Total rules flagged:		2

## Notes on the Comparison to the Normative Sample

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

**Response Time** is the average speed of correct responses to targets, and is a measure of information processing speed. **Response Time was borderline in Half 2, and not within normal limits in Quarters 1, 2, and 4, Half 1, and Total.**

**Commission Errors** occur when the subject incorrectly responds to a nontarget, and are a measure of inhibitory control. **Commission Errors were borderline in Quarter 4 and Half 1, and not within normal limits in Quarter 1.**

**Omission Errors** occur when the subject does not respond to a target, and are a measure of sustained attention. **Omission Errors were not within normal limits in Quarters 1, 2, 3, and 4, Half 1 and 2, and Total.**

## Other Notes

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

## 13 Auditory Report

The Auditory T.O.V.A. test is normed for ages 6 to 29. The Auditory test report is read the same as the Visual test, except there is no Attention Comparison Score or embedded Performance Validity for Auditory tests.

An example Summary page from an Auditory T.O.V.A. test is attached below.

ID: 1 **Example Subject** (May 1, 2001)  
**Female - 16y 1m 0d**

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

## Session and Response Validity

This session meets session and response validity criteria.

## T.O.V.A. Interpretation

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

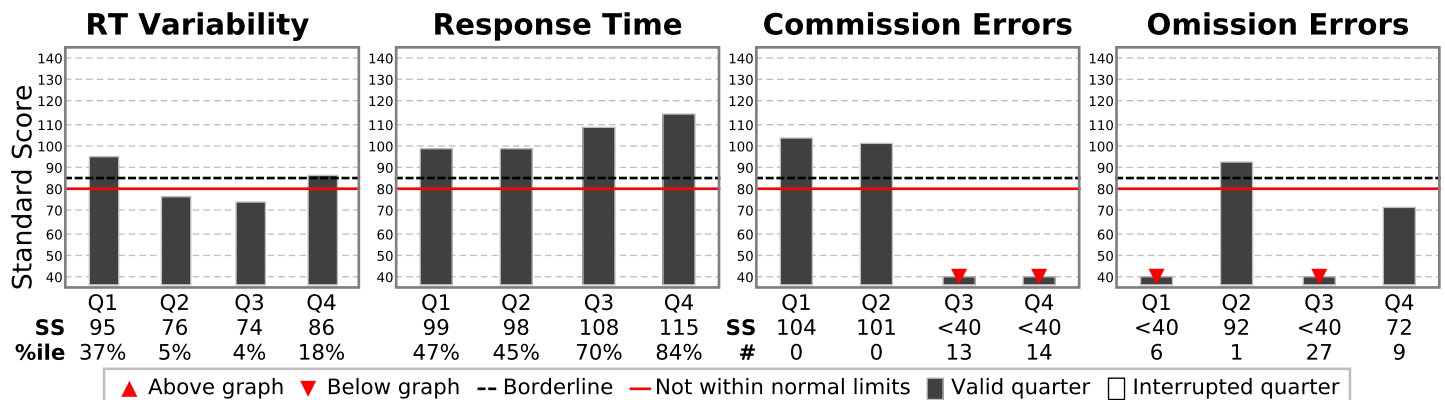
## Treatment

No treatments entered.

## Comparison to the Normative Sample

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

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





## Part IV

# Appendix

## 14 T.O.V.A. Observation Form

The T.O.V.A. Observation Form is designed to provide information about factors that may influence T.O.V.A. results. **Pre-test** information can help the clinician understand some of the conditions that may influence T.O.V.A. performance. **During test** information provides behavioral clues and other information not collected by the T.O.V.A. **Post-test** information can provide insight into the subject's approach to, and experience of, the test.

## Section 1: Pre-test

Name: \_\_\_\_\_ DOB: \_\_\_\_\_ Age: \_\_\_\_\_ Gender: \_\_\_\_\_

Test Date: \_\_\_\_\_ Test Time: \_\_\_\_\_ AM/PM Test type: \_\_\_ Visual \_\_\_ Auditory

Hours of sleep last night: \_\_\_\_\_

	Type	Amount	Last Dose (Hrs)	Duration of use (days/Wks/Mths/Yrs)
Challenge Medication				
Caffeine Intake				
Nicotine Intake				
Medications/Other				
Medications/Other				

Other pre-test observations or comments:

## Section 2: During test

Practice Test Results: RTV: \_\_\_\_\_ ms RT: \_\_\_\_\_ ms Omissions: \_\_\_\_\_ Commissions: \_\_\_\_\_

Please rate all observed behaviors quarter by quarter. Note any behaviors not listed below under 'Other' or 'External Distractions'. Circle the part of the quarter where the behavior occurred. Each number (1-5) corresponds with the minutes during each quarter. For short form test sessions (e.g., 4-5 year old sessions), only quarters 1 and 2 should be used.

Quarter		1	2	3	4
<b>Time at start of quarter</b> (each quarter is 5 min 12 sec)					
Talks, makes sounds	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Fidgets/taps feet and or fingers	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Moves in chair (leaning, spinning, etc)	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Looks away from the computer	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Stops Responding	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Falls asleep	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Covers screen with hand	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Complains	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Prompting needed	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
External distractions (list): _____	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Other (list): _____	Minute #	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Unsolicited comments made by the subject during the test:

## Section 3: Post-test

Unsolicited comments made by the subject at the end of the test:

Answer to "How did it go?" and/or "How did you do?":

Other observations/comments: