CLINICAL MANUAL

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The TOVA Company
March 28, 2016
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Part I

Introduction

The T.O.V.A.

The Test of Variables of Attention® is an objective, standardized, and highly accurate continuous performance test (CPT) that is used to measure attention and impulsivity. The Visual T.O.V.A. and Auditory T.O.V.A. are non-language-based, sufficiently long (21.6 minutes), computerized tests that require no left-right discrimination or sequencing. Responses are recorded with a specially designed, highly accurate (±1 ms) electronic microswitch.

The T.O.V.A. measures key components of visual and auditory attention. These measurements are then compared to those of a group of people with attention disorders and a group without. The T.O.V.A. can also establish a personal baseline of attention for future comparison or track response to treatment, including medication. It can even flag unusual patterns of performance, such as malingering or poor effort.

1 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.

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

Attention-Deficit Hyperactivity Disorder (ADHD) refers to a specific symptom complex defined in the current manual of diagnoses, the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV).

Target symptoms and measures refer to the particular symptoms that are specified for treatment and the particular measures being used to determine the effectiveness of that treatment. In this manual, attentional characteristics (specifically those variables measured by the T.O.V.A.) and hyperactivity are evaluated and treated separately.
2 Attention-Deficit Hyperactivity Disorder (ADHD)

2.1 ADHD and DSM IV

2.1.1 Sub-Types

Four sub-types of ADHD are defined in DSM-IV:

**Predominantly Inattentive Type** (314.00) – Must have six or more of the following symptoms for six months 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

**Predominantly Hyperactive-Impulsive Type** (314.01) – Must have six or more of the following symptoms for 6 months 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)

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

**ADHD Not Otherwise Specified** (314.9) – Criteria for other subtypes are not met, but symptoms are judged to interfere with the affected individual’s functioning for six months or more. This category typically used for adults with ADHD.

### 2.1.2 Requirements

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

• Onset of symptoms no later than seven years of age

• Symptoms must be present in two or more situations

• There must be clinically significant distress or impairment in social, academic, or occupational functioning

• Condition cannot 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

### 2.1.3 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 seven 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.

- There is no mention of the status of the Central Nervous System; that is, brain damage can cause ADHD in DSM-IV.

- Criteria specifically applicable to adults is lacking.

- Executive functions are not included.

### 2.2 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 psychodepressants 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, dementia, and Traumatic
Brain Injury

- **Family style and organization**
  This may include social and cultural factors

- **School readiness, learning style, and motivation**
  Some children (including those with ADHD) have a hands-on rather than a listen & understand learning style

- **Stress**
  Resulting from emotional trauma and overwhelming situations

- **Intellectual impairment and precocity**

- **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 or obsessive-compulsive traits/disorders, depression, PDD, ODD, dementia, conduct disorder, and reactive attachment disorder and/or anxiety

- **Substance use, abuse, and withdrawal**
  All substances, including 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 40-65% of substance abusers have ADHD. In addition, untreated individuals with ADHD often develop low self-esteem, depression, and acting out which may obscure the underlying ADHD.

### 2.3 Diagnosis of ADHD

The components of a diagnostic workup for ADHD may include:

- **History:** Nothing (not even the T.O.V.A.) 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 them 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 2—are especially useful. Behavior ratings for adults include 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-IV Symptom checklists:** These checklists help clinicians to thoroughly review all symptoms of ADHD.

- **T.O.V.A.:** The T.O.V.A. objectively measures visual and auditory attention, variability, response time, and impulsivity, 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.

### 2.4 Treatment of ADHD

Figure 1 illustrates the underlying neurophysiological problem in ADHD by comparing the subject’s original baseline visual T.O.V.A. to his response to treatment—in this case, medication. The effects of 5 mg of methylphenidate on the T.O.V.A. tests of a physician with an attention deficit are represented. Shown are the mean response time histograms of the responses to the visual T.O.V.A. target stimuli. The mean response time of 580 ms in the test without medication is significantly slower than the normal for an adult. Indeed, 580 ms is normal for six-year-old boys. In contrast, the mean response time of 340 ms in the test given 1.5 hours after 5 mg of methylphenidate is normal for an adult.

![Figure 1: Response time histogram of a subject, on- and off-medication](image)

The treatment intervention is generally multifaceted, reflecting the many symptoms of ADHD and possible
comorbid conditions. Although the T.O.V.A. can be used to measure treatment effects on attention, variability, response time, and impulsivity, we do not advocate treating the T.O.V.A. and losing sight of the person in the real world.

A number of methods are currently being used to treat the symptoms of ADHD. These include:

- **Providing information about ADHD and techniques to manage inattention and behavior**
  Confirming the diagnosis is sometimes sufficiently therapeutic, in and of itself. Even with the diagnosis, some cases are mild enough or the life circumstances (particularly for adults) are such that education and awareness are the only treatment necessary. In some cases, other treatment may be provided on an as-needed basis, for example when extensive reading is necessary.

- **Individual/parental/spousal counseling and coaching to improve management techniques**
  There are many management or coping strategies that can reduce the problems to a more manageable size: reduction of distractions, breakdown of tasks into shorter units, time-limited activities, time-management techniques, memory-enhancing activities, positive toward-task redirection, relaxation exercises, etc.

- **School/workplace consultation**
  Use of the T.O.V.A. Individualized Home and School Success Strategies can be very helpful in the classroom setting and in the home. Findings need to be translated into relevant suggestions like a private office space or a quiet homework area for a distractible person, etc.

- **Vocational considerations**
  While we want to avoid self-fulfilling prophesies, attentional characteristics should be considered when counseling about vocational opportunities. As an example, some persons with ADHD should be advised to consider occupations that are active and varied, rather than tedious and repetitive. Some individuals with ADHD tend to do well in a computer-related vocation.

- **Recreational considerations**
  Consider faster-paced activities like swimming and handball instead of slowly paced activities.

- **Neurofeedback**
  Using a pre- and a post-treatment T.O.V.A. (along with other measures), many clinicians working with individuals with ADHD are reporting dramatic responses to these treatments. A number of well-designed collaborative studies with the T.O.V.A. are now underway, and we expect to learn more about the indications, types, and outcome of neurofeedback in the near future.

- **Behavior modification**
  These types of treatment are extensively described in the literature. However, it should be noted that they are especially useful in the treatment of impulsivity/disinhibition.

- **Psychotherapy**
  This treatment is indicated with related self-defeating coping strategies and comorbid issues such as depression, substance abuse, anxiety, ODD, and others.
• **Natural Remedies**

Continued research indicates there may be gains from Omega 3 fatty acids, vitamins, homeopathic remedies, natural supplements, meditation, martial arts, brain development programs and exercises, and others. Use of the T.O.V.A. provides an objective measure to the effectiveness of the treatment.

• **Medication**

See the section below.

2.5 **Medication for ADHD**

**Note:** It is beyond the scope of this brief introduction to give extensive details about the pharmacotherapy of children and adults. For more information we recommend having and reading one of the handbooks written on this subject.

As with any intervention, it is important to determine exactly what symptoms to target for treatment, and to select appropriate measures of these symptoms. With the availability of CPTs like the T.O.V.A., the clinician can now specifically target attentional variables and reliably, objectively measure medication effects. Behavior ratings alone may not be sufficiently sensitive enough to be used to determine optimal dosage levels in the treatment of inattention.

Although antidepressants may be prescribed to treat ADHD, especially in cases with comorbid substance abuse, they may not be as effective as stimulant medication on attention. The T.O.V.A. is used to measure individual performance on antidepressants as well as with stimulants.

2.5.1 **Commonly Used Stimulant Medications**

• **Methylphenidate** is the most frequently prescribed stimulant medication. Since the strength of the generic (MPH) form can be ±20% of Ritalin™, switching from one to the other can be problematic. Ritalin SR (sustained release)™ and Ritalin LA (long acting) often has an uneven release over time in our experience. In contrast, Concerta™ has a much smoother release over time and is particularly useful when taking a noon dose is inconvenient (e.g., having to go to the school nurse's office) or problematic (e.g., forgetting to take the medication). Focalin™ (with liquid and tablet forms) and Daytrana™ (the patch) appear quite promising, especially when small doses are prescribed.

• **Dextroamphetamine** (D-A) is twice as potent as MPH. Thus, 5 mg of D-A is roughly equivalent to 10 mg MPH. As with MPH, generic D-A may be less powerful than Dexedrine™. D-A appears to have a higher incidence of side effects (the same side effects as MPH). D-A and MPH are thought to be equally effective. D-A is often the preferred medication for patients with seizures since it may lower seizure threshold less than MPH. Dexedrine Extendtabs™ (the slow release form of Dexedrine) appear to have a more even release mechanism. Short-acting MPH or D-A is used with Extendtabs to provide more even coverage, particularly in the late afternoon.

• **Adderal™**, a mixture of long- and short-acting amphetamines and d-amphetamines, is long-acting, has little to no rebound, and is easy to divide into small doses.

• The recently approved Vyvanse™ is a “pro-drug” that is converted into an active stimulant in the
intestine and, thus, is less likely to be abused.

- **Magnesium pemoline** (Cylert™) is no longer generally available because of serious side effects (such as liver damage).

**NOTE:** Since most recommendations about dosing are based on behavior ratings and body weight, dosing may be excessive, particularly if the targeted symptom is inattention.

### 2.5.2 Common undesirable effects of stimulant medication

Bothersome but not serious side effects can include decreased appetite, weight loss, abdominal pain, sleep disturbance (or increase), and afternoon irritability (“rebound”), which are often handled by a reduction in dosage, administration of medication just before meals, or the addition of a smaller dose in the afternoon to reduce “rebound”. Irritability, tiredness, or feeling “jumpy” or “edgy” are frequently encountered side effects when a teenager or adult is given too much medication.

### 2.5.3 Rare undesirable effects of stimulant medication

Less common effects may include tics, hypertension and tachycardia, temporary height suppression, and sadness or depression, for which reassessment of the medication and dosage are promptly indicated. The use of stimulant medication in persons who also have a tic or seizure disorder is controversial but is effective in many cases.

### 2.5.4 Predicting and measuring response to stimulants medication

Comparing the baseline (no medication) T.O.V.A. and a T.O.V.A. 1.5 to 2.5 hours after a single dose of medication, one can predict whether there will be a good response to medication and determine a good beginning dosage.

However, since patterns of behavior tend to change slowly, a clinical trial of medication is needed to ascertain the degree of response. It is not possible to predict response to antidepressants in the same way since they can take 3-4 weeks to build up.

A double-blind clinical study of the effects of MPH on attention and impulsivity was conducted with 154 children with ADHD. 143 children were MPH responders and 11 were non-responders.

While both groups showed some improvement in T.O.V.A. performance with MPH, only the responders obtained a significant improvement (Figure 2).
2.5.5 Dosage considerations

With the availability of the T.O.V.A., the effects of different dosages can be very accurately measured to obtain the best effects on attention. Use of the T.O.V.A. in clinical practice has resulted in a dramatic increase in efficacy (95%), decrease in dosage levels (50%), low incidence of side effects (<5%), and higher compliance. The decrease in dosage reflects the literature indicating that low doses of stimulant medication affect attention, that high doses affect behavior, and that there is either little overlap between the two effects, or that attention actually worsens with high doses (Figure 3).

![Figure 3: Schematic representation of psychostimulant dosage effects on attention and behavior.](image)

In treating attention disorders, it is important to carefully determine target symptoms and the means of measurement. For example, low-dose methylphenidate (MPH) affects attention primarily, while higher doses affect behavior primarily and may affect attention adversely. If one were only to use subjective sources of data (i.e.: history and behavior rating scales) to determine response to treatment, the effects on attention could be missed.

2.5.6 Non-stimulant medications

- **Atomoxetine** (Strattera™) appears primarily useful in the treatment of problems of executive function.
  
  Use the T.O.V.A. to compare on- and off-medication responses.

- **Guanfacine** (Intuniv™), an antihypertensive medication, was recently approved for use in ADHD, and initial studies are encouraging.

- **Wellbutrin™** and other antidepressants are prescribed for ADHD in cases with depression and/or concern for potential substance abuse with stimulant medication.
• When a stimulant medication is used to treat an attention problem, Clonidine™ or Depakote™ may be considered in addition.

2.5.7 Assessing and monitoring effects

Since optimal medication dosage can change over time, children and teenagers may need to be re-evaluated every six months and adults once a year. It is recommended that the clinician obtain periodic interim history (including undesirable treatment effects), parent/classroom/self behavior ratings, a new baseline (no medication) T.O.V.A., and a new on-medication T.O.V.A. Evaluate results and determine whether to continue or change treatment.

Below are two illustrations of the use of the T.O.V.A. and behavior ratings to monitor clinical course over time. In the first case of a child diagnosed with ADHD, she gradually improved, and her T.O.V.A. and behavior ratings normalized by age 10 1/2 (Figure 4). The two subsequent evaluations, which documented her improvement, were obtained because of a research protocol. As would be true for any person who “outgrows” ADHD, the last two off-medication T.O.V.A.’s were within normal limits, and the on-medication T.O.V.A.’s improved but not significantly.

![Figure 4: Outgrowing the need for medication: on- and off-medication trials over time.](image)

The second illustration documents the clinical course of another girl diagnosed with ADHD who did not improve by 11 1/2 (Figure 5). She may prove to be one of the 50% who do not “outgrow” her ADHD.

![Figure 5: Continued need for medication: on- and off-medication trials over time.](image)
3 Continuous Performance Tests (CPTs)

3.1 History

Rosvold and his group introduced the CPT in the mid-1950s. His CPT was a sequential, visual, language based A-X task in which the subjects 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 a few have been made available commercially for researchers, schools, and clinicians. Research with early CPTs did not show very promising results. These CPTs focused on omission and commission scores with inaccurate measures of response time. We know that accurate Response Time (RT) and Variability of RT are critical for CPTs to be sensitive and useful. Only the T.O.V.A. tests have been extensively normed and have highly accurate (pm\(1\ ms) and sensitive response time measures.

The T.O.V.A. began as a large electronic rack with a tachistoscopic shutter in our first clinical study in 1966. It was nicknamed “Herman” by one of the children. With an accuracy of pm\(100\ ms), the CPT results were significant and documented the efficacy of stimulant medication (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 Questionnaire) 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 Ille in the late 70s, the current design (with two test conditions, see below) and the research-quality microswitch were created. It was 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-80s.

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 Auditory T.O.V.A. was released. Additional norming studies and programmatic enhancements, including the Home Intervention Report, led to the release of Version 7.3 in 2007. In 2008, the Symptom Exaggeration Index was developed. In 2011, version 8 was released with several changes and new hardware. The Symptom Exaggeration Index is now embedded in the report as Performance Validity, the ADHD score was reworked and is now the Attention Comparison Score (ACS) and additions were made to the Home and School Intervention Reports which were renamed the Individualized Success Strategies-Home and School.

3.2 CPT variables

Fourth-generation CPTs, like the T.O.V.A., 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 ADHD 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 inter-stimulus 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 following variables are important for CPTs to measure, and T.O.V.A. includes them:

### 3.2.1 Response Time Variability

Response Time Variability is a measure of variability (consistency) of response time and is the standard deviation of correct response times (that is, the time in ms taken to respond correctly to a target). Individuals with ADHD tend to be inconsistent—they may be able to perform within normal limits for a while, but they “lose it” much sooner than others. As parents frequently note, a child with ADHD can focus (even “hyperfocus”) and stay on task some times, particularly when the task is very interesting and fast paced (like a computer game). Since Response Time Variability is the single most important measure of the T.O.V.A. (accounting for >80% of the variance), the timing measurements must be very accurate; hence, the need for an accurate microswitch rather than rely on the significantly less accurate mouse button or keyboard.

### 3.2.2 Correct Response Time

Correct Response Time is the processing time (in ms) taken to respond correctly to a target. Counterintuitively, 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 first (or boring) half, accounting for >12% of the variance.

### 3.2.3 $d'$ or Response Sensitivity

$d'$ or Response Sensitivity (the ratio of hit rate to false alarm rate) is a measure derived from 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 deteriorates faster than others. $d'$ helps to distinguish individuals with ADHD from those without ADHD and accounts for 6% of the variance in the T.O.V.A.

### 3.2.4 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 errors of commission 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, excessive impulsivity is a hallmark of ADHD.
3.2.5 Errors of Omission

Errors of Omission are 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 or is sounded. Because the T.O.V.A. covers a broad age span (4-80+), omissions in the visual (but not auditory) test have a ceiling effect in adults. That is, the task is too easy for adults without ADHD who rarely make omission errors. On the other hand, omission errors are a sensitive measure in children, teenagers, and the elderly. When evaluating omissions, always look at the absolute or raw numbers. In some cases one or two errors reach statistical significance yet there may be little or no clinical significance. 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.

It is important to review the Tabulated Data form of the T.O.V.A. report to identify how many omission errors occurred. Always interpret standard score (or standard deviation) data along side actual raw data to determine clinical significance of the results.

3.2.6 Anticipatory Responses

Anticipatory Responses (AR) are a measure of impulsivity, guessing which stimulus is presented, or of a different game strategy in which the subject may be trying to “kill” any stimulus as soon as possible. An AR occurs whenever a response (pressing the microswitch) is made between 150 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. Most persons need more than 150 ms to distinguish between a target and a non-target and to respond by pressing the microswitch; hence, the use of the word “anticipatory”. 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.

To prevent what may be incorrect interpretations, the T.O.V.A. Summary page labels the variables in any quarter with excessive ARs (equal or exceeding 10%) as possibly “invalid” and needing to be cautiously interpreted.

While we don’t want to confuse you (any further), it now turns out that there is a fourth reason why some people have excessive ARs. Some people are much, much faster than most people. They are so fast that they can accurately respond to the targets in less than the usual 150 ms, avoiding the non-targets. Thus, when you examine the ratio of target to non-target ARs, you’ll find that these people have very few non-target ARs. Most if not all of their ARs are with targets. Since the presentation of stimuli is randomized, they can’t be guessing. They are really processing the information and responding significantly faster than others.

As you might expect, some experienced computer game players, musicians, and athletes can perform so well that their correct responses can fall into the AR range, and their test results are labeled as possibly invalid by the interpretation program because of the excessive ARs.

Recognizing that some tests with excessive ARs should not be invalidated, we recommend that when there are excessive ARs that the clinician examine the target : non-target ratio for ARs (Tabulated Data), and not invalidate those quarters in which the ratio is better than 1 target : 3.5 non-targets in quarters 1 and 2 or better than 3.5 targets : 1 non-target in quarters 3 and 4. In other words, a really fast and accurate person...
will perform better than the ratio of targets to non-targets in that quarter.

3.2.7 Post-Commission Response Time

Post-Commission Response Time is the response time immediately following 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.

3.2.8 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, but they do appear to indicate nonspecific neurological immaturity or dysfunction.

3.3 Significant features

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

3.3.1 Stimuli

- Visual and auditory modes
  Both need to be studied 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, etc.

  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 (“go/no-go” like T.O.V.A.) or sequential
  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 6) minimize the potential confounding of the results by language, cultural effects, 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).

![Figure 6: The T.O.V.A. visual stimuli.](image)

• **Configuration**

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

• **Monochromatic vs. multicolored 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.

• **Degradation**

Although useful in work with schizophrenia, partial degradation of the stimuli are not features of CPTs used to measure attention.

### 3.3.2 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 their attention span.

• **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.

- **Reward and/or cost**
  While these features may be helpful if a CPT was used as a treatment intervention (to train someone to be more attentive), these features are not commonly used in CPTs.

- **Alerting signal**
  CPTs do 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.

### 3.3.3 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. actually has a small novelty effect—there may be non-significant commission error changes (increases) in the first half of the second test but not thereafter. Thus, the T.O.V.A. can be repeated even in the same day.

### 3.3.4 Length of test and subtests

The longer the test, the harder it is to attend and inhibit. The 21.6 minute test with two 10.8 minute subtests in the T.O.V.A. are in commercially available CPTs.

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.

### 3.3.5 Norms

- **The number of subjects per cell**
  This is a critical factor. In contrast to the T.O.V.A., some CPTs were introduced with insufficient or even no norms. The Visual T.O.V.A. and Auditory T.O.V.A. were normed with 1714 and 2680 individuals, respectively. We plan to continue to add additional adult norms to both.

- **Sample characteristics**
Unlike the very carefully selected controls with no comorbidity for the T.O.V.A., some other CPTs have inadequately defined and mixed samples.

- **Controlled variables**

**Age:** Since attention variables significantly change from birth to the late teens, year by year norms are necessary for accurate measurement and comparison.

To illustrate, Figure 7 shows a norm curve of Total Response Time Variability (the first standard deviation of response time) for females.

![Figure 7: The response time variability for females in the T.O.V.A. norming study.](image)

For the Visual T.O.V.A. there are year by year norms for each gender from 4-19 and grouped norms by gender from 20-80+. For the Auditory T.O.V.A. there are year by year norms for each gender from 4-19 and grouped norms by gender from 20-29. The norms for the Visual T.O.V.A. and the Auditory T.O.V.A. can be found in the T.O.V.A. Professional Manual.

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

**Intelligence:** Intelligence may affect CPT performance and may be an important consideration. Research on this topic is inconclusive.

**Test conditions:** Time of day and sequencing are important variables that can significantly affect performance on a CPT. All norms for the T.O.V.A. were obtained in the morning, and the T.O.V.A. was administered before other testing to avoid excessive fatigue.
3.3.6 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 distractors (foot tapping, talking, chewing gum, etc) that may act to arouse the person and help them focus. This warrants being noted.

3.3.7 Timing Accuracy of CPTs

The T.O.V.A. Microswitch is used to ensure that the timed responses are measured accurately. Small variations and inconsistent timing can produce high false positives. To demonstrate why the T.O.V.A. uses the microswitch, the following comparisons were made:

<table>
<thead>
<tr>
<th>Software Device</th>
<th>Preset Exact Response Time (ms)</th>
<th>Mean Measured Response Time (ms)</th>
<th>Std. Dev Response (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.O.V.A. Microswitch</td>
<td>300</td>
<td>300</td>
<td>&lt;1</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>599</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Conners’ with Mouse</td>
<td>300</td>
<td>353</td>
<td>+28</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>655</td>
<td>+14</td>
</tr>
<tr>
<td></td>
<td>900</td>
<td>943</td>
<td>+21</td>
</tr>
<tr>
<td>Conners’ with Keyboard</td>
<td>300</td>
<td>355</td>
<td>+28</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>656</td>
<td>+11</td>
</tr>
<tr>
<td></td>
<td>900</td>
<td>948</td>
<td>+25</td>
</tr>
</tbody>
</table>

Table 1: T.O.V.A. Microswitch Comparison

Thus, the microswitch in combination with T.O.V.A. software is significantly more accurate than the Conners’ or any of the other CPTs that use the mouse or keyboard and that use more than one computer. (ADHD Report. 1995:3(6), 7-8).
4 The T.O.V.A.

4.1 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 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 inhibit 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 and 5 years of age** – the ratios of targets to non-targets remain the same; however, the number of stimuli and length are half of those above.

4.2 Sensitivity and Specificity

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

The **specificity** of a test is its ability to correctly identify individuals who do not have ADHD. The greater the specificity, the fewer false positives (incorrectly concluding that a person has ADHD).

Since sensitivity and specificity may vary inversely, it is necessary to arbitrarily select a cut-off that best meets the expected use of the test. For the T.O.V.A., sensitivity and specificity were balanced to obtain the highest accuracy of both rather than favor one or the other. For instance, we could have selected a higher sensitivity for the screening version to minimize false negatives; however, the specificity would be correspondingly lower, and there would be more false positives. Instead of using different cut-offs for the two versions, they both have the same cut-off.

Of the two common ways to determine sensitivity and specificity, discriminant analysis is the usual and less conservative one. If dealing with large representative samples from which generalizations about other samples could be safely made, discriminant analysis would be the acceptable procedure. However, none of the currently available CPTs, including the T.O.V.A., have large enough samples to use this statistical method. We feel that it is best to be cautious about generalizing from one sample to others, and we do not use discriminant analysis in determining sensitivity and specificity. If we did, the results would be:

- **Discriminant analysis** of T.O.V.A. variables with 29 UADD (ADHD without hyperactivity) cases and 29 matched controls correctly classified 79% of the UADD cases and 90% of subjects without ADHD. Discriminant analysis of T.O.V.A. variables with 73 ADHD subjects and 73 matched subjects without ADHD correctly classified 84% and 89%, respectively (see Table 2). ADHD and UADD subjects per-
formed more slowly and inconsistently and had more errors of omission (inattention) and commission (impulsivity) than subjects without ADHD. Discriminant analysis of the T.O.V.A. and 10-item Conners’ Parent-Teacher Questionnaire of 61 of the youngsters with ADHD and 61 of the matched subjects without ADHD correctly classified 87% of subjects without ADHD and 90% of the ADHD subjects with 13% false positives and 10% false negatives. Our sensitivities have been independently validated. (See Forbes, G. B., Clinical Utility of the Test Of Variables of Attention (TOVA) in the Diagnosis of Attention-Deficit /Hyperactivity Disorder. Journal of Clinical Psychology, Vol. 54 (4), 1998, 461-476.)

**Receiver Operator Characteristic** (ROC) analysis is another way to determine sensitivity and specificity. ROC analysis is the more conservative technique that is used when it is best to be cautious about generalizing from one sample to others. Even though to our knowledge the T.O.V.A. is the best normed CPT, we should be hesitant to assume that the norms from a middle socioeconomic, predominant culture sample would apply to other samples everywhere even though the growing number of culturally diverse norms that are appearing in the literature are remarkably consistent. While the T.O.V.A. norm groups are noteworthy because of the absence of confounding comorbidities, they are restricted- but perhaps less so than the usual samples of multi-problematic individuals. Accordingly, the T.O.V.A. uses the more conservative ROC analysis (see Table 3).

<table>
<thead>
<tr>
<th>Actual group</th>
<th>Non-ADHD</th>
<th>UADD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-UADD* (n = 29)</td>
<td>90%**</td>
<td>10%</td>
</tr>
<tr>
<td>UADD* (n = 29)</td>
<td>21%</td>
<td>79%***</td>
</tr>
</tbody>
</table>

**Overall Correctly Identified 84%**

<table>
<thead>
<tr>
<th>Actual group</th>
<th>Non-ADHD</th>
<th>ADHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-ADHD (n = 73)</td>
<td>89%**</td>
<td>16%</td>
</tr>
<tr>
<td>ADHD (n = 73)</td>
<td>11%</td>
<td>84%***</td>
</tr>
</tbody>
</table>

**Overall Correctly Identified 86%**

* UADD = ADD without hyperactivity, ** = specificity, *** = sensitivity

Table 2: Classification By T.O.V.A.– Discriminant Analysis

**Receiver Operator Characteristic Analysis**

<table>
<thead>
<tr>
<th>Sensitivity of 0.80</th>
<th>False negatives = 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity of 0.80</td>
<td>False positives = 20%</td>
</tr>
</tbody>
</table>

(Cut-off score of 1.8)

Table 3: Sensitivity and Specificity of T.O.V.A. using ROC analysis

Thus, there is an 80% chance that any given T.O.V.A. (with no other information about the individual) will correctly identify whether the subject has ADHD or not. Of course, with the necessary clinically relevant data (including behavior ratings and history), the “hit” rate improves significantly to above 90%.
4.3 Test-Retest Reliability

Temporal stability of the Visual T.O.V.A. was examined in a study of school aged subjects using an interval of ninety (90) minutes. The subjects were without histories of learning disabilities, psychiatric (including ADHD) disorders, neurological disorders, or medical disease, and not on any medications.

The 24 subjects (15 males, 9 females) had a mean age of 8.31 years (SD = 2.35). Each subject received an initial T.O.V.A. and was re-administered the second T.O.V.A. ninety minutes after completing the initial test. Each subject completed both tests by 1 p.m. on the same day.

Data analysis yielded no significant differences within the group between the two tests (Table 2).

<table>
<thead>
<tr>
<th>T.O.V.A. ®</th>
<th>TEST</th>
<th>RETEST</th>
<th>p</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Score Mean</td>
<td>SS Mean</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omission Errors (#) 18.54</td>
<td>20.41</td>
<td>25.42</td>
<td>28.84</td>
<td>.063</td>
</tr>
<tr>
<td>Commission Errors (#) 30.50</td>
<td>19.98</td>
<td>31.33</td>
<td>22.49</td>
<td>.773</td>
</tr>
<tr>
<td>Response Time (ms) 539.66</td>
<td>110.56</td>
<td>530.85</td>
<td>111.50</td>
<td>.992</td>
</tr>
<tr>
<td>Variability (ms) 202.46</td>
<td>65.07</td>
<td>279.87</td>
<td>95.27</td>
<td>.175</td>
</tr>
</tbody>
</table>

Table 4: Table of Means, SD, t values and Correlations for Test / Retest Scores

The Visual T.O.V.A. demonstrated temporal stability over a ninety minute episode. The ninety minute test interval was selected because many clinicians use the T.O.V.A. as a tool to determine the effects of stimulant medications by comparing a baseline (no medication) test and an on-medication test 90 minutes later.

Another test-retest study with 33 randomly selected non-ADHD children, 40 children with ADHD, and 24 non-ADHD adults also revealed no significant differences in the T.O.V.A. variables, using paired t-tests.

4.4 T.O.V.A. Formulas

Formulas and algorithms for calculating the all T.O.V.A. variables can be found in the T.O.V.A. Professional Manual.

4.5 Screening Version

The Screening Version of the T.O.V.A. is used by schools, other educational settings (including learning centers), and non-licensed health care professionals. Uses of the Screening Version include:

- Measuring attention in persons without an attention disorder to determine:
  - attention assets and liabilities
  - baseline functioning in individuals (such as athletes and military personnel) at risk for injury
• Screening children and adults for attention problems

The Screening Version is the same test as the Clinical Version; however, the printouts are formatted differently to reflect that they are used for screening rather than as part of a clinical assessment or treatment monitoring process.

The Screening Version Summary states that it is used for screening purposes only, not for clinical assessments. The results are or are not within normal limits, and if not within normal limits, a referral to a clinician is warranted. Contact the T.O.V.A. Referral Service and telephone number, 1-800-REF-TOVA (733-8682) for referrals to clinicians specializing in attentional disorders in that area.

The Screening Version includes the Individualized Success Strategies-School and Home

4.6 Clinical Version

The Clinical Version of the T.O.V.A. is used by licensed clinicians and researchers.

The Clinical Form analyzes the Raw Data and includes the Individualized Success Strategies-School and Home.

Uses of the Clinical Version include:

• Measuring attention in persons without an attention disorder to:
  – determine attentional assets and liabilities
  – establish baseline functioning in individuals at risk for injury (due to head injuries from accidents, sports, military service) or CNS disorders

• Measuring attention in individuals being evaluated for an attention disorder, including ADHD and Traumatic Brain Injury

• Measuring attention in other disorders affecting the brain, including AIDS and dementia

• Measuring effects of nonmedical treatment interventions, including Neurofeedback

• Measuring medication effects using a challenge dose of a stimulant medication

• Helps to document the optimal dosage of medication

• Monitors the course of attention problems and treatment over time

4.7 Administering the T.O.V.A.

Training of both professionals and nonprofessionals to administer and monitor the test should follow the
general outline of the instructions in the Professional Manual 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. (See Appendix A for Testing instructions.)

The T.O.V.A. should be administered in the morning to comply with the norming procedure 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 similar 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 the auditory and visual T.O.V.A. are to be administered, a sufficient time (>1.5 hours) should elapse between the tests to enable the subject to rest.

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.

When testing for the first time, the practice test should be given in its entirety. For subsequent testing, only a portion of the practice test may be necessary to remember the task.

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

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

4.7.1 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.

2. Time of Day: Testing is best done between 6 AM and 1 PM to control any diurnal effects.

3. 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 monitor should be placed so that the keyboard is not visible or available to the subject.

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.
   • Determine from subject or caregiver any medications taken in the last 12 hours (Ritalin, anticon-
vulsants, and/or antihistamines). Add these, with dosage and interval since administered, in the New Test Session window.

- 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.
Part II

Interpreting the T.O.V.A.

The clinician determines the application of the T.O.V.A. in measurement, tracking, assessment and treatment. 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. Thousands of clinicians have used the T.O.V.A. for a variety of purposes that call for the objective measurement of variables of attention. The following information is based on both the readout of the reports and the clinical work of the authors. Clinical casework or reflections are chosen to illustrate the authors’ use of the T.O.V.A. and are not a recommendation for assessment or treatment.

5 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 effect on attention. Thus, a person without ADHD can do poorly on the T.O.V.A. if they do not indulge in their habitual two or more cups of 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, etc., may perform normally on the visual T.O.V.A. due to the eye-hand training. The auditory T.O.V.A. is useful in these situations although musicians may do better on the auditory T.O.V.A. than others.

- 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 to be able to interpret T.O.V.A. results, taking these factors into account.
6 The T.O.V.A. Report

The T.O.V.A. Interpretation Report

The following pages contain a Clinical T.O.V.A. Interpretation Report and discussion of the forms and findings. Some of the forms are designed for use by researchers and some by advanced T.O.V.A. users. 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 non-clinical setting such as a school, we recommend sending only the Introduction and the Summary forms. When sending a Report to a clinician, we recommend sending the Introduction, Summary, Analyzed Data, Analyzed Data Page, Tabulated Data, and Raw Data Graphs.

Introduction

This page provides basic information about the T.O.V.A. and its uses.
The **T.O.V.A. (Test Of Variables of Attention)** is a state-of-the-art continuous performance test that is designed to be used in clinical, vocational, and research settings to objectively measure attention, implusivity, and adaptability in children and adults, ages 4 to 80+.

The T.O.V.A. provides objective measurements of attention than can be used by health care professionals in the diagnosis and treatment monitoring of attention problems, such as Attention-Deficit/Hyperactivity Disorder (ADHD) and Traumatic Brain Injuries (TBI). The T.O.V.A. can also be used to establish attention baselines and monitor performance over time.

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 (in the visual T.O.V.A. test) or tones (in the auditory T.O.V.A. test) that are presented in two-second intervals. These measurements (accurate to ±1 ms) are then compared 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. The T.O.V.A. report is based on these two comparisons as well as other statistical measures.

The T.O.V.A. does **not** make a diagnosis. It is designed to augment—not replace—an evaluation done by a trained health care professional. Attention problems may be caused by a number of conditions, including ADHD, depression, anxiety, stress, pervasive development disorder, learning problems, sleep disorders, head injuries, medications, drug abuse, as well as excessive caffeine or nicotine.

The T.O.V.A. can also be used to screen children starting school, establish baseline performance in all ages, monitor the effects of treatment, and track changes in attention over time resulting from head injuries and aging.

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/](http://www.tovatest.com/) or contact us at info@tovatest.com or call 800.PAY.ATTN (800.729.2886 or 562.594.7700).
Summary

This page and pages to follow include Demographic data about the subject—ID number, subject's name, gender, and age—as well as general session information—visual or auditory, version #, serial #, date and time of administration.

- **Comments**: relevant comments about the session may be entered here.

  For the sample protocol:

  *Baseline.*

- **T.O.V.A. Interpretation**: summarizes the results by comparing the subject's performance with individuals who do not have an attention problem and with individuals who have been independently diagnosed with ADHD, matched for age and gender.

  The interpretation statement will be one of the following:

  - If the performance and the Attention Comparison Score (ACS) are within normal limits:
    
    *The results of this T.O.V.A. test are within normal limits.*

  - If the performance is not within normal limits but the ACS is within normal limits, the sentence will be:
    
    *The results of this T.O.V.A. test are not within normal limits and are suggestive of an attention problem.*

  - If the performance and the ACS are not within normal limits, the sentence will be:
    
    *The results of this T.O.V.A. test are not within normal limits and are suggestive of an attention problem, including ADHD.*

  - If the performance is within normal limits but the ACS is not within normal limits, the sentence will be:
    
    *Although the results of this T.O.V.A. test are within normal limits, based on the pattern of performance there is some evidence of a possible attention problem, including ADHD (see the Attention Comparison Score).*

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

  Since the performance and the ACS were not within normal limits in the sample protocol, the Interpretation is:

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

- **Session and Response Validity** summarizes whether there were any occurrences that might invalidate or effect the results, such as user interruptions, excessive errors, or the testing was not administered in the morning.

  When one or more quarters are labeled “invalid”, and the remaining quarters are within normal limits, the protocol would be interpreted as within normal limits. When this happens, a statement is made that the invalid quarter(s) may have been the result of an attention disorder, and that the printed interpretation and results should be viewed cautiously.

**Validity Measures**

- Tests obtained after 1 PM must be interpreted cautiously since all of the norms were obtained
between 6 AM and 1 PM and because of possible diurnal effects on attention.

**Note:** Repeated tests for the same person (e.g. at different ages, and before and with treatment) can be compared if administered approximately the same time of day.

- **User interrupts:** The tester can interrupt the test and restart it at the same place if necessary. However, the remainder of an interrupted test must be cautiously interpreted since the norms would not strictly apply.

- **Excessive Omission Errors ($\geq 90\%$/quarter)** These errors invalidate the quarter since there are too few responses to be a sufficient sample. Generally, it means that the subject stopped responding or, rarely, that the hardware malfunctioned.

- **Response Times = 0 ms:** If there are no recorded correct responses, that quarter would be considered invalid.

- **Excessive Anticipatory Responses ($\geq 10\%$/quarter of responses were $<150$ 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. However, a small number of people (especially athletes and computer game players) can respond correctly faster than 150 ms. To determine whether someone was guessing or processing information and correctly responding faster than most people, compare Nontarget to Target ratios found on the Tabulated Data Page. If the ratio of Anticipatory Responses for targets to nontargets is greater than 2.35 ($>0.57$) in quarters 1 or 2 or smaller than 4:1 ($<4$) in quarters 3 or 4, the individual did better than chance, and the quarter is valid.

- **Excessive Commission Errors** may affect the other variables in that quarter since rapid and additional responses tend to decrease Omission Errors and Response Time and increase Variability. Interpret these quarters cautiously.

### Table 5: Excessive Commission Errors Alert

<table>
<thead>
<tr>
<th>T.O.V.A. ® (Visual)</th>
<th>Age</th>
<th>Quarters 1 or 2</th>
<th>Quarters 3 or 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>$\geq 20%$</td>
<td>$\geq 70%$</td>
<td></td>
</tr>
<tr>
<td>6-12</td>
<td>$\geq 10%$</td>
<td>$\geq 60%$</td>
<td></td>
</tr>
<tr>
<td>13+</td>
<td>$\geq 10%$</td>
<td>$\geq 50%$</td>
<td></td>
</tr>
</tbody>
</table>

*The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am-1:00pm), matching the conditions of the T.O.V.A. normative studies.*

**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. Reasons for these kinds of results range from severe disability.
to malingering ("taking bad") to poor effort. 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.
- 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 if the test performance is consistent with an attention disorder and/or the result of malingering or poor effort. Malingering should be considered especially when the possibility of secondary gain exists.

- **Treatment**: Current treatments, including any prescribed or over the counter medications (with dosages and medication-test interval), if any, are recorded.

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

  *None was entered.*

- **Comparison to the Normative Sample**:

  - The first statement summarizes whether the overall performance (the T.O.V.A. Interpretation) was or was not within normal limits. For the sample protocol:

    *The overall performance was not within normal limits.*

  - The next statements summarize which variables, if any, were not within normal limits.

    For the sample protocol:

    *Inconsistency (Response Time Variability) was borderline in Q1 & Q2 and not within normal limits in Q3 & Q4. This finding is important since inconsistency is the most sensitive measure in the T.O.V.A. Impulsivity (Commission Errors) was not within normal limits in Q3.*

    **Comment**: Note that when Response Time slows the most in quarter 4, Commission Errors significantly improve.

  - Bar graphs

    The quarter by quarter standard scores for the four primary variables are illustrated.

    Standard scores above 110 are above average.

    Standard scores between 85-110 are average.

    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.
• **Attention Comparison Score**

A negative ACS indicates that the T.O.V.A. performance was similar to a pattern characteristic of someone independently diagnosed with ADHD. However, a negative score does not make a diagnosis of ADHD, and a person with ADHD can have a score within normal limits.

For the sample protocol:

*The ACS of -0.39 is characteristic of someone diagnosed with ADHD.*
**T.O.V.A. Interpretation**

The results of this T.O.V.A. test are not within normal limits, and the overall pattern of performance suggests an attention problem, including ADHD.

**Session and Response Validity**

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

**Symptom Exaggeration Index**

Based on the subject's pattern of performance, there is no evidence of symptom exaggeration.

**Treatment**

None entered.

**Comparison to the Normative Sample**

The overall performance was not within normal limits.

Inconsistency (response time variability) was borderline in Q1, Q2 and abnormal in Q3, Q4. This finding is important since inconsistency is the most sensitive measure in the T.O.V.A. Impulsivity (commission errors) was abnormal in Q3.

**Attention Performance Index**

The Attention Performance Index of -0.39 is in the range of individuals independently diagnosed with ADHD.

Note: This finding alone is not sufficient to establish a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).

\[-0.39\]
Analyzed Data

- **Comparison to the Normative Sample**
  After a brief description of the use of standard scores and standard deviations, the table contains the analyzed data, organized by quarters, halves, and total results.
  - **Codes** used in this table are:
    - [ ] (score in brackets) means that the quarter may not be valid and must be interpreted cautiously.
    - ! ! (score between two exclamation points) means that there were excessive Commission Errors in that quarter. Quarters with excessive Commission Errors need to be interpreted cautiously since Response Time Variability can be artificially increased, and Response Time and Omission Errors can be.
    - * (score flagged with an asterisk) means that the results are valid, not within normal limits, and compatible with an attention disorder.
    - ‘b’ means that the results are valid and borderline.
  For the sample protocol:
  
  *This protocol has a number of quarters with * and a few with b.*
  - Interpreting the Analysis Table
  For the sample protocol:
  
  *Variability and Commission Errors are not within normal limits and are suggestive of an attention disorder.*

- **Attention Comparison Score** (see discussion above for the Summary)
  A brief description of the ACS is followed by the criteria and data.
  For the sample protocol:
  
  *The ACS of -0.39 is characteristic of someone diagnosed with ADHD.*
  
  *Note that this finding does not make the diagnosis of ADHD. The clinician needs to consider additional sources of information, including the history, behavior ratings, and the comparison to the normative sample.*

- **Performance Validity** (see discussion above for the Summary)
  A brief description of PV is followed by the criteria and scores.
  For the sample protocol:
  
  *This was a valid administration of the T.O.V.A., and the subject appears to have been compliant with the instructions and demonstrated adequate effort.*
**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.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT Variability</td>
<td>83 b</td>
<td>83 b</td>
<td>71*</td>
<td>63*</td>
<td>66*</td>
</tr>
<tr>
<td>Response Time</td>
<td>116</td>
<td>106</td>
<td>105</td>
<td>92</td>
<td>101</td>
</tr>
<tr>
<td>Commission Errors</td>
<td>85</td>
<td>89</td>
<td>78*</td>
<td>104</td>
<td>83 b</td>
</tr>
<tr>
<td>Omission Errors</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

[] = Invalid quarter  b = Borderline result  * = Significantly deviant result

**Attention Performance Index**

The T.O.V.A. Attention Performance Index (API) provides information about the subject’s overall performance on the T.O.V.A. compared to a sample of individuals independently diagnosed with ADHD. It provides a single number, a general index of likely impairment. Scores greater than 0 suggest minimal or no impairment. Scores below 0 suggest increasing levels of impaired functioning. The T.O.V.A. API is based on (but different than) the ADHD Score reported in previous versions of the T.O.V.A.

- Response Time (Half 1): 0.72
- D Prime (Half 2): -0.63
- Variability (Total): -2.28
- Calibration constant: 1.80
- Attention Performance Index: -0.39

**Symptom Exaggeration Index**

The T.O.V.A. Symptom Exaggeration Index (SEI) is a measure of symptom exaggeration or “faking bad”. Symptom exaggeration is characterized by unusual patterns of performance that are not typically seen in clinical disorders. The SEI is only applicable to ages 17 or older. It is only relevant when the overall test performance is not within normal limits, and the possibility of secondary gain exists.

0 Either total omission (100) or commission errors (83) less than 45 SS
0 Total response time variability (93.20 ms) greater than 180 ms
0 Not enough post-commission responses
0 Frequent half commission error response time (287.43 ms) greater than response time (355.77 ms)
0 Based on the subject’s pattern of performance, there is no evidence of symptom exaggeration.
Analyzed Data (Graphs)

- **The Graphs** present T.O.V.A. results using standard scores. If the standard score is below the limit of the vertical axis (<40), it would be noted as a downward facing red triangle.

  The “X” axis of the graph will be moved (up or down) automatically as necessary to allow sufficient room for the results. If the standard score is above the limit of the vertical axis (>120), it would be noted as an upward facing red triangle.

  The results of four tests can be displayed side-by-side to compare performances over time or no treatment and treatment. See the User’s Manual for details on how to compare tests.
### RT Variability

- **Q1**: 83
- **Q2**: 83
- **Q3**: 71
- **Q4**: 63

### Response Time

- **Q1**: 116
- **Q2**: 106
- **Q3**: 105
- **Q4**: 92

### Commission Errors

- **Q1**: 85
- **Q2**: 89
- **Q3**: 78
- **Q4**: 104

### Omission Errors

- **Q1**: 100
- **Q2**: 100
- **Q3**: 100
- **Q4**: 100

**Comments**: Baseline
Tabulated Data

As noted Tabulated Data is provided for researchers and advanced T.O.V.A. users.

- **Comments**, if any.

  Data are listed by quarters, halves and total, and include:
  
  - RT Variability (ms)
  - Response Time (ms)
  - Post-Commission Responses (#, Response Time in ms, and Variability in ms)
  - D Prime\(^1\) (Standard Score and Raw Score)
  - Commission Errors (# and %), Response Time (ms)
  - Omission Errors (# and %)
  - Anticipatory Responses (To Nontargets- # and To Targets- #)
  - Multiple Responses #
  - Total Correct # (Correct Responses # Correct Nonresponses #)
  - Beta\(^1\)
  - User Interrupts #
  - Hardware Errors #

- **Session Parameters**

  - Standard configurations:
    
    Infrequent = quarters with infrequent targets
    
    Frequent = quarters with frequent targets
    
    IIFF for ages 6- to 80+ (Standard or form 1 with 4 quarters, 21.6 minutes)
    
    or
    
    IF for ages 4 and 5 (form 2 with 2 quarters, 10.8 minutes)
    
    - Inter-Stimulus Interval (time between successive stimuli): 2000 ms
    
    - On-Time (time when the stimulus appears in a 2000 ms period): 200 ms
    
    - Off-Time (time when the stimulus disappears in a 2000 ms period): 300 ms
    
    - Anticipatory Cutoff: If a response (microswitch press) occurs within 150 ms of On-Time (200 ms), the response is considered an Anticipatory (usually a guess or impulsive response)

  **Note:** Research configurations may be altered as needed

- **Import file identification number and import date** (if applicable)

  For the sample protocol:

  *No tester identification*, designation of test, or comments were recorded. Test Format was #1 (IIFF with the standard timing). The test (version 7.2) was administered on May 31, 2005 and reformatted in version 8.0 on July 23, 2010.

  *The tester identification was removed for the sample protocol.*
**Comments:** Baseline

This page is provided for researchers and advanced T.O.V.A. users. It contains tabulated raw data, and documents T.O.V.A. session parameters.

<table>
<thead>
<tr>
<th></th>
<th>Quarter</th>
<th></th>
<th></th>
<th>Half</th>
<th></th>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>RT Variability</td>
<td>ms</td>
<td>59</td>
<td>66</td>
<td>93</td>
<td>91</td>
<td>66</td>
<td>99</td>
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<tr>
<td>Response Time</td>
<td>ms</td>
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<td>361</td>
<td>318</td>
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<td>2</td>
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<tr>
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<td>ms</td>
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<td>0</td>
<td>51</td>
<td>134</td>
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<td>113</td>
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<tr>
<td>Commission Errors</td>
<td>#</td>
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<td>1/126</td>
<td>2/36</td>
<td>5/36</td>
<td>2/252</td>
<td>7/72</td>
</tr>
<tr>
<td>(Impulsivity)</td>
<td>%</td>
<td>0.8</td>
<td>0.8</td>
<td>13.9</td>
<td>5.6</td>
<td>0.8</td>
<td>9.7</td>
</tr>
<tr>
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<td>399</td>
<td>258</td>
<td>362</td>
<td>294</td>
<td>287</td>
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<tr>
<td>Omission Errors</td>
<td>#</td>
<td>0/36</td>
<td>0/36</td>
<td>0/126</td>
<td>0/126</td>
<td>0/72</td>
<td>0/252</td>
</tr>
<tr>
<td>(Inattention)</td>
<td>%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D Prime</td>
<td></td>
<td>6.68</td>
<td>6.68</td>
<td>5.35</td>
<td>5.86</td>
<td>6.68</td>
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</tr>
<tr>
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<td>78</td>
<td>80</td>
<td>95</td>
<td>73</td>
<td>91</td>
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<td>Beta</td>
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<td>0</td>
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<td>0</td>
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<tr>
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<td>%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>To Nontargets</td>
<td>#</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>To Targets</td>
<td>#</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multiple Responses</td>
<td>#</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total Correct</td>
<td>#</td>
<td>161/162</td>
<td>161/162</td>
<td>157/162</td>
<td>160/162</td>
<td>322/324</td>
<td>317/324</td>
</tr>
<tr>
<td>Correct Responses</td>
<td>#</td>
<td>36/36</td>
<td>36/36</td>
<td>126/126</td>
<td>126/126</td>
<td>72/72</td>
<td>252/252</td>
</tr>
<tr>
<td>Correct Nonresponses</td>
<td>#</td>
<td>125/126</td>
<td>125/126</td>
<td>31/36</td>
<td>34/36</td>
<td>250/252</td>
<td>65/72</td>
</tr>
<tr>
<td>User Interrupts</td>
<td>#</td>
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<td>0</td>
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<td>0</td>
</tr>
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<td>Hardware errors</td>
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<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

**Session parameters**

- **Format:** 1 (standard)
- **ISI:** 2000 ms
- **Stim. On Time:** 200 ms
- **Stim. Off Time:** 300 ms
- **Ant. Cutoff:** 150 ms

**Import parameters**

- **Filename:** 01001001.M34
- **Date:** Apr 4, 2011 4:20:56 PM

---

\(^1\)Beta and D prime are part of the Receiver Operator Characteristic (ROC) analysis, and are not used in the T.O.V.A. Interpretation. They are included for researchers.
Raw Data (Graphs)

All of the subject's responses are sequentially displayed.

Codes:

- ■ = Correct responses and correct non-responses (black square)
- × = Omission, Commission, and Anticipatory Errors (red ‘X’)
- ● = Post-Commission Error Responses (green dot)

- Light gray area = Responses within normal limits 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 doesn’t recognize the error, is impulsive, and/or doesn’t care.)
  - Omission errors are underscored (_) in red. 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, or, rarely, a hardware error.
Comments: Baseline

This page graphically displays the subject’s responses. Black squares mark correct responses and correct non-responses. Red ‘X’s mark commission and anticipatory errors. Red ‘X’s with underlines mark omission errors. The light gray region represents the normal range of responses from the T.O.V.A. normative study. Commission errors and post-commission-error correct responses are linked by a line: a positive slope (light gray) indicates a normal slow-down associated with making an error, while a negative slope (black) indicates an unusual reaction of either a slow commission error or an speed-up after an error.
Raw Data (Tables)

In addition to the identifying information, these tables present the sequence of targets and non-targets, and the subject’s response to each one. Errors are shown in red, and response times are in ms. A negative response time indicates a response that was made before the stimulus appeared.

The codes are:

- T = target
- N = nontarget
- TO = Omission Error
- NC = Commission Error
- TA = Anticipatory Response
- M = Multiple Responses
- Red = Error Responses
- Green = Post-Commission Error Response
- * = User or Hardware Interrupt
TOVA

Raw Data Tables

ID: 10010  Example Subject (Mar 19, 1971)
Male - 34y 2m 13d

Visual T.O.V.A. (v7.289 sn16292)
May 31, 2005 at 8:42 AM

Comments: Baseline
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.

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T = Correct response to target
N = Correct noreponse to target
Green = Post-Commission-error correct response
NC = Commission error to nontarget
NC = Commission error to nontarget
A = Anticipatory response
M = Multiple response
-

800.PAY.ATTN  •  http://www.tovatest.com  •  info@tovatest.com
3321 Cerritos Ave., Los Alamitos, CA 90720 U.S.A.  •  Phone 800.729.2886 or 562.594.7700  •  Fax 800.452.6919 or 562.594.7770
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Report Version: 8.0-Head-DEV  Page 10/10
Error Graphs

This error descent graph displays the number of Commission, Omission, and Anticipatory Errors and norms by quarter and total errors (the red line). The gray area represents the norm (standard score of 100) for age and gender. The light gray line represents a standard score of 85, and the black line represents a standard score of 80. We are in the process of determining the clinical usefulness of this display.
Comments: Baseline

This page graphically presents the errors over the course of the T.O.V.A. test. The line descends one unit for each error that occurs, and moves one unit to the right with every stimulus presentation. Gray areas indicate the expected path of performance for Commission and Omission Errors.
Response Time Histogram

This histogram is included for researchers and advanced T.O.V.A. users. We are examining new models of Response Time that may make the T.O.V.A. even more accurate and helpful for clinicians and researchers. We have been using the traditional Gaussian distributions (“bell curves”) to model Response Time histograms. We are now exploring a new model, the “ExGaussian” distribution with its unique measure, Tau.

Gaussian and ex-Gaussian models are very similar, except for Tau. The ex-Gaussian Mu corresponds to the Gaussian Mu (the average response time), and ExGaussian Sigma corresponds to the Gaussian Sigma (variability or width of the curve). The new parameter, Tau, models an exponential decay of the Response Time histogram to the “right” (longer response times). Normally Tau is very small; however, recent research indicates that Tau may be a more sensitive parameter defining attention deficits than either Mu or Sigma alone. Our hypothesis is that although Mu and Sigma may be within normal limits, a significantly skewed Tau may be indicative of ADHD.

Codes:

- Gray = Correct Responses
- Light Gray = Norm
- Red = Commission Errors
- Blue = Post-Commission
- —— = ExGaussian

The ms for Mu, Sigma, and Tau are listed by quarters, halves, and total in the table.
Comments: Baseline

This page is intended for researchers and advanced T.O.V.A. users. Clinical interpretation guidelines for the exGaussian parameters will be provided in a future version of the T.O.V.A. For more information on interpreting the T.O.V.A. reaction time histograms and the exGaussian distribution parameters, please see the T.O.V.A. Clinical Manual.
7 Individualized Success Strategies: School

These strategies are designed for individuals who need support in their school environment. Whether the person has an attention problem, demonstrates behavior problems, or just needs more structure to succeed, these strategies focus on creating successful habits and developing successful structure in the classroom and school environment. Interpreting a student's T.O.V.A. results along with interviews and behavior ratings can help determine the most appropriate strategies for the individual. We recommend coordinating the school and home strategies for the student to maintain consistency and minimize the possibility of overload. Available by clicking on the Help button on the main T.O.V.A. Screen, these strategies are also an entry into dialogue with teachers and school staff.

8 Individualized Success Strategies: Home

These strategies are designed for individuals who need support in their home environment. These may be used for children, adolescents and adults. Depending upon the person's age, they may also be adapted to be utilized in the workplace if needed. If the individual is in school, we recommend coordinating the home and school strategies to ensure consistency in the approach to success. Whether the person has an attention problem, demonstrates behavior problems, or just needs more structure to succeed, these strategies focus on creating successful habits and developing successful structure in the home environment. Interpreting a person's T.O.V.A. results along with interviews and behavior ratings can help determine the most appropriate strategies for the individual.

9 T.O.V.A. ® Protocols

Reading and understanding the T.O.V.A. in the context of the a clinical evaluation or in establishing a baseline for attention requires an understanding of the relationship between the variables and the quarters, as well as the meaning of the Attention Comparison Score (ACS) and Performance Validity (PV), and their link to the Comparative to the Normative Sample standard scores. When first reading a T.O.V.A. follow the standard scores for each variable from quarter to quarter. Look for scores below 85 to indicate difficulty with consistency, processing speed, impulsivity or attention. Note decreases or increases between quarters and halves. Pay attention to the relationship between certain variables. For instance, is the person fast but makes a lot of errors, or are they slow and make few errors? Is the person inconsistent in the first half (low arousal) but fast, consistent and accurate in the second half (high arousal)? This can tell you something about the person and the person's test taking strategy. One can extrapolate from this to how the person may behave, but it is important to ask the subject if your “story” fits. Often it will if you follow the inferences that one can deduce from the T.O.V.A.

Experienced T.O.V.A. users consult the Tabulated Data, the Error Graph and the Raw Data Graphs pages on a regular basis to gain more insight into the subject's performance on the T.O.V.A., and the Raw Data Tables when necessary. Each of these pages give more data that help “tell the story” of the subject. Along with the four variables, the T.O.V.A. also provides information on vigilance over the 21.6 minutes, adaptability (changes from half 1 to half 2), and neurological status (consecutive omissions and excessive multiple responses). Gathering all this data together helps form a picture of the person's performance on the T.O.V.A. which can be useful in understanding the person and in designing appropriate treatment interventions or protocols.
The ACS is not a read-alone score. It should always be analyzed in relationship to the Comparison to the Normative Score. The ACS is a comparison of the person’s scores based on selected measures that persons with an independent diagnosis of ADHD frequently demonstrated. Primarily focused on variability, response time and d’ prime (degradation of performance over time), the ACS is an adjunct to the Comparison to the Normative Sample. It provides research-based information and can be used as additional information in understanding the subject’s performance and when comparing tests pre- and post-treatment to determine one aspect of the success of treatment.

Performance Validity (PV) is a research-based measure determined by the results of persons who “faked bad” on the T.O.V.A. If the PV indicates the possibility of malingering and secondary gain is a concern, consider the possibility of “faking bad”, or other reasons that a person may have triggered a high score on the PV, such as drug use, psychiatric conditions, oppositional behavior, and/or very severe problems with attention. The PV is meant to alert the clinician to unusual patterns of performance, leading to conversations with the subject concerning their test results.

Though two T.O.V.A.’s may look similar, remember that no two people are the same. Always understand the T.O.V.A. in the context of the person, and the person in the context of the T.O.V.A. results. Good clinical practice makes use of the T.O.V.A. in interpreting the person, but relies on a complete assessment of the person to determine diagnosis and treatment decisions.

The protocols below are presented and reviewed to illustrate the T.O.V.A. s and their uses.
Clinical Protocol #1

This 41-year-old male has been in psychotherapy off and on for 7 years due to relational issues. Gradually, the therapist learns that he frequently doesn’t keep commitments, avoids paper work, accounting, decision making, and doesn’t pay attention to tasks that require sustained attention. He frequently forgets appointments and feels overwhelmed. No history of learning disabilities or psychiatric diagnoses. He recently reported that he had a head injury in a motorcycle accident 20 years ago when he was unconscious for unknown amount of time.

First Visual T.O.V.A. Summary: Baseline

T.O.V.A. Interpretation: The results of this T.O.V.A. test are not within normal limits, and suggest the presence of an attention disorder, including ADHD.

Session and Response Validity: Acceptable

Performance Validity: No evidence of unusual patterns of performance

Treatment: None recorded

Comparison to the Normative Score: Good Response Time Variability (RTV) in low arousal condition (Quarters 1 and 2). However, the standard score drops 8 points in the change to high arousal (Quarter 3) and drops to 66 (not within normal limits) in Quarter 4. Response Time (RT) drops 8 points from Quarter 2 to Quarter 3 and then another 19 points to 89 in Quarter 4. Commission Errors are within normal limits. Omission Errors drop to 56 (not within normal limits) in Quarter 3 and improve to 100 in Quarter 4. Overall, the scores suggest difficulty with transition and adaptability (RTV, RT and Omissions drop in Quarter 3) and tiring after 15 minutes (RTV and RT drop in Quarter 4).

Attention Comparison Score score is 0.57 (within normal range). Comments: He was referred to his personal physician with a preliminary diagnosis of Traumatic Brain Injury.
**TOVA**

### Summary

**ID:** 10014  **Example Subject 1** (Jun 10, 1968)  
**Male - 41y 9m 18d**

**Visual T.O.V.A.** (v7.3-4377 sn018130)  
**Mar 29, 2010 at 8:10 AM**


---

**T.O.V.A. Interpretation**

- The results of this T.O.V.A. test are not within normal limits, and suggest the presence of an attention problem, including ADHD.

---

**Session and Response Validity**

- The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

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**Symptom Exaggeration Index**

- The Symptom Exaggeration Index is applicable only to outcomes that are significantly outside of normal limits.

---

**Treatment**

- None entered.

---

**Comparison to the Normative Sample**

- The overall performance was not within normal limits.

  - Inconsistency (response time variability) was abnormal in Q4. This finding is important since inconsistency is the most sensitive measure in the T.O.V.A. Inattention (omission errors) was abnormal in Q3.

  - Caution: In the T.O.V.A. normative sample, teenagers and adults made few or no omission and commission errors. Thus, only a few errors may result in a significantly low standard score. However, these few errors may not be clinically significant. The clinician should review the actual number of errors (see the Comparison to the Normative Sample page) and interpret these results cautiously.

---

**Attention Performance Index**

- The Attention Performance Index of 0.57 is within the normal range.

  - Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).

---

**RT Variability**

- Q1: >120, Q2: >120, Q3: 112, Q4: 66

**Response Time**

- Q1: 115, Q2: >120, Q3: 108, Q4: 89

**Commission Errors**

- Q1: 110, Q2: 105, Q3: 102, Q4: 107

**Omission Errors**

- Q1: 100, Q2: 100, Q3: 56, Q4: 100

---

**Standard Score**

- ADHD Sample: 0  
  Normative Sample: 10
Second Visual T.O.V.A.: On 20 mg Methylphenidate SR

Note: The baseline (no medication) T.O.V.A. is in the previous section.

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

Performance Validity: No evidence of unusual patterns of performance

Session and Response Validity: Acceptable.

Treatment: 20 mg. of Methylphenidate SR taken 2.2 hours before testing

Comparison to the Normative Sample: All 4 Quarters are within normal limits.

Comments: T.O.V.A. and behavior ratings are within normal limits. Good response to medication.
**Omission Errors**

Q1: 100
Q2: 100
Q3: 101
Q4: 100

**Commission Errors**

Q1: 110
Q2: 105
Q3: 120
Q4: 116

**Response Time**

Q1: 107
Q2: 109
Q3: 104
Q4: 104

**RT Variability**

Q1: >120
Q2: >120
Q3: 118
Q4: 116

---

**T.O.V.A. Interpretation**

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

**Session and Response Validity**

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

**Symptom Exaggeration Index**

The Symptom Exaggeration Index is applicable only to outcomes that are significantly outside of normal limits.

**Treatment**

Challenge: 20.0mg dose of Methylphenidate SR taken 2.2 hours before testing.

**Comparison to the Normative Sample**

The overall performance was normal.

NOTE: While this finding does not suggest an attention disorder, the clinician must take into account factors that may produce a false negative result, including use of psychostimulant(s) such as caffeine and nicotine or unusually strong motivation. Since some attention problems may be primarily auditory, consider administering an Auditory T.O.V.A. test.

**Attention Performance Index**

The Attention Performance Index of 4.86 is within the normal range.

Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).
**Clinical Protocol #2**

This 17-year-old female was referred because of academic difficulties. She reported being frequently bored, daydreaming excessively and feeling mildly depressed.

**T.O.V.A. Interpretation:** The results of this test are not within normal limits, and suggest the presence of an attention problem, including ADHD.

**Session and Response Validity:** Acceptable

**Performance Validity:** No evidence of unusual patterns of performance

**Treatment:** none recorded (baseline T.O.V.A.)

**Comparison to the Normative Sample:** The overall results are not within normal limits. Inconsistency (Response Time Variability) was not within normal limits in Quarters 1 and 2 and was borderline in Quarter 3. This finding is important since RTV is the most sensitive measure of the T.O.V.A. Interestingly, her RTV scores progressively improved throughout the test, so that by the end (Quarter 4) her RTV score was within normal limits.

**Attention Comparison Score:** 1.36 (within normal limits) Comments: Based on history, behavior ratings and T.O.V.A. scores, she was referred to her physician who prescribed medication and requested an on-medication T.O.V.A. The 18-year-old female (case # 2) was administered the T.O.V.A. on trial medication.
T.O.V.A. Interpretation

The results of this T.O.V.A. test are not within normal limits, and suggest the presence of an attention problem, including ADHD.

Session and Response Validity

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

Symptom Exaggeration Index

The Symptom Exaggeration Index is applicable only to outcomes that are significantly outside of normal limits.

Treatment

Challenge: 0.0mg dose of Minicyclene taken 0.0 hours before testing.

Comparison to the Normative Sample

The overall performance was not within normal limits.

Inconsistency (response time variability) was borderline in Q3 and abnormal in Q1, Q2. This finding is important since inconsistency is the most sensitive measure in the T.O.V.A.

Attention Performance Index

The Attention Performance Index of 1.36 is within the normal range.

Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).
Second Visual T.O.V.A. FOR CASE #2: On 5 mg Adderall

T.O.V.A. Interpretation: The results of the T.O.V.A. are borderline, and may suggest an attention problem, including ADHD.

Session and Response Validity: Acceptable

Treatment: 5 mg Adderall taken 1.5 hours before taking medication.

Comparison to the Normative Sample: The overall performance was borderline. Impulsivity was borderline in Quarter 4. RTV and RT improved from baseline T.O.V.A.; however, Commission Errors were worse as were Quarter 4 Omissions.

Attention Comparison Score: 3.63 (unremarkable and better than baseline) Comments: The on-medication results are mixed (some variables better and some worse) when compared with baseline T.O.V.A. ACS is much improved; however, this doesn’t take into account the borderline impulsivity score. Overall, mixed results are usually indicative of excessive medication and that a lower dosage may produce better results. See below.

Based on self-report and the mixed T.O.V.A. results with 5 mg of Adderall, the 18-year-old female (case #2) was retested on a lower dosage of medication.
Omission Errors

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>102</td>
<td>106</td>
<td>88</td>
</tr>
</tbody>
</table>

Commission Errors

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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<tr>
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Response Time

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<tbody>
<tr>
<td>&gt;120</td>
<td>&gt;120</td>
<td>&gt;120</td>
<td>&gt;120</td>
</tr>
</tbody>
</table>

RT Variability

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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</thead>
<tbody>
<tr>
<td>108</td>
<td>115</td>
<td>116</td>
<td>110</td>
</tr>
</tbody>
</table>

Commission Errors

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>115</td>
<td>116</td>
<td>110</td>
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</tbody>
</table>

Omission Errors

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>102</td>
<td>106</td>
<td>88</td>
</tr>
</tbody>
</table>

**T.O.V.A. Interpretation**

The results of this T.O.V.A. test are borderline, and may suggest an attention problem, including ADHD.

**Session and Response Validity**

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

**Symptom Exaggeration Index**

The Symptom Exaggeration Index is applicable only to outcomes that are significantly outside of normal limits.

**Treatment**

Challenge: 5.0mg dose of Adderall taken 1.5 hours before testing.

**Comparison to the Normative Sample**

The overall performance was borderline.

Impulsivity (commission errors) was borderline in Q4.

**Attention Performance Index**

The Attention Performance Index of 3.63 is within the normal range.

Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).

![](chart.png)

-10 ADHD Sample 0 Normative Sample 10

3.63
Third Visual T.O.V.A.: On 2.5 mg of Adderall

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

**Session and Response Validity:** Acceptable

**Performance Validity:** No evidence of unusual patterns of performance

**Treatment:** 2.5 mg. of Adderall taken 1.5 hours before testing.

**Comparison to the Normative Sample:** All quarters are within normal limits and as good or better than baseline scores.

**Attention Comparison Score:** 5.12 (better than baseline and with 5 mg of Adderall)

**Comments:** Good response to 2.5 mg of Adderall. ACS continues to improve and all quarters are within normal limits.
T.O.V.A. Interpretation

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

Session and Response Validity

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

Symptom Exaggeration Index

The Symptom Exaggeration Index is applicable only to outcomes that are significantly outside of normal limits.

Treatment

Challenge: 2.5mg dose of Adderall taken 1.5 hours before testing.

Comparison to the Normative Sample

The overall performance was normal.

NOTE: While this finding does not suggest an attention disorder, the clinician must take into account factors that may produce a false negative result, including use of psychostimulant(s) such as caffeine and nicotine or unusually strong motivation. Since some attention problems may be primarily auditory, consider administering an Auditory T.O.V.A. test.)

Attention Performance Index

The Attention Performance Index of 5.12 is within the normal range.

Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).
Clinical Protocol #3

History: This boy, almost 11 years old, was referred for psychotherapy due to impulsive behaviors, distractibility, lack of focus, difficulty with follow through and arguing with his parents. He had a previous diagnosis of ADHD, combined type, and was on medication at the beginning of treatment. At the time of the referral the physician was considering raising his medication to obtain better clinical results.

T.O.V.A. Interpretation: The results of this T.O.V.A. are not within normal limits, and the overall pattern of performance is suggestive of an attention problem, including ADHD.

Session and Response Validity: There are excessive >10% Anticipatory Errors in Quarters 3 and 4 (21% and 26.5%, respectively). Since excessive ARs tend to increase Commissions and decrease Omissions, the results need to be interpreted cautiously.

Performance Validity: Not available for a person under 17 years of age.

Treatment: None (baseline).

Comparative to the Normative Sample: The overall performance was not within normal limits. Response Time Variability was borderline in Quarter 1 and not within normal limits in Quarters 2 and 4. This is important as it is the most sensitive measure of the T.O.V.A. Response Time was not within normal limits in Quarter 4. Impulsivity (Commission Errors) was not within normal limits in Quarters 1 and 2 and inattention (Omission Errors) was not within normal limits in Quarter 4. There were 25 multiple responses in Quarter 4. Note that in Quarter 3, all variables were within normal limits. It may be that the increased arousal in Half 2 improved performance, but after 5 minutes, he began to tire in Quarter 4 (increased Response Time Variability, Omissions and Multiple Responses.).

ACS: -5.61 (compatible with a pattern commonly seen in persons diagnosed with ADHD)

Case #3: T.O.V.A. test to compare his baseline T.O.V.A. to his medication scores.
T.O.V.A. Interpretation

The results of this T.O.V.A. test are not within normal limits, and the overall pattern of performance suggests an attention problem, including ADHD.

Session and Response Validity

There are more than 10% anticipatory errors in quarters Q3, Q4. This unusually high number of anticipatory errors will impact the standard scores for omissions and commissions.

Treatment

None entered.

Comparison to the Normative Sample

The overall performance was not within normal limits.

Response time was abnormal in Q4. Inconsistency (response time variability) was borderline in Q1 and abnormal in Q2, Q4. This finding is important since inconsistency is the most sensitive measure in the T.O.V.A. Impulsivity (commission errors) was abnormal in Q1, Q2. Inattention (omission errors) was abnormal in Q4. There were an unusually high number of multiple responses made in Q4. Although this may simply represent an idiosyncratic response set, it might be caused by an underlying neurological condition and may warrant further investigation.

Attention Performance Index

The Attention Performance Index of -5.61 is in the range of individuals independently diagnosed with ADHD.

Note: This finding alone is not sufficient to establish a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).

-5.61

ADHD Sample 0 Normative Sample 10
Second Visual T.O.V.A. for Case #3: On 50 mg Adderall XR

T.O.V.A. Interpretation: The results of this test are not within normal limits, and are suggestive of an attention disorder, including ADHD.

Session and Response Validity: Acceptable

Treatment: 50 mg Adderall XR taken 2.5 hours before taking the test.

Comparison to the Normative Sample: This test is not within normal limits. Impulsivity (Commission Errors) was borderline in Quarter 2 and not within normal limits in Quarters 1 and 4.

Attention Comparison Score: 1.27 (not compatible with a pattern commonly seen in persons diagnosed with ADHD) Comments: The ACS is much improved in comparison to the baseline. However, some variables are now worse on medication than when off medication. Impulsivity is now worse and this is one of the behaviors that the subject exhibits. Mixed results suggest a lower dosage of medication may work better for this subject.

Case #3: Test to compare his baseline T.O.V.A. to his 50 mg Adderall XR T.O.V.A. score and his 10mg Adderall XR T.O.V.A. score.
**Omission Errors**

- Q1: 98
- Q2: 105
- Q3: 96
- Q4: 106

**Commission Errors**

- Q1: 74
- Q2: 84
- Q3: 94
- Q4: 76

**Response Time**

- Q1: 110
- Q2: 109
- Q3: 114
- Q4: 118

**RT Variability**

- Q1: 92
- Q2: 106
- Q3: 87
- Q4: 117

**Commission Errors**

- Q1: 74
- Q2: 94
- Q3: 76
- Q4: 96

**Omission Errors**

- Q1: 98
- Q2: 105
- Q3: 96
- Q4: 106

**Average Standard Score**

- ADHD Sample: 0
- Normative Sample: 10

---

**T.O.V.A. Interpretation**

The results of this T.O.V.A. test are not within normal limits, and suggest the presence of an attention problem, including ADHD.

**Session and Response Validity**

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

**Treatment**

- Challenge: 50.0mg dose of Adderall taken 2.5 hours before testing.

**Comparison to the Normative Sample**

The overall performance was not within normal limits.

Impulsivity (commission errors) was borderline in Q2 and abnormal in Q1, Q4.

**Attention Performance Index**

The Attention Performance Index of 1.27 is within the normal range.

Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).
Third Visual T.O.V.A.: On 10 mg of Adderall XR

T.O.V.A. Interpretation: The results of this test are within normal limits.

Session and Response Validity: Acceptable

Treatment: Challenge dose of 10mg of Adderall XR taken 2.5 hours before testing.

Comparative to the Normative Sample: Overall performance is within normal limits.

Attention Comparison Score: 3.37 (better than baseline and with 50 mg of Adderall XR) Comments: All scores are within normal limits. The ACS is higher than in both previous tests. Impulsivity scores are very good. The dosage was decreased to 10 mg of Adderall XR rather than raising dosage from 50 mg.
T.O.V.A. Interpretation

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

Session and Response Validity

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

Treatment

Challenge: 10.0mg dose of Adderal xr taken 2.5 hours before testing.

Comparison to the Normative Sample

The overall performance was normal.

NOTE: While this finding does not suggest an attention disorder, the clinician must take into account factors that may produce a false negative result, including use of psychostimulant(s) such as caffeine and nicotine or unusually strong motivation. Since some attention problems may be primarily auditory, consider administering an Auditory T.O.V.A. test.)

Attention Performance Index

The Attention Performance Index of 3.38 is within the normal range.

Note: This finding does not rule out a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).
Clinical Protocol #4

History: This 9-year-old girl was tested because of inattention and verbal impulsivity in the classroom where she was not performing well. The same problems were evident in the home as well. A visual T.O.V.A. and an Auditory T.O.V.A. were administered to determine her strengths and challenges with visual and auditory processing.

Visual T.O.V.A. for Case #4

T.O.V.A. Interpretation: The results of this T.O.V.A. are not within normal limits and the overall pattern of performance suggests an attention problem, including ADHD.

Session and Response Validity: acceptable

Treatment: none recorded.

Comparison to the Normative Sample: The overall performance was not within normal limits. Response Time Variability (RTV) was borderline in quarters 1 and 2 and not within normal limits in quarter 3. Response Time (RT) was borderline slow in quarter 1 and gradually increased in quarters 2, 3, and 4. Commissions (a measure of impulsivity) were within normal limits in all four quarters but were significantly higher in quarter 3. Omissions (a measure of inattention) were within normal limits in Half 1 but were significantly deviant (high) in Half 2. There is one set of three omissions in a row in quarter 4. As noted elsewhere in the Manual, this could be indicative of an underlying neurological problem, such as narcolepsy or seizures, and is reason for a referral to a neurologist. Overall, she had difficulty with consistency and speed in half 1 (low arousal), had difficulty with impulsivity in the change to half 2 (high arousal) and had difficulty with attention throughout half 2 (high arousal).

Attention Comparison Score: -2.59. Her performance was similar to that of someone with ADHD.

Note: Subject was retested one week later at a similar time of day on the Auditory T.O.V.A. to compare her performance to her Visual T.O.V.A.
T.O.V.A. Interpretation

The results of this T.O.V.A. test are not within normal limits, and the overall pattern of performance suggests an attention problem, including ADHD.

Session and Response Validity

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

Treatment

None entered.

Comparison to the Normative Sample

The overall performance was not within normal limits.

Response time was borderline in Q1, Q2. Impulsivity (commission errors) was borderline in Q3. Inattention (omission errors) was borderline in Q2 and abnormal in Q4.

Attention Performance Index

The Attention Performance Index of -1.08 is in the range of individuals independently diagnosed with ADHD.

Note: This finding alone is not sufficient to establish a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).

-1.08

-10 ADHD Sample 0 Normative Sample 10
Auditory T.O.V.A. for Case #4

**T.O.V.A. Interpretation**: The results of this T.O.V.A. are not within normal limits and the overall pattern of performance suggests an attention problem, including ADHD.

**Session and Response Validity**: acceptable

**Treatment**: none recorded.

**Comparison to the Normative Sample**: The overall performance was not within normal limits. Her performance on the Auditory T.O.V.A. was significantly worse than on the Visual T.O.V.A. for all four variables. Interestingly, her Response Time was fastest in quarter 3 when she made the most Commission errors. When she slowed in quarter 4, her Commissions improved. Omissions, which were worse in Half 1, occurred in bunches (3-7 in a row) twice in quarter 3 and six times in quarter 4, rather than the usual scattered pattern in an attention disorder. These are shown in the Raw Data Tables in the report. As noted elsewhere in the Manual, this could be indicative of an underlying neurological problem, such as narcolepsy or seizures, and is reason for a referral to a neurologist.

**Notes**: The Attention Comparison Score research for the Auditory T.O.V.A. is pending.

Up to 10-12% of people process visual differently than auditory information; hence, as in this case, the recommendation to do both Visual and Auditory Screening T.O.V.A.

The subject’s performance is not within normal limits on both the Auditory T.O.V.A. and the Visual T.O.V.A. As the Auditory T.O.V.A. is worse, some clinicians use it as a baseline while others use the Visual T.O.V.A. or both. Treatment, including school and home strategies (see Individualized Success Strategies-Home and School), should take into account the need to address both sensory domains.
**Summary**

**ID:** 10010  **Example Subject 4** (Jul 2, 2001)  **Visual T.O.V.A.** (v7.3-4377 sn018130)  **Female - 9y 4m 2d**

**Nov 3, 2010 at 9:49 AM**

**Comments:** Visual baseline.

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**T.O.V.A. Interpretation**

The results of this T.O.V.A. test are not within normal limits, and the overall pattern of performance suggests an attention problem, including ADHD.

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**Session and Response Validity**

The test was completed with no interruptions or excessive errors, and administered at the appropriate time of day (6:00am - 1:00pm), matching the conditions of the T.O.V.A. normative studies.

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**Treatment**

None entered.

---

**Comparison to the Normative Sample**

The overall performance was not within normal limits.

Response time was borderline in Q1. Inconsistency (response time variability) was borderline in Q1 and abnormal in Q3. This finding is important since inconsistency is the most sensitive measure in the T.O.V.A. Inattention (omission errors) was abnormal in Q3, Q4.

---

**Attention Performance Index**

The Attention Performance Index of -2.59 is in the range of individuals independently diagnosed with ADHD.

**Note:** This finding alone is not sufficient to establish a diagnosis of ADHD. The clinician needs to consider additional sources of information, such as Comparison to the Normative Sample (see above), as well as history and collateral information (such as behavior rating scales).

\[-2.59\]

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<thead>
<tr>
<th>-10</th>
<th>ADHD Sample</th>
<th>0</th>
<th>Normative Sample</th>
<th>10</th>
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3321 Cerritos Ave., Los Alamitos, CA 90720 U.S.A. • Phone 800.729.2886 or 562.594.7700 • Fax 800.452.6919 or 562.594.7770
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Part III

Appendices

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

For a copy of the T.O.V.A. observer Rating Form, please contact The TOVA Company.
11 DSM IV Symptom Checklist

Please check all that apply.

☐ Often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities.

☐ Often has difficulty sustaining attention in tasks or play activities.

☐ Often does not seem to listen when spoken to directly.

☐ Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions).

☐ 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).

☐ Is often easily distracted by extraneous stimuli.

☐ Is often forgetful in daily activities.

☐ 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 it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness).

☐ Often has difficulty playing or engaging in leisure activities quietly.

☐ Is often "on the go" or often acts as if “driven by a motor”.

☐ Often talks excessively.

☐ 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).
Have these behaviors persisted for more than 6 months?  
YES  NO  Don’t know

Have these behaviors been maladaptive and inconsistent with development level?  
YES  NO  Don’t know

Were these behaviors present before age 7?  
YES  NO  Don’t know

Do these behaviors occur in more than one setting (e.g. at home and at school or at home and at work)?  
YES  NO  Don’t know

Have these behaviors impaired social relationships?  
YES  NO  Don’t know

Have these behaviors impaired academic or work performance?  
YES  NO  Don’t know

Has there ever been any other psychiatric or psychological diagnosis before?  
YES  NO  Don’t know

If so, what and when?