

CLINICAL MANUAL

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

T.O.V.A.[®] Clinical Manual

Test Of Variables of Attention Continuous Performance Test

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Edition Number 844 (February 20, 2008)

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Printed in the United States of America.

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1. Introduction

The T.O.V.A.s

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

T.O.V.A.s:

- Assess attention in neuropsychological and neuropsychiatric evaluations
- Screen for disorders of attention
- Measure key components in the diagnosis of disorders of attention
- Measure medication response
- Monitor treatment response over time

I. Terms and Concepts

Below, some terms and concepts used in this manual are defined.

- A. "Off-task behavior" is a descriptive term with no specific etiologic or diagnostic implications. It is used in this manual to indicate that the person is not engaged in the appropriate or assigned task when it is reasonable to expect that they should be. They are not on-task for whatever reason or reasons that may have nothing to do with attention disorders.
- B. The term, "Attention Deficit Disorders" (ADD), is used to indicate that attention is disordered (that is, abnormal or deviant from the norm). There are many different types of ADD, including but not limited to ADHD.
- C. "Attention-Deficit Hyperactivity Disorder" (ADHD) refers to a specific symptom-complex defined in the current manual of diagnoses, the Diagnistic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV).
- D. Target symptom(s) and measure(s) 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.

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 history and a behavior rating scale to determine response to medication, the effects of treatment on attention could be missed. Thus, the pharmacotherapist must decide whether psychostimulants are to be used to treat attention or behavior.

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

A. Four sub-types of ADHD are definded in DSM-IV:

- Predominantly Inattentive Type (314.00) Must have six or more of the following symptoms: 1) Often fails to give close attention to details or makes careless mistakes in schoolwork, work, etc.; 2) Often has difficulty sustaining attention; 3) Often does not seem to listen to what is being said; 4) Often does not follow through on instructions and fails to finish school work, chores, or work (but not oppositional and not because of a failure to understand); 5) Often has difficulty organizing tasks and activities; 6) Often avoids or strongly dislikes tasks requiring sustained mental effort; 7) Often loses things necessary for tasks or activities; 8) Often easily distracted by extraneous stimuli; and 9) Often forgetful in daily activities.
- 2. Predominantly Hyperactive-Impulsive Type (314.01) Must have four or more of the following symptoms: 1) Often fidgets with hands or feet or squirms in seat; 2) Often leaves seat in classroom; 3) Often runs about or

climbs excessively (For teenagers and adults: may be limited to feelings of restlessness); 4) Often has difficulty playing quietly; 5) Often blurts out answers to questions too soon; 6) Often has difficulty waiting in line or waiting for turn.

- 3. Combined Type (314.01) Both inattentive and hyperactive/impulsive symptoms are present.
- 4. ADHD Not Otherwise Specified (314.9) Critera for other subtypes are not met, but symptoms are judged to interfere with the affected individual's functioning. This category typically used for adults with ADHD.

B. Requirements

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

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

C. Issues

Conceptually, the diagnostic category, "ADHD", has many limitations.

- 1. The symptoms are subjective, unreliable, and culture-bound.
- 2. 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).
- 3. The assumption that hyperactivity and attention deficits are necessarily linked is misleading and an artifact of equating symptom complexes with disorders (Unfortunately, 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).
- 4. The requirement that the onset be by seven years of age ignores the fact that non-hyperactive, bright children with attention deficits who come from advantaged backgrounds often do not have manifested symptoms until later.
- 5. 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.
- 6. Although the emphasis is on inattention, individuals with ADD are highly variable in their attention over time, and can hyperfocus.
- 7. Finally, there is no mention of the status of the Central Nervous System; that is, brain damage can cause ADHD in DSM-IV.

III. Causes of Off-Task Behavior

Differential diagnosis for off-task behavior includes:

A. Normal range behavior:

Age appropriate behavior that is mislabeled. For example, Characteristics of "active alert" children include: active, alert, bright, controlling, fearful, intense, attention-hungry, trouble getting along with others, fluctuating self-esteem, performer, and empathic.

B. General medical problems: Anemia, hyperthyroidism, otitis media, and dietary inclusions/sensitivities which are relatively uncommon).

- C. Medications: Ssuch as anticonvulsants, antihistamines, and psychodepressants that sedate or slow the brain.
- D. Toxic conditions: Environmental exposures, drug induced, or an illness.
- E. Sensory deficits and hypersensitivities: Missed hearing and visual impairments, any sensory (including olfactory and kinesthetic) hypersensitivity.
- F. Neurologic problems (other than ADHD): Distractibility, sleep disturbances (including apnea and narcolepsy), epilepsy, Traumatic Brain Injury (TBI)
- G. Family style and organization (including social and cultural factors).
- H. School readiness, learning style, and motivation Some children (including those with ADHD) have a hands-on rather than a listen & understand learning style.
- I. Stress Including emotional trauma and inappropriate demands.
- J. Intellectual impairment and precocity
- K. Learning disabilities: One third of individuals with an attentional disorder also have a learning disability and visa-versa.
- L. Psychiatric conditions: Abuse/PTSD, psychosis, bipolar or obsessive-compulsive traits/disorders, depression, and anxiety.
- M. Substance use, abuse, and withdrawal: All substances, including caffeine and nicotine.
- N. Behavior disorder, impulsivity, and oppositionality and defiance
- O. Disorders of attention (ADHD)

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

IV. Diagnosis of ADHD

The components of a diagnostic workup for ADHD can include:

- A. History: Nothing (not even the T.O.V.A.) replaces a detailed history that includes family history of ADD, temperamental type, licit and illicit substance uses (including nicotine and caffeine), CNS symptoms (such as head injuries and seizures), parental/spousal/patient's techniques to manage attention and behavior, etc.
- B. Physical and screening neurological exam: Recent exam by family doctor or pediatrician is essential. EEG should be considered if suspicion of seizures or narcolepsy.
- C. Psychological/neuropsychological evaluation: Emphasis on learning style, cognitive assets and liabilities, and CNS functioning.
- D. Evaluation of classroom/work place behavior and performance: Direct observations (generally not feasible) or telephone interview of teacher or supervisor are very helpful, especially to prepare them for your recommendations.
- E. Mental status examination/ personality assessment to help identify other and co-morbid conditions (such as depression).
- F. Structured interviews: The DICA and DISC, which are primarily used for clinical research, are time-consuming but

comprehensive. The relationships between patient, parent, and teacher versions remain problematic.

G. Behavior ratings by teachers, parents, spouses, and significant others: The ACTERS, SBCL, and BASC are especially useful for children. Note that, while behavior ratings are an important part of the diagnostic process, they are not sufficient by themselves. Clinicians need to be wary - most of the many behavior ratings are poorly constructed, poorly standardized, and overemphasize disruptive behaviors, minimizing attentional symptoms and are subject to rater bias.

Studies predating the use of CPTs and relying on behavior ratings identified 1) more boys than girls (who are often not hyperactive) and 2) missed many children and adults who have poor attention but are not hyperactive. This limited assessment approach has led to the use of higher than optimal dosages of medications with many side effects.

- H. Self-ratings for adults: The BAADS and the T.O.V.A.[®] Adult ADD Rating Scale (Appendix B), are currently in development.
- I. DSM-IV Symptom checklists: These check lists help clinicians to thoroughly review all symptoms of ADHD.
- J. Neuro-imaging: Primarily for clinical research at this time, but very promising.
- K. Continuous performance tests (CPTs): T.O.V.A.[®] and T.O.V.A.-A[®]: Increasingly used as diagnostic tools. However, the T.O.V.A.s do not make diagnoses of anything, and certainly not ADD or ADHD. Instead, they are tests that measure certain aspects of visual and auditory attention and impulsivity under very specific conditions. At best they measure some attentional characteristics which can be affected by any number of contributing factors. If the T.O.V.A. is significantly deviant from the norm, the clinician needs to explain it. If the T.O.V.A. is within normal limits, and the clinical impression is that of an ADD, the clinical picture should prevail. More about this when we review sensitivity and specificity.

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



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

V. Treatment of ADHD

The treatment intervention is generally multifaceted- reflecting the many symptoms of ADHD and co-morbid conditions. Although T.O.V.A.s can be used to measure treatment effects on attention and impulsivity, we do not advocate treating the T.O.V.A. and losing sight of the patient in the real world.

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

- A. 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, perhaps 30% of the cases are mild enough or the life circumstances (particularly for adults) are such that treatment is not necessary. In some cases treatment may be on an as needed basis as when extensive reading is necessary.
- B. Parental/patient/spousal counseling and coaching to improve management techniques: There are many management or coping strategies that can reduce the problems to 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.
- C. School/work place consultation: Use of the T.O.V.A. School and Home Intervention Programs can be very helpful in the classroom setting and in the home. Findings need to be translated into relevant suggestions like private office space or quiet homework area for a distractible person, etc.
- D. 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. Individuals with ADHD tend to do well in a computer-related vocation.
- E. Recreational considerations: Consider faster paced activities like swimming and handball instead of slowly paced activities like bridge.
- F. Neurofeedback: Using pre- and post-treatment T.O.V.A.s (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 T.O.V.A.s are now underway, and we expect to learn more about the indications, types, and outcome of neurofeedback in the near future.
- G. Behavior modification: These types of treatment are extensively described elsewhere. However, it should be noted that they are especially useful in the treatment of impulsivity/disinhibition. As we will discuss later, the clinician needs to determine whether to treat inattention or the behavioral manifestations of ADHD with psychostimulants. If inattention is the targeted symptom for a psychostimulant, then behavior modification and/or the addition of another medication should be considered for the disrupting behaviors.
- H. Psychotherapy: Particularly indicated with co-morbid depression and related self-defeating coping strategies.
- I. Medication: See below.

VI. Medication for ADHD

Note: It is beyond the scope of this brief introduction to give estensive details about the pharmacotherapy of children and adults with ADHD. For the non-physician, we recommend having and reading one of the handbooks written for other professionals.

As with any intervention, it is important to determine exactly what symptoms to target for treatment, and to select appropriate measures of these symptoms. For many years, clinicians have relied on behavior ratings which, until very recently, have been poorly standardized and have overemphasized hyperactivityand impulsivity at the expense of attentional problems. With the availability of CPTs, like the T.O.V.A.s, the clinician can now specifically target attentional variables and reliably, objectively measure medication effects. Behavior ratings have not been sufficiently sensitive to be used to determine optimal dosage levels in the treatment of inattention although some do discriminate between no medication and on-medication conditions.

Although antidepressants are prescribed to treat ADHD, especially in cases with co-morbid substance abuse, we are not impressed with their effects on attention, *per se*, particularly in children. However, the T.O.V.A.s are used with antidepressants as well as with psychostimulants to help determine optimal dosage if inattention is the targeted symptom.

A. Commonly Used Psychostimulants

1. Methylphenidate (Ritalin[™])

This is the most frequently prescribed psychostimulant. Since the strength of the generic (MPH) form can be ±20% of Ritalin, switching from one to the other can be problematic. Ritalin Sustained Release[™] form 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 or problematic (like having to go to the school nurse's office or forgetting to take the medication). Focalin[™] (with liquid and tablet forms) and Daytrana[™] (the patch) appear quite promising espscially when small doses are prescribed.

2. Dextroamphetamine (Dexedrine[™])

This medication (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 (but 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. Extendtabs[™] (the slow release form of Dexedrine) appear to have a more even release mechanism. Short acting MPH or D-A can be used with Extendtabs to provide more even coverage, particularly in the late afternoon, or increased dosage for particularly difficult times.

3. Adderall[™]

This medication (a mixture of long- and short-acting amphetamines and d-amphetamines) is recommended because it is long acting, has little to no rebound, is easy divide into small doses, and patients prefer it.

4. Magnesium pemoline (Cylert[™]) is no longer available for use because of serious side effects (such as liver damage).

NOTE: Beware of drug companies recommendations about dosing. They are based on behavioral research and dosing tends to be excessive. Perhaps more importantly, manufacturers have a vested interest in emphasizing the positive and minimizing the negative aspects of their products.

B. Common side effects of psychostimulants: 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 reduced "rebound". Irritability or feeling "jumpy" or "edgy" is a frequently encountered side effect when a teenager or adult is given too much medication.

C. Rare side effects of psychostimulants: These include tics, hypertension and tachycardia, temporary height suppression, sadness or depression for which reassessment of the medication and dosage are promptly indicated. The use of psychostimulants in patients who also have a tic or seizure disorder is controversial but is effective in many cases.

D. Predicting and measuring response to psychostimulants

1. 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 (5 mg MPH, except for children 8-12 years of age, when 10mg is used), 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 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.

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

While both groups showed some improvement in T.O. V.A. performance with MPH, only the responders obtained a significant improvement.



E. Dosage considerations: children vs teenagers/adults

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. has resulted in a dramatic increase in efficacy (95%), decrease (50%) in dosage levels, low incidence (<5%) of side effects, and higher compliance. The decrease in dosage reflects the literature indicating that low doses of psychostimulants 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.





F. Nonpsychostimulants

1. Atomoxetine (StratteraTM) appears primarily useful in the treatment of problems of executive function. The pharmaceutical company's recommendations for mg/kg dosage tend to lead to unnecessarily high doses and side effects. In contrast to the psychostimulants, atomoxetine often has little or no effect on T.O.V.A. performance (that is, attention). We generally begin treatment with a psychostimulant and then determine whether to add atomoxetine.

2. Multiple medications: We tend to use a psychostimulant to treat the attentional problems, not the behavior. If a long acting stimulant is used, we sometimes supplement with a short-acting form to obtain optimal results. If we use medication (rather than or in addition to behavior modification) to treat behavior, we may use other medications (like Clonidine™ or Depakote™) to treat the impulsivity/hyperactivity component. If depression is significant, antidepressants should be considered in addition to a psychostimulant.

G. Assessing and monitoring effects: We recommend obtaining interim history (including side effects) and classroom/self behavior ratings in addition to baseline (before taking the morning dose) and on-medication T.O.V.A.s to determine whether the dose needs to be adjusted.

In general, dosage increases with age until the later latency or early teens when it decreases until the late teens and early

20's. The dosage remains steady until the late 60's when it often drops further. As will be noted later in this manual, many teenagers and adults need surprisingly small doses (1-5 mg MPH) and show "no improvement" or even get worse with the more commonly prescribed higher doses.

H. Re-evaluations: Since they are growing rather rapidly, and the medication may need to be increased periodically, we formally re-evaluate the dosage (and other treatment interventions) for children every six months. We also see teenagers every six months since they may be "outgrowing" the ADHD or may simply need less medication as they mature. Adults are usually re-evaluated once a year.

Two illustrations of the use of the T.O.V.A. (and behavior ratings) to monitor clinical course over time follow. In the first case, the patient gradually improved, and her T.O.V.A.s (and behavior ratings) normalized by age 10¹/2. The two subsequent evaluations, which documented her improvement, were obtained because of a research protocol. As would be true for any non-ADHD person, 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.



The second illustration documents the clinical course of another girl who did not normalize by 11 1/2. She may prove to be one of the 50% who do not "outgrow" her ADHD.



VII. Continuous Performance Tests (CPTs)

A. History

Rosvold and his group introduced the CPT in the mid-50's. His CPT was a sequential, visual, language based A-X task in which the subject responded whenever they saw an "A" followed by a "X." Since that time, many CPTs have been created primarily for use in research projects, but a few have been made available commercially for researchers, schools, and clinicians. Research with early CPT's did not show promising results. These CPT's focused on omissions & commission scores and/or primitive and inaccurate measures of response time. We know that accurate Response Time (RT) and Variability of RT are critical for CPT's to be sensitive and useful. Only the T.O.V.A. tests have been extensively normed and have highly accurate 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 ADD in 1966. It was nicknamed "Herman" by one of the children. With an accuracy of ± 100 ms, the CPT results were significant and documented the efficacy of a psychostimulant (dextroamphtamine) 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 IIe in the late 70's, the current design (with two test conditions, see below) and the researchquality 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-80's.

Since then, we have continued to upgrade the test by making it more user friendly, collecting additional subjects to have year by year norms for children, and adding signal detection indices for a comparison ADHD score. The School Intervention Report and Version 7.0 with an improved scoring and interpretation system were completed in 1996 when the T.O.V.A.-A., the auditory version, was released. Additional norming studies and programmatic enhancements, including the Home Intervention Report, led to the release of Version 7.3 in 2007.

B. CPT variables

Fourth generation CPTs, like the T.O.V.A.s, accurately measure far more significant variables of both auditory and visual information processing than the earlier CPTs. Length of the test (or subtest) makes a big difference since some individuals with 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 target presentation modes, or when the interstimulus interval changes. In addition, we must keep in mind that labeling something doesn't mean that the variable is actually measuring what we think that it's measuring.

The following variables are important for CPTs to measure, and T.O.V.A. includes them:

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

2. **Correct Response Time** is the processing time (in ms) that it takes to respond correctly to a target. Counter-intuitively, individuals with ADHD often have slower than normal response times, rather than faster ones. This measure is one of the more important ones in the T.O.V.A., especially in the first (or boring) half, accounting for >12% of the variance.

3. **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 normals. d' helps to distinguish non-impaired individuals from those with ADHD and accounts for 6% of the variance in

the T.O.V.A.s.

4. Errors of Commission are considered to be 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.s, commission errors are far more frequent in the second half (high response demand) even in non-impaired individuals. 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 caustiously since the other variables may or may not be valid. Of course, excessive impulsivity is a hallmark of ADHD.

5. Errors of Omission are considered to be a measure of inattention and occur when the subject does not respond to the designated target; that is, the subject omits pressing the button when a target appears. Because the T.O.V.A.s cover a broad age span (4-80+), omissions in the visual (but not auditory) version have a ceiling effect in adults. That is, the task is too easy for non-impaired adults who make no omission errors. On the other hand, omission errors are a sensitive measure in children, teenagers, and the elderly. 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 raw data obtained on Form 5, of the T.O.V.A. Interpretation Report, in comparison to the analyzed data on Form 3. Always interpret standard score (or standard deviation) data along side actual raw data to determine clinical significance of the results.

6. Anticipatory Responses are a measure of guessing which stimulus is presented or of a different game strategy in which the subject is trying to "kill" any stimulus as soon as possible. An AR occurs whenever a response (microswitch press) is made between 150 ms before and 150 ms after any stimulus (target or non target) appears or, in the case of T.O.V.A.-A., any stimulus is heard. Since these responses are considered guesses, they 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. While most teenagers and adults need more than 150 msecs to distinguish between a target and a nontarget and to respond by pressing the microswitch, the time it takes to actually respond may be lessened by a variety of causes, including extensive experience with computer games.

To prevent what would be incorrect interpretations, the T.O.V.A. program labels the variables in any quarter with excessive ARs (equal or exceeding 10% in any quarter of the test) as possibly "invalid" even though all of the variables are scored and recorded. The variables are encased in brackets ([]) in Form 3 to indicate that they must be interpreted cautiously since they may be invalid. When this happens, the variables in that quarter are not included in the interpretation (Form 1).

Excessive ARs are abnormal and are often a symptom of ADHD. They are thought to be the result of two conditions: 1) some subjects are oppositional and/or convert the instructions to balance speed and accuracy into a game strategy in which they try to "kill" the stimulus as soon as possible, sometimes even before it occurs; and 2) some individuals just can't restrain ("inhibit") themselves, and speed takes precedence over accuracy. Often the observer can determine which condition explains a particular result. Having someone (who can't control their responses) take the test again often doesn't change the situation. They can't do it correctly until they're being treated.

While we don't want to confuse you (any further), it now turns out that there is a third reason why some people have excessive ARs. Some people are much, much faster than the norm. They are so fast that they can accurately respond to the targets in less than the usual 150 msecs, avoiding the nontargets, Thus, when you examine the ratio of target to nontarget ARs on Form 5, you'll find that these people have very few nontarget 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 the norm.

As you might guess, 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 : nontarget ratio for ARs (Form 5), and not invalidate those quarters in which the ratio is equal to or better than 1 target : 3.5 nontargets in quarters 1 or 2 or equal to or better than 3.5 targets : 1 nontarget in quarters 3 and 4.

7. **Post-Commission Response Time** is the response time immediately following a commission error. Clinical observations (but not carefully conducted research) indicate the 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 co-morbid condition.

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

C. Significant CPT features

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

1. Stimuli

a. Visual and auditory modes

Both need to be studied since there can be problems with auditory and/or visual information processing. Most individuals are concordant for visual and auditory information processing. That is, without a visual or auditory disorder, they process visual and auditory information similarly in terms of speed, variability, etc.

However, approximately 12% of individuals are discordant and process one type of sensory input differently than the other. Thus, someone's visual T.O.V.A. performance may be within normal limits, but their auditory T.O.V.A.-A. may not be normal. Unfortunately, most available CPTs are only visual.

b. 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.s that use a "go/no go" design with single stimuli.

c. Non-language or language based

Non-language based stimuli (like in the T.O.V.A.s) minimize the potential confounding of the results by learning, cultural effects, and a learning disability.

The visual T.O.V.A. test uses the following stimuli:



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

d. Configuration

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

e. Monochromatic vs colored

Monochromatic stimuli (like in the T.O.V.A.s) are simpler and less arousing than colored ones.

f. Degradation

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

2. Presentation of stimuli

a. Infrequent and frequent target modes

1) The infrequent target mode (or low response demand mode in quarters 1 and 2) is the more boring task and is the traditional form for measuring vigilance. Individuals with "low CNS arousal" do poorly on this form.

2) The frequent target mode (or high response demand mode/high inhibition demand mode in quarters 3 and 4) is a more stimulating task during which individuals with "high CNS arousal" can become overstimulated.

b. Fixed or variable InterStimulus Interval (ISI)

A fixed ISI (the interval between the stimuli) like in the T.O.V.A.'s (2 seconds) minimizes stimulating/alerting changes while a variable ISI can be more arousing and/or difficult. It is generally accepted that a two seconds ISI is the most discriminating interval.

c. 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.

d. Alerting signal

CPTs do not use alerting signals which would make the task easier and increase false negatives.

e. Stimulus-on-time

The shorter the time the stimulus is "on", the more difficult is the task. 100 msec (as in the T.O.V.A.s) is average for CPTs.

f. Focal point

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

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.s actually have a small novelty effect- there are non-significant commission error changes (increases) in the first half of the second test but not thereafter. Thus, the T.O.V.A.s can be used as serial measures even in the same day.

4. Length of subtests

The longer the subtest, the harder it is to attend and inhibit. The 10.8 minute length of the subtests in the T.O.V.A.s are the longest in commercially available CPTs.

5. Norms

a. The number of subjects per cell

This is a critical factor. In contrast to the T.O.V.A.s, most of the CPTs were introduced with insufficient or even no norms. The T.O.V.A. and T.O.V.A.-A. were normed with1664 and 2680 individuals, respectively. We plan to continue to add additional adult norms to both T.O.V.A. and T.O.V.A.-A.

b. Sample characteristics

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

c. Controlled variables

1) **Age**

Since attentional variables significantly change from birth to the late teens, year by year norms are necessary for accurate diagnosis.

2) Gender

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

3) Intelligence

Intelligence may affect CPT performance and is an especially important diagnostic variable.

4) 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.s were obtained in the morning, and the T.O.V.A.s were administered before other tests to avoid excessive fatigue.

To illustrate, the following are sample norm curves of Total Variability of Response Time for females.

T.O.V.A.® (Visual)

VARIABILITY (SD, msec): TOTAL TEST - FEMALES 5/95



For the T.O.V.A. there are year by year norms for each gender from 4-19 and grouped norms by gender from 20-80+.

T.O.V.A.-A.[®] (Auditory)

T.O.V.A.-A VARIABILITY OF RESPONSE TIME: TOTAL TEST - FEMALES 8/95



The norms for T.O.V.A. and T.O.V.A.-A. are in the Appendiices.

6. Distractions

Few commercially available CPTs have distracters at this time. It is very difficult to control the novelty (arousing) effects of so-called distractions which may actually enhance performance in some cases.

It has been our experience that some distractible people come with their own built-in distractions and can be distracted whether outside distractions are provided or not. With treatment, distractions are significantly dampened. In fact, when distractions start to appear while on medication, it is a good indicator that the medications are wearing off, and it is time for another dose.

VIII. The T.O.V.A.s

A. Sensitivity and specificity

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

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

3. Since sensitivity and specificity 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.s, 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, both T.O.V.A.s have the same cut-off.

4. Of the two common ways to determine sensitivity and specificity, discriminant analysis is the usual one. If dealing with large enough representative samples from which generalizations about other samples could be safely made, discriminant analysis would be the acceptable procedure.

a. 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 normals. Discriminant analysis of T.O.V.A. variables with 73 ADHD subjects and 73 matched normals correctly classified 84% and 89% respectively. (See table below.) ADHD and UADD subjects performed more slowly and inconsistently and had more errors of omission (inattention) and commission (impulsivity) than normals. 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 normals correctly classified 87% of normal 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.)

Classificatio	Classification By T.O.V.A. [®] - Discriminant Analysis							
Actual group	Normals	UADD						
Normals (n = 29) UADD (n = 29)	90%* 21% Overall Correctly	10% 79%** / Identified 84%						
Actual group	Normals	ADHD						
Normals (n = 73) ADHD (n = 73)	89%* 16%	11% 84%**						
(* = specificity, ** = sensitivity)	Overall Correctly (UADD = ADD w	/ Identified 86% /ithout hyperactivity)						

b. **Receiver Operator Characteristic** 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 the T.O.V.A.s are the best normed CPTs, we should be hesitant to assume that the norms from a middle socio-economic, predominant culture sample would apply to other samples everywhere. While the T.O.V.A.s' norm groups are noteworthy because of the absence of confounding co-morbidities, they are also restricting- but perhaps less so than the usual samples of multi-problematic individuals. Accordingly, the T.O.V.A.s use ROC analysis with the following results:

	Sensitivity and S Receiver Operator	Specificity of T.O.V.A. Characteristic Analysis					
—	Sensitivity of 0.80	False negatives = 20%					
	Specificity of 0.80 False positives = 20%						
	(Cut-off score of 1.8)						

Thus, there is a 20% chance that any given T.O.V.A. (with no other information about the individual) is either a false positive or a false negative. Of course, with additional clinically relevant data (such as behavior ratings or history), the "hit" rate improves significantly.

B. Test-Retest Reliability

Temporal stability of the 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.

Table 2. Table of Means, SD, <i>t</i> values and Correlations for Test / Retest Scores								
T.O.V.A. [®] Total Score	TEST Mean	Sd	RETEST Mean	SD	p	Correlation Coefficient		
Omission ¹ Commission ¹ Response	18.54 30.50	20.41 19.98	25.42 31.33	28.84 22.49	.063 .773	.80 .78		
Time ² Variability ²	539.66 202.46	110.56 65.07	530.85 279.87	111.50 95.27	.992 .175	.93 .77		
1. represents m	ean number of e	errors	2. \	values repres	ent millis	seconds		

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

The 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 effectiveness 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 normal adults also revealed no significant differences T.O.V.A. variables, using paired t-tests.

C. Use of the T.O.V.A.s in attention and neurological disorders in children and adults

1. The T.O.V.A.s measure **neuropsychological variables** that are important in a variety of conditions and disorders, not just ADHD.

2. The **Screening Version**, used by schools and non-healthcare professionals, is the same test as the Clinical Version with the following differences:

a. The Interpretation Form (1) does not use diagnostic terms. Instead it notes whether the results warrant (or do not warrant) a referral to a clinician (who would repeat the T.O.V.A., using controlled test conditions) for a clinical assessment.

b. The Screening Version contains statements that

1) It is used for screening purposes only, not for clinical assessments;

2) There is a free national T.O.V.A. Referral Service (800-REF-TOVA) for referrals to clinicians specializing in attentional disorders in that area.

c. This version does not contain Notes to the Clinician.

3. The Clinical Version

In addition to clinical impressions, the clinical version is used to:

a. Measure medication response using a challenge dose of a psychostimulant

1) Using a single low dose of a psychostimulant, the response to medication and preliminary dosage guidelines can be accurately determined by comparing two T.O.V.A.s (off- and on-medication). The two tests can be administered the same morning or on different days.

2) Subjects were administered the T.O.V.A. before and 1.5 hours later after a 10 mg of MPH prior to beginning a six week clinical trial of medication. (The T.O.V.A. results were blind.) On the basis of CPTQ-A ratings and global clinical judgment (but not T.O.V.A. results), 11 of 154 ADHD children were judged later to be MPH nonresponders after six weeks of treatment. There were no significant differences in the mean dosage level for responders and nonresponders (.38 ±.8 mg/kg/dose and .41±mg/kg/dose, respectively.) Following completion of the clinical study, the baseline and "challenge" T.O.V.A.s of the 11 nonresponders and 30 consecutive medication responders were compared. (The pre-medication CPTQ-As and T.O.V.A.s of the nonresponders were not different than those of responders.) Differences between groups were analyzed using a one-way analysis of covariance with post-treatment scores serving as the dependent measures and baseline scores as the covariates. Statistically, adjusted means of responders were significantly lower than nonresponders on omission errors, response times, and variability (p<.001). (See VI. E. for illustration.) The on-medication T.O.V.A.s of the more deviant ADHD subjects approached but did not all fall into the normal range in contrast to the less deviant subjects whose T.O.V.A.s normalized. (Approximately 10% of the ADHD subjects had normal baseline T.O.V.A.s which improved significantly with medication.)

3) An improvement of \geq .5 std dev (\geq 8 std score) is considered a significant change.

b. Determine the optimal dosage of medication

1) If the response to the challenge dose was not optimal (that is, not within normal range), the T.O.V.A.s (along with other clinically relevant data) can be used to help determine dosage.

2) Guidelines for additional challenge dose tests:

a) If there was insufficient improvement, increase dosage and retest.

b) If worse, decrease dosage and retest.

c) If mixed results (some better, some worse), decrease dosage and retest.

d) If no change, increase dosage for children and decrease for teenagers and adults, then retest.

31 children with ADHD were administered the T.O.V.A. before MPH was initiated and 1.5 hours after medication after a two-week non-blind clinical trial of each dosage level. CPTQ-A ratings, completed by the classroom teachers for each two week period, were significantly different from baseline to medication conditions but not between MPH levels.

MPH was initiated at 5 mg/dosage, given morning and noon, and increased by 5 mg/dosage increments (morning and noon) every two weeks until reaching the predetermined and arbitrary limits. Across individual doses, 5 mg MPH produced significantly (p<.001) better performance than no medication for all measures; 10 mg MPH produced significantly (p<.01) better performance than 5 mg for omission errors, response variability and reaction time and marginally (p=.076) better performance for commission errors; 15 mg produced significantly better performance than 10 mg for response variability and reaction time; for all measures, 15 mg MPH was

associated with significantly (p<.001) better performance than 20 mg. (See illustration below.)



c. Monitor treatment over time.

1) 107 MPH responders were followed at six month intervals, using the CPTQ-A ratings by teachers and T.O.V.A.s (obtained before and 1.5 hours after the morning dose of MPH). Over the next five years, 61 subjects (ages 11-15, mean 12) "outgrew" ADHD as evidenced by normalizing CPTQ-A scores and T.O.V.A.s. Follow-up for 12 months without MPH was obtained and confirmed the absence of ADHD symptoms for all but two of these subjects. Forty-six subjects (ages 12-16, mean 14.3) improved significantly with age over the five years, but the CPTQ-A and/or T.O.V.A. remained deviant from the norm. Clinical trials off medication confirmed the continued presence of ADHD symptoms. Initial T.O.V.A. and CPTQ-A variables did not appear to predict long-term outcome. (See illustrations in VI.H.)

2) In general, dosage increases until early/mid-teen years when it begins to decrease until the late teens/early 20's when dosage stabilizes until the late 60's.

3) Thus, children and teenagers should be reassessed with the T.O.V.A. (and other clinical tools) every six months.

4) Adults can be reassessed with the T.O.V.A. on a yearly basis.

D. T.O.V.A. formulas

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

1. Errors of Omission (or Inattention) =

<u>Raw Score - Mean Score</u>¹ = Std Deviation (Z) Score Standard Deviation¹

	Quarter					Ha	alf	Total
	1	2	3	4	Ì	1	2	1
# Targets	36	36	126	126		72	252	324

2. Errors of Commission (or Impulsivity/Disinhibition) = <u># Commissions</u>* X 100 = Raw Score # Nontargets - # Nontarget A.R.**

	<u>Raw So</u> Standar	<u>core - N</u> rd Devi	<u>lean Sco</u> ation ¹	o <u>re</u> ¹ = Sto	d Deviation	(Z) Score				
			Qu	arter			Half		Total	
		1	2	3	4	j 1		2		
	# Nontargets	36	36	126	126	72	2	52	324	
 3. Response Time (msecs) = Raw Score* - Mean Score¹ Standard Deviation¹ 4. Correct Response Time Standard Deviation (or Variability) = Raw Score* - Mean Score¹ Standard Deviation¹ * from protocol ** # Target or non target Anticipatory Responses from protocol ¹from norms table 							table			
5	. d' or Respons	e Sens	sitivity- ca	lculation	available on	request				
6. Standard Score = (Standard Deviation x 15) + 100) =	= 1 1	Std D Std D	ev is -1.1, Std Score is 8 ev is 1.1, Std Score is 1	33.5 116.5

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

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

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

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

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

3. Length of each subtest- 10.8 minutes.

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

1. **Training** of both professionals and nonprofessionals to administer and monitor the test should follow the general outline of the instructions 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 and Appendix B for rating forms.)

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

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

4. When testing for the first time, the **practice test** should be given in its entirety. For subsequent testing, 10-30 seconds of practice may be sufficient to remember the task.

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

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

IX. Timing Accuracy of CPTs

The T.O.V.A.[®] Microswitch is used to ensure that the timed responses are measured accurately. Small variantions and inconsistent timing can produce high false positives. To confirm the accuracy of the microswitch, the following comparisons were made:

Software Device	Preset Exact Response Time	Mean Measured Response	Time Std Dev Response
	(ms)	(ms)	(ms)
T.O.V.A. Microswit	ch 300	300	<1
	600	599	<1
Conners' with Mou	se 300	353	+28
	600	655	+14
	900	943	+21
Conners' with Keyt	board 300	355	+28
	600	656	+11
	900	948	+25

Thus, the microswitch in combination with T.O.V.A. software are significantly more accurate than the Conners' or probably any of the other CPTs that use the mouse or keyboard. (ADHD Report. 1995:3(6), 7-8).

2. Intepreting the T.O.V.A.

I. Versions

A. 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 diagnostic or treatment monitoring assessment.

1. This version is used by schools, other educational settings, and other professionals who do not provide diagnostic or treatment services for attention disorders.

2. The screening version does not include the Notes to the Clinician section.

3. Interpretation (Form 1) of the Screening Version states that the results do or do not warrant consideration of a referral to a mental health clinician for a clinical assessment.

4.. The Screening Version includes:

a.) The School Intervention Report which is reviewed in IV.

b.) A notation about the T.O.V.A.[®] Referral Service and telephone number, 1-800-REF-TOVA (733-8682).

B. There are two forms of the Clinical Version.

1. The Research Form which does not analyze the raw data, contain the T.O.V.A. Interpretation Service, or the School or Home Intervention Reports.

2. T.O.V.A. Interpretation Service, which includes the School and Home Intervention Reports and Notes to the Clinician, is reviewed in Section III.

II. Clinical Interpretation Guidelines

A. Rules

The following results are compatible with an attention deficit:

Clinical Interpretation Rules

1. O + C + RT + V \geq -3.6 std dev and O + RT + V = \geq -2.6

2. O or RT or V >-2 std dev (<70 std score)

3. O + RT + V ≥-3 std dev

4. If O + RT + V >-2 and <-3 std dev, borderline condition

5. If RT ≥-2 std dev (≤70 std score), and O and V each >-1 std dev (<85 std score), and C <-2 std dev (>70 std score)

6. If RT \geq -2 std dev (\leq 70 std score), O and V each <-1 std dev (>85 std score), and C <-2 std dev (>70 std score), compatible with depression and/or attention deficit

7. If any two (O, RT, V) \geq -1.5 std dev (\leq 77.5 std score)

8. If any two (O, RT, V) >-1 and <-1.5 std dev (77.5-84 std score), borderline condition

9. If ≥13 years old, and C ≥-2 std dev (≤70 std score)

10. If >13 years old, and C ≥-1.5 and <-2 std dev (77.5-71 std score), and O, RT, and/or V ≥-1.5 std dev (<77.5 std score)

11. If ≥13 years old, and C ≥-1.5 std dev (≤77.5 std score), and two others are >-1 and <-1.5 std dev (84-77.5 std score)

O = omission errors, C = commission errors, RT = response time, V = variability

B. Intelligence Considerations

Although the literature is not definitive, a person with an above average intelligence generally performs better than average on a CPT. Conversely, someone with a lower than average intelligence generally performs less than average on a CPT.

C. Factors Affecting T.O.V.A.® Performance

1. As a measure of attention, the T.O.V.A. performance can significantly improve or worsen by anything that affects attention, including intelligence.

2. Someone with ADHD can successfully self medicate with caffeinated beverages, assuming that excessive quantities are not ingested. Thus, a person with ADHD who has two cups of coffee one to two hours before testing may very well perform within normal limits on the T.O.V.A.

3. On the other hand, caffeine (and nicotine) withdrawal can have adverse effect on attention. Thus, a normal person (without ADHD) can perform very badly on the T.O.V.A. and appear to have an attention deficit if they do not indulge in their habitual two or more cups of coffee in the morning. (For an example of the effects of caffeine, see Protocol P862.)

4. Of course, 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 will be abnormal just as someone receiving lithium for a bipolar disorder may have abnormally slow response times.

5. People with ADD/ADHD who have extensive video game experience and highly trained athletes, etc. may perform normally on the T.O.V.A. (visual) due to the eye-hand training. The T.O.V.A.-A. (auditory) is useful in these situations although musicians may do better on the T.O.V.A.-A. than others.

6. Sleep deprivation, anxiety, and depression, as well as a number of psychiatric conditions, can adversely affect CPT performance whether comorbid with ADHD or not.

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.

III. INTERPRETING THE T.O.V.A.s- The T.O.V.A.[®] REPORT

The computerized interpretation of test data was completely revised for Version 7.3 to include all of the new clinical and research findings and to be more "user friendly".

The clinical T.O.V.A. Report contains the table of contents page, six forms, and three optional reports:

Table of Contents T.O.V.A. Interpretation (Form 1) T.O.V.A. Analysis Graph (Form 2) T.O.V.A. Analyzed Data (Form 3) T.O.V.A. Signal Detection Data (Form 4) T.O.V.A. Information and Results (Form 5) T.O.V.A. Notes to the Clinician (Form 6)

Optional reports: Raw Data T.O.V.A. School Intervention Report T.O.V.A. Home Intervention Report

The following section reviews a T.O.V.A. protocol for a 34 years old male with ADHD (Subject 014810)

A. Cover page – Table of Contents

- 1. A brief description of the T.O.V.A. is given for those who have not used it before.
- 2. A brief clinical note reminds the reader that there are many causes of attention problems, and that clinicians use more than just the T.O.V.A. for diagnosis and treatment.
- 3. Since the Notes to the Clinician is not in the Screening Version and is not shared with patients or their families, and since the School and Home Intervention Reports are optional, they are not listed in the Table of Contents if they are not selected to print.
- 4. The following statements appear in the Screening Version:

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

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

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

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

The Interpretation compares the subject's performance with normal individuals of average intelligence and with individuals with ADHD, matched for age and gender.

1. The top sections contain the demographic data and a brief description of the T.O.V.A.

2. The T.O.V.A. Interpretation follows: a. If using a Clinical Version, the statement will be that

The results are within normal limits.

o

Overall, this T.O.V.A. is suggestive of (or consistent with) an attention problem.

The illustration T.O.V.A. is clearly deviant from the norm and suggestive of an attention problem.

b. If using a Screening Version, the statement will be that The results are within normal limits.

or

The results are not within normal limits and warrant a referral to a clinician for a clinical assessment.

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

$\texttt{T.O.V.A.} \circledast$ Visual Continuous Performance Test Report

for Example Subject

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

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

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

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

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

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

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T.O.V.A.@ Interpretation (Form 1)

 Name:
 Example Subject
 Test Date:
 05/31/05
 Version:
 7.2E3844

 Subject:
 01
 0010
 Gender:
 Male
 Birth Date:
 03/19/71
 Serial:
 001000

 Session:
 01
 Age:
 34y
 02m
 12d
 Test
 Time:
 08:42
 AM
 Test
 Type:
 Visual

The T.O.V.A. (Test Of Variables of Attention) test is a computerized visual continuous performance test for the evaluation of attention and impulsivity in children and adults. This test provides reliable and relevant screening and diagnostic information about attention and impulsivity that is not otherwise available. The T.O.V.A. is also used to document treatment effectiveness (e.g., determine optimal medication dose) and monitor the course of treatment over time.

T.O.V.A. Interpretation

Overall, this T.O.V.A. is suggestive of an attention problem, including ADHD/ADD.

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

- Additional Interpretation Notes

There are no additional notes.

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

- Validation Notes:

All quarters are valid and interpretable.

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Although it does not say so, please remember that a "suggestive of an attention problem" notation does not necessarily mean that the person has ADHD. A "suggestive" statement only means that the results were not within normal limits (for age, gender, and average intelligence)

c. The next section also contains a statement containing both the T.O.V.A. Interpretation and the ADHD Score: The test results (See Form 3) are (or are not) within normal limits, and the ADHD Score (see Form 4) is consistent with ADHD or is inconclusive. Alternatively, if there are one or more invalid quarters, it would state that the ADHD Score cannot be calculated because of invalid quarters.

The illustration test results are not within normal limits, and the ADHD Score (-2.18) was also not within normal limits. Note: An ADHD Score "within normal limits" is considered "inconclusive", and is not incompatible with ADHD. "Within normal limits" only means that the test results are not the typical ADHD pattern.

3. The next section contains additional Interpretation Notes, including suggestions for behavioral interventions (related primarily to attention span and impulsivity), if there are any.

There were no additional interpretation notes.

4. The next section contains Validation Notes if there are any invalid quarters.

5. When one or more quarters are invalid, and the valid 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 the printed interpretation should be viewed cautiously.

C. Form 2: Analysis Graph

1. The top section contains the demographic data.

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

Response Variability is significantly deviant (high) in quarters 3 and 4, and borderline inquarters 1 and 2. Response Time gradually worsens (lengthens) quarters 1 through 4 but remains within normal limits. Commission Errors are borderline (high) in quarters 1 and 2 and significantly deviant in quarter 3. Omission Errors are within normal limits.

3. The "X" axis of the graph will be changed (up or down) automatically as necessary to allow sufficient room for the results. If the values are above the scale, they would be noted as i i.

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

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



D. Form 3: Analysis Data

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

2. 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.

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

a. [] (score is in brackets) means that the quarter may not be valid and must be interpreted cautiously.

b. !! (score is between two explaimation 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

increased, and Response Time and Omission Errors can be decreased.

c. * (score is flagged with an asterisk) means that the results are valid and significantly deviant from the norm and compatible with an attention disorder.

This protocol has a number of quarters with *.

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

4. The following Validity Measures are recorded in Notes to Clinician, if applicable:

a. Tests obtained after 1:00 pm are technically considered invalid since all of the norms were obtained between 6 AM and 1 PM and because of possible diurnal effects on attention.

Baseline tests should be obtained between 6 AM and 1 PM.

Note: We can compare baselines (no medication) with on medication tests as long as both tests are taken in the morning or, if necessary, in the afternoon.

b. User interrupts

The tester can interrupt the test and restart it at the same place if necessary. However, the remainder of an interrupted test would be considered invalid and must be cautiously interpreted since the norms would not strictly apply. Interpretation Codes
[] = invalid !! = excessive commission errors
* = significantly deviant result

Name: Example Subjec	t	Te	est Date	: 05/31,	/05 Vers	sion:	7.2B3844
Subject: 01 0010 Gende	r: Male	Bi	irth Date	e: 03/19,	/71 Sers	ial:	001000
Session: 01 Age:	34y 02	2m 12d Te	est Time	: 08:42	AM Test	Type:	Visual
These results, compar- intelligence group, are scores (std scores). Th and std scores indic problem). Normal result normal results for std points.	ed to t reported e higher ate the s for st scores an	the norr las sta (more po devian devian d devs a re 85 or	nal same andard de ositive) ce from are -1.00 higher	e-gender, eviations the scor the nor 0 or hig . Note: 2	same-a s (std de re, the h rm (e.g., gher (mon l std dev	age, and better. the ex- re posit: r = 15 s ⁻	d average standard Std devs tent of a ive) and td score
Analysis Table	1	Qua 2	arter 3	4	Ha: 1	lf 2	Total
RT Variability msec Std Deviation (Z) Standard Score	59b -1.16b 82b	66b -1.12b 83b	93* -1.92* 71*	-2.48* 62*	66* -1.51* 77*	99* -2.79* 58*	93* -2.28* 65*
Response Time msec	317	360	317	393	339	355	352
Std Deviation (Z)	1.10	0.41	0.32	-0.54	0.73	-0.12	0.05
Standard Score	116	106	104	91	110	98	100
d' (DPrime)	6.68	6.68	5.35	5.86	6.68	5.56	6.18
Std Deviation (Z)	<-4	-1.50	-1.35	-0.33	-1.79	-0.63	-0.86
Standard Score	<40	77	79	94	73	90	87
Commission Errors	0.79%	0.79%	13.89%*	5.56%	0.79%*	9.72%	2.78%b
Std Deviation (Z)	-1.00	-0.75	-1.44*	0.24	-1.75*	-0.63	-1.10b
Standard Score	85	88	78*	103	73*	90	83b
Omission Errors	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Std Deviation (Z)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Score	100	100	100	100	100	100	100
[] = Invalid Quarter	b = Bord	derline :	result	* = Sign	nificant:	ly Devia	nt Result

T.O.V.A.® Analyzed Data (Form 3)

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

Test Results	N	N	*	*	*	*	*
Test Results Key: N	= Withir	normal	limite	assuming	average	intellic	Tence

Test Results Key: N = Within normal limits assuming average intelligence * = Not within normal limits E = Borderline ? = Not interpretable ADHD Score = -2.18

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c. Excessive Omission Errors (≥ 90%/quarter)

invalidate the entire quarter since there are too few responses to be a sufficient sample. Generally, it means that the subject stopped responding or, less commonly, that the microswitch malfunctioned.

Excessive Commission Errors Alert T.O.V.A. [®] (Visual)							
Age	Quarters 1 or 2	Quarters 3 or 4					
4-5 years old	≥20%	≥70%					
6-12 years old	≥10%	≥60%					
13+ years old	≥10%	≥50%					
	T.O.V.AA.®	(Auditory)					
Age	Quarters 1 or 2	Quarters 3 or 4					
6-7 years old	≥20%	≥60%					
8-12 years old	≥10%	≥60%					
13+ years old	≥10%	≥50%					

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

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

These errors may invalidate all of the variables in that quarter. A response less than 150 ms is considered an Anticipatory Response since most people do not process and respond to information that quickly. An Anticipatory Response is considered a "guess". When they equal or exceed 10% per quarter, that quarter is considered invalid because excessive guessing 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 faster than 150 ms. To determine whether someone was guessing or processing information and correctly responding faster than most people, compare Target to Nontarget ratios (Form 5). If the ratio of Anticipatory Responses for targets (Correct Responses) to Anticipatory Responses for nontargets (Incorrect Responses) is less than 1:3.5 in quarters 1 or 2 or less than 3.5:1 in quarters 3 or 4, those quarters are considered **invalid**.

Note: Invalid quarters are not normal. ADHD is one of the possible causes of invalid quarters.

f. Excessive Commission Errors

Excessive Commission Errors may invalidate 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.

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

5. Reading the Analysis Table

a. We first examine the totals for significant findings

Variability and Commission Errors are all significantly deviant from the norm and suggestive of an attention disorder.

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

1) Half 1 is the "boring" task, and people who tend to be "underaroused" have difficulty maintaining attention and control. If this half is symptomatic, Notes to the Clinician will include statements about increasing toward-task stimulation, decreasing time on-task, introducing activity, etc.

2) Half 2 is the active or high response demand task, and people who tend to get "overstimulated" have difficulty. Of course, everyone (normals included) tends to be faster and make many more Commission Errors than in half 1. If this half is

		Т	.O.V.A.® Ana	lyzed Data (1	Form 3)		
Name: Subject: Session:	Example 01 0010 01	Subject Gender: Age:	Male 34y 02m 12d	Test Date: Birth Date: Test Time:	05/31/05 03/19/71 08:42 AM	Version: Serial: Test Type:	7.2B3844 001000 Visual

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

Analysis Table	Quarter			1 4	Ha	Lf	Total
	1	2	3	4	1	4	
RT Variability msec	59b	66b	93*	91*	66*	99*	93*
Std Deviation (Z)	-1.16b	-1.12b	-1.92*	-2.48*	-1.51*	-2.79*	-2.28*
Standard Score	82b	83b	71*	62*	77*	58*	65*
Response Time msec	317	360	317	393	339	355	352
Std Deviation (Z)	1.10	0.41	0.32	-0.54	0.73	-0.12	0.05
Standard Score	116	106	104	91	110	98	100
d' (DPrime)	6.68	6.68	5.35	5.86	6.68	5.56	6.18
Std Deviation (Z)	<-4	-1.50	-1.35	-0.33	-1.79	-0.63	-0.86
Standard Score	<40	77	79	94	73	90	87
Commission Errors	0.79%	0.79%	13.89%*	5.56%	0.79%*	9.72%	2.78%b
Std Deviation (Z)	-1.00	-0.75	-1.44*	0.24	-1.75*	-0.63	-1.10b
Standard Score	85	88	78*	103	73*	90	83b
Omission Errors	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Std Deviation (Z)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Score	100	100	100	100	100	100	100
l - Invalid Quarter	h - Bord	dorlino -	roeult	* - Sim		Ly Dovia	t Rocult

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

Test Results	N	Ν	*	*	*	*	*
Test Results Key: N	= Within	n normal	limits	assuming	average	intelliq	gence

* = Not within normal limits B = Borderline ? = Not interpretable
ADHD Score = -2.18

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symptomatic, Notes to the Clinician will contain statements about decreasing distractions and pace, etc.

3) If both half 1 and 2 are significant, the person has difficulty with both halves, and Notes to the Clinician will contain suggestions for interventions for both conditions.

Both halves are significantly deviant.

c. Comparing quarters within and across halves

1) If there is a significant worsening from quarter 1 to 2, we should consider the possibility of a short (5-6 minutes) attention span and/or anxiety. If there is a significant worsening from quarter 3 to 4, maintaining self-control may be a problem and/or a limited (12-15 minutes) attention span.

> Response Time Variability significantly [> 7.5 std score or > .5 std dev] increases from quarter 2 to 3 and 3 to 4. Response Time worsens (slows) from quarter 3 to 4 but remains within normal limits. d' significantly improves from quarter 1 to 2 and from quarter 3 to 4. Commission Errors significantly worsen (rise) quarter 3, then improve. He appears to have difficulties with both "boring" and "stimulating" tasks.



2) If it appears that quarter 3 is much worse than quarter 4, consider a change-of-set problem at the beginning of quarter 3 by examining the Response by Response option. (See E below.) This could be indicative of obsessive-compulsive traits or anxiety.

3) Look for test taking strategy influences or changes. For some individuals being fast is more important than making fewer errors, and visa-versa. Some persons will dramatically slow down to reduce errors in half 2 while others may speed up as if losing control.

Note: It is important to emphasize in the initial instructions that speed and accuracy need to be balanced.

4) The program labels significant discrepancies between Commission Errors and Response Time in Notes to the Clinician. If someone were deliberately slow to avoid errors, the Response Time could be significantly deviant and the error rate significantly better than average. However, it would not necessarily follow that the person had an attention problem.

Note: When only Response Times are significantly deviant, consider depression.

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

6) If there are significantly high (≤80 standard score) Omission Errors look for clusters of Omission Errors in the Response by Response option (E, below) to determine whether narcolepsy, seizures, etc., might be possible since individuals with ADHD tend to have scattered rather than runs of Omission Errors.

d. Test Results are analyzed quarter by quarter as normal (N), not within normal limits (*), borderline (B), and not interpretable (?). *Quarters 3 and 4 are interpreted as not within normal limits.* e. The ADHD Score (Form 4) is interpreted.

E. Form 4: Signal Detection Data

1. The first sections contain the demographic data and a brief description of d'.

2. The Graph of d Prime (d') is printed with standard scores and %iles

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

3. The ADHD Score is described.

4. The following formula is used to calculate the ADHD Score: Z Score Response Time (Half 1) + Z Score d' (Half 2) + Z Score Variability (Total) (from Forms 3 and 4)

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

b. An ADHD Score of -1.80 or less (more negative) is suggestive of ADHD, while a score more positive than -1.80 (like -1.60 or 1.2) is considered inconclusive.

5. In the Clinical Version, the statement in 5 b (above) would read:

The ADHD Score is suggestive of ADHD or The ADHD Score is inconclusive.



medication(s) may have had on the T.O.V.A. results.

3. Weight and height are optional.

4. Test data-tester, ISI or InterStimulus Interval (02000 msec), (signal) OnTime (0200 msec), (signal) Offtime (0300 msec), Anticipatory Response Time (150 msec), test format (#1 is the standard IIFF format for ages 6+; #6 is the IF format for 4-5 year olds), test version #, and test serial #.

5. Comments by tester, if any

6. Results Table

The reported variables for each quarter, half and total are: Response Time Variability (ms), Response Time (ms), D Prime, Commission Errors (%, #), Omission Errors (%, #), Anticipatory Responses (%, # nontargets, and # targets), Multiple Responses (#), Correct Responses (#), Correct Nonresponses (#), Post-Commission (#), Post-Commission Response Time (msec), Post-Commission Variability (msec), User Interrupts (#), and Hardware Errors (#).

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

F. Form 5: Information and Results

This table contains the raw data, medication information (if any), and all of the validity measures. This table comprises the print-out for the Research and Self-Interpretation Forms.

1. The first section contains the demographic data- name, test date, version, subject #, gender, date of birth, serial #, session #, age (to closest birthday), test time, and test type.

2. Medication

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

a. Challenge medicine

Leave blank if not conducting a challenge test. If not left blank, the report will have medication notations on several pages even if the recorded medication is "none". *No medication was recorded.*

b. Med #2 and #3

Although these spaces are generally for a psychoactive medication (that is, a medication that has an effect on the brain and on attention and, therefore, on the T.O.V.A.), other medications, like antibiotics, can also be entered here since the clinician may want to know that other medical conditions are being treated.

The clinician will need to determine what effects the

G. Notes to the Clinician (Form 6)

1. This form contains interpretative notes and explanations that are intended solely for a clinician is not in the Screening Version. Because some of the notes may contain sensitive material, **this form is not given to patients or families**.

2. A suggestion that the clinician consider referral for a neurological and/or neuropsychological screening will be made if:

- a. Omission Errors ≥-2.0 std dev/quarter, and/or
- b. Response Time = 0/quarter, and/or
- c. Multiple Responses >20/test

While the probability of an underlying neurological problem (such as narcolepsy or seizures) is low, the clinician should be aware of the possibility and make a decision to refer or not refer on all of the available information, not just the T.O.V.A.

3. As noted in the text, Notes to the Clinician also contains a number of messages about adjustments for IQ, validity measures, cautions affecting interpretations, possible clinical implications of the results, etc.

Clinical Notes: NOTE: The clinician needs to take into account factors that may result in "false negative" or a "false positive" result. These factors may inclu psychiatric and medical conditions including sleep disorders, medication(s) (e.g., prescribed, over the counter, homeopathic or illicit), caffeine an incotine, and highly developed eye-hand coordination skills (e.g., comput- games experience, trained athletes). In addition, the interpretation assume average intelligence. Since an attention problem may also be secondary t auditory (not visual) processing difficulties, a T.O.V.AA. (auditory) test or be performed. Since a percentage of false negatives and positives occur with ai tests, the clinician must rely on all of the relevant information, not just th T.O.V.A. test can be administered after a single challenge dose or medication to measure response to treatment. The T.O.V.A. test can also be uss to evaluate different doses of medication and to monitor medication efficat over time. Please see the T.O.V.A. Clinical Guide. Although adult norms are based on a small number of subjects, the results vel- closely approximate the predicted (theoretical) curves for age and genden Preliminary data indicate that T.O.V.A. performance does not significantly van between the ages of 19 and 60. Thus, interpretations from this norming base of be considered reliable.	Name: Subject: Session:	Example 01 0010 01	Subject Gender: Age:	Male 34y 02m 12d	Test Date: Birth Date: Test Time:	05/31/05 03/19/71 08:42 AM	Version: Serial: Test Type:	7.2B3844 001000 Visual
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Validity Measures: Time of test, Test version, Omission %/quarter, Commission %/quarter, Anticipatory %/quarter, User Interrupt, Hardware Error

H. Raw Data

1. This option allows the examination of each response throughout the test. It can be viewed on screen or printed out as needed. To access response by response, select the last choice on the T.O.V.A. Display menu.

- 2. The four columns of information are:
- a. Stimulus Type: Target (T) or nontarget (NT)
- b. Response Type:
 - None Correct Response (Corr Resp) Correct Non-Response (Corr Nresp) Omission Commission Anticipatory Response (Anticip) Post-Commission Response (Post Comm)
- c. Response Time (ms)
- d. Response Flags: Multiple Responses (M) User Interrupt (I) Button Hold Error (B)

Note: Groupings of non-responses on a test may indicate a neurological condition such as epilepsy (including petit mal), narcolepsy and sleep deprivation in addition to a lack of cooperation and ADHD. A neurological assessment may be indicated.

Name: Example Subject	Test Date: 05/31/05 Version: 7 283916	-			(Norn	Response T	ime = 386 ms	sec)		
Subject: 01 0010 Gende	r: Male Birth Date: 03/19/71 Serial: N/A	ST	Type	Time Flgs	ST	Type	Time Flgs	ST	Туре	Time Flg
ession. or Age.	54y ozm izd iest iime. 00.42 AB iest iype. Visual	- NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
		NT	Corr Nresp	0	NT	Corr Nresp	0	Т	Corr Resp	392
	Tester:	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
SI: 2000 msec Ontime	: 0200 msec Offtime: 0300 msec Anticipatory: 0150 mse	c NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
Test Format: I(Std)	lest version: /.289 lest Serial: 16292	NI	Corr Nresp	0	NI	Corr Nresp	0	T	Corr Nresp	202
Medication	Dosage Med-Test Interval	T	Corr Resp	322	NT	Corr Nresp	ő	NT	Corr Nresp	0
Challenge:	0.00 mg 0.0 hours	NT	Corr Nresp	0	Т	Corr Resp	269	NT	Corr Nresp	ō
Med. #2:	0.00 mg 0.0 hours	Т	Corr Resp	473	NT	Corr Nresp	0	NT	Corr Nresp	0
Med. #3:	0.00 mg 0.0 hours	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
Wei	ght: 0.0 lbs Height: 0 in.	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
Commentes Descline		NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
comments: Baseline		NI	Corr Mresp	0	NT	Corr Nresp	0	1 MT	Corr Nrosp	514
		NT	Corr Nresp	ŏ	T	Corr Resp	278	NT	Corr Nresp	ŏ
Legend	to the Quarter by Quarter Raw Data Listing	NT	Corr Nresp	ō	NT	Corr Nresp	0	NT	Corr Nresp	ŏ
		T	Corr Resp	299	Т	Corr Resp	278	NT	Corr Nresp	0
ST = Stimulus Type:	NT = Nontarget	NT	Corr Nresp	0	Т	Corr Resp	401	NT	Corr Nresp	0
	T = Target	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
		NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
Type = Response Type:	NONE = Test stopped before this ISI	T	Corr Resp	315	T	Corr Resp	296	T	Corr Resp	366
	Corr Nreen = Correct Nonreenonee (To Nontarget)	NT	Corr Nreep	0	NT	Corr Nreep	0	NT	Corr Nresp	0
	Omission = Missed Target	NT	Corr Nresp	ů.	NT	Corr Nresp	ő	NT	Corr Nresp	0
	Commission = Response to Nontarget	NT	Corr Nresp	õ	Т	Corr Resp	359	NT	Corr Nresp	ŏ
	Anticip = Anticipatory Response (before 150ms)	Т	Corr Resp	198	NT	Corr Nresp	0	Т	Corr Resp	285
	Post Comm = 1st correct response after Commission	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
		NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
Time = Response Time:	(in milliseconds)	NT	Corr Nresp	0	NT	Corr Nresp	0	Т	Corr Resp	275
		NT	Corr Nresp	U	NT T	Corr Nresp	200	T	Corr Resp	420
Flas = Response Flags.	M = Multiple responses	T	Corr Resp	261	MT.	Corr Nresp	209	NT	Corr Nresp	0
rigo neoponoe riago.	I = User Interrupt	Î	Corr Resp	459	NT	Corr Nresp	ŏ	NT	Corr Nresp	ŏ
	B = Button Hold Error	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
		NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
Note: Raw data is lis	ed sequentially down each column.	Т	Corr Resp	296	Τ	Corr Resp	271	Т	Corr Resp	351
(i.e., read "do	wn" the columns for sequential ISIs)	NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
inere are 162 I	sis per quarter, 54 in each column of the page.	NT	Corr Nresp	U	T	Corr Resp	364	T	Corr Kesp	270
		NI	Corr Nresp	ő	ŇТ	Corr Nresp	0	NT	Corr Nresp	ő
		NT	Corr Nresp	ŏ	NT	Corr Nresp	ŏ	NT	Corr Nresp	ŏ
		Т	Corr Resp	299	NT	Corr Nresp	0	NT	Corr Nresp	0
		NT	Corr Nresp	0	NT	Corr Nresp	0	Т	Corr Resp	310
		NT	Corr Nresp	0	NT	Corr Nresp	0	Т	Corr Resp	323
		NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Commission	189
		NT	Corr Nresp	277	NT T	Corr Nresp	271	NT	Corr Nresp	U
		NT NT	Corr Nresp		ŃT.	Corr Nresp		NT	Corr Nresp	0
		NT	Corr Nresp	ŏ	NT	Corr Nresp	ŏ	NT	Corr Nresp	ŏ
		NT	Corr Nresp	ō	NT	Corr Nresp	ō	Т	Post Comm	340
		Т	Corr Resp	333	NT	Corr Nresp	0	NT	Corr Nresp	0
		- NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
I.O.V.A. Visual Continu	ous Performance Test © Lawrence M. Greenberg 200	6 NT	Corr Nresp	0	NT	Corr Nresp	0	NT	Corr Nresp	0
	Distributed by The TOVA Company	Т	Corr Resp	358	T	Corr Resp	285	NT	Corr Nresp	0

IV. School Intervention Report

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

A. Features

- 1. It can be personalized by adding the person's name in the appropriate space. The name will then be used in several of the paragraphs. If no name is used, the paragraphs will be constructed in a generic fashion.
- 2. The tester can choose (by typing an "X" in the appropriate box) and/or edit the paragraphs as needed.
- 3. The tester can export the Program to a word processing program for other changes.
- C. There are five categories that the Program addresses.
 - 1. Increasing focus on tasks (decreasing distractibility)
 - 2. Improving social skills and managing social deficits
 - 3. Increasing thinking before action and decreasing impulsivity
 - 4. Effective behavioral interventions
 - 5. Promoting consistency in school performance (decreasing variability)

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

The following pages illustrate a generic Intervention Report with all 5 categories included.

T.O.V.A.® School Intervention Report

01/31/07

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

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

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

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

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

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

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

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T.O.V.A. Visual Continuous Performance Test © Lawrence M. Greenberg 2007 Distributed by The TOVA Company 1.800.PAY.ATTN Fax: 714.229.8782 info@tovatest.com http://www.tovatest.com
Along with breaking up the need for sustaining attention for a long period, the student would do better when allowed frequent breaks to move around inside and outside the classroom. This may vary from a daily outside walk, doing errands around the building, to classroom stretching exercises.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(continued on next page)

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

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

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

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

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

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

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

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

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

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

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

A. Features

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

- 2. The writer can choose (by typing an "X" in the appropriate box) and/or edit the paragraphs as needed.
- 3. The writer can export the Program to a word processing program for other changes.
- B. There are many areas that the Program addresses.
- Effects of family modeling
- Paraphrase
- Enclosed homework areas
- Posted Daily Schedule
- Preemptive preparation for the morning routine
- Limiting choices
- Planned movement during study periods
- Plan attention-needed activities in the morning
- Making optimal use of medication
- Task modification
- Frequent monitoring/feedback
- Eye contact
- Single step instructions

- Provide examples
- Stay there until it starts
- Plan for transitions
- Use of a timer
- Avoid Spontaneity (when Identify/rehearse/practic Individual daily focused attention is necessary)
- Limit over-stimulation
- Avoid fatigue
- When/then statements
- Hands on tasks
- Pairing

release is needed to send them to the school and other professionals.

- One friend at a time
- Pre-plan activities prior to visits
- Social goal-setting in play groups
- Encourage friendship

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

- development outside of school
- Detailed observations Verbalize mental
- processing
- е
- Stop-Think-Talk-Do
- Identify support people
- Individualize
- Frequent feedback
- High stimulation reward · Point systems/reward
- menu
- Response/cost
- Charting/Punch cards • Verbal/Non-verbal
- encouragement Redirection

C. Confidentiality- The Home Intervention Report (like the T.O.V.A. Interpretation Report) is confidential- a signed

style/temperament organization

Stop the flood

• Cues

- Clean backpacks
- Accompany oral with written directions

After-school medications

Variations in parenting

- Monthly calendar with dates
- Message Center
- Posting of household rules

T.O.V.A.® Home Intervention Report

01/31/07

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

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

Effects of family modeling

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

Quiet homework areas

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

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Posted Daily Schedule

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

Preemptive preparation for the morning routine

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

Limiting choices

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

Planned movement during study periods

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

Plan attention-needed activities in the morning

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

Making optimal use of medication

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

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Task modification

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

Frequent monitoring/feedback

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

Eye contact

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

Single step instructions

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

Provide examples

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

Paraphrase

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

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Stay there until it starts

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

Plan for transitions

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

Use of a timer

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

Avoid Spontaneity (when focused attention is necessary)

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

Limit over-stimulation

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

Avoid fatigue

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

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When/then statements

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

Hands on tasks

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

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

Pairing

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

One friend at a time

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

Pre-plan activities prior to visits

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

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Social goal-setting in play groups

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

Encourage friendship development outside of school

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

Observational detail

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

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

Verbalize mental processing

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

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Identify/rehearse/practice

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

Stop-Think-Talk-Do

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

Identify support people

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

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

Individualized

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

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Frequent feedback

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

High stimulation reward

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

Point systems

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

Response/cost

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

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Charting/Punch cards

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

Verbal/Non-verbal encouragement

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

Redirection

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

Cues

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

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

Stop the flood

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

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After-school medications

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

Variations in parenting style/temperament

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

Individual daily organization

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

Clean backpacks

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

Accompany oral with written directions

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

Display monthly calendar with important dates

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

Message Center

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

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Posting of household rules

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

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

Protocol	Subject
001	Adjusting for IQ
006	High Omission Errors
004	Excessive Commission Errors
007	Excessive Anticipatory Responses
008	Adult ADD Pattern
002	"Acquired" ADD, Secondary to a Head Injury
020	Neurological Pattern- Lapse Seizures

Adjusting for IQ

Protocol 001

13 years old female with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER	QUARTER HALF					TOTAL
		1	2	3	4	1	2	
RT Variability Standard	msec	73	100	96	114	88	106	105
Deviation		.01	-1.2	24	69	58	47	44
Standard Score		100	82	96	96	91	93	93
Response Time	msec	470	492	431	409	481	420	434
Standard Deviation		9	97	-1.04	74	96	92	96
Standard Score		87	85	84	89	86	86	86
Commission Errors	%	.79	.79	8.33	13.89	.79	11.1	3.09
Standard Deviation		13	85	.36	.01	56	.19	.06
Standard Score		98	87	105	100	92	103	101
Omission Errors	%	0	0	0	0	0	0	0
Standard Deviation		.23	.39	.44	.35	.42	.39	.45
Standard Score		103	106	107	105	106	106	107
[] - Invalid Quarter * - Significantly Deviant Populat								

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

- 1. Although Response Time Variability is low and Commission Errors are high in quarter 2, and Response Times are somewhat slow, this protocol is within normal limits, assuming average intelligence.
- If IQ = 120, we would expect Response Time and Response Time Variability to fall within +/- one standard deviation of the IQ (105-135). However, in this protocol, Response Time and Response Time Variability are significantly lower than expected in all quarters, both halves and total. Under these circumstances, this protocol could be interpreted as compatible with ADHD.
- 3. If IQ = 75, we would expect Response Time Variability and Response Time to fall within +/- one standard deviation of IQ (60-90). In this protocol, RT and RTV are actually better than expected. Under these circumstances, this protocol could not be interpreted as compatible with ADHD.

Note: The correlation between IQ and CPT performance is by no means well established.

High Omission Errors in an Adult

Protocol 006

38 years old female with clinical diagnosis of ADHD

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

[] = Invalid Quarter

* = Significantly Deviant Result

!! = Excessive Commission Quarter

b = Borderline Result

1. Significantly high Omission Errors in quarters 1 and 3 and both halves.

Always check the absolute # (Form 5) of Omission Errors and do not rely on the standard scores alone as they can be misleading in adults. If there were only one error a quarter, Notes to the Clinician would indicate that while one error for an adult is statistically significant, it is not clinically significant, and the analysis and the Interpretation would disregard it.

2. This protocol with significantly high Commission Errors in quarter 4, and significantly high Response Time Variability in quarters 1 and 3 (with or without the high Omission Errors) is compatible with ADHD.

3. Note that the deviant Omission Errors and high Response Time Variability occur in the same two quarters. Inspection of the Raw Data (Response by Response option) reveals that the deviant Response Time Variability scores occurred in association with two or more consecutive Omission Errors in quarters 1 and 3. The clustering of Omission Errors may be indicative of a neurological problem such as narcolepsy or a seizure disorder that resulted in brief (2-4 sec) unconsciousness/off task.

4. If the problems were in the beginning of quarters 1 and 3, we would consider the possibility that the woman had difficulty adjusting to the test situation at the onset (quarter 1) and when the test conditions changes without warning (between quarters 2 and 3 when Infrequent target mode switches to Frequent target mode). In such cases, we might consider interference by personality factors such as obsessive-compulsive traits or anxiety.

5. Subsequent evaluation revealed narcolepsy for which she was prescribed methylphenidate (the treatment for her ADD as well).

6. The Notes to the Clinician contains a notation to consider a neurological/neuropsychological assessment because of the high Omission Errors.

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

Excessive Commission Errors

Protocol 004	8 years old male with clinical diagnosis of ADHD
	o youro ola maio mai oli noai alagnoolo or i ibi ib

	QUARTER	QUARTER			HALF	TOTAL	
	1	2	3	4	1	2	
msec	172	429*	!187!	!193!	342*	!191!	!232!
	92	>-4*	!.74!	!39!	>-4*	!53!	!-1.5!
	86	<40*	!88!	!88!	<40*	!92!	!77!
msec	521	749*	!381!	!342!	631b	!361!	!394!
	.02	-2.4*	1.76!	!.98!	-1.2b	!.91!	!.86!
	100	63*	!111!	!114!	81b	!113!	!112!
%	6	8b	75*	86*	7	81*	23*
	45	-1.2b	-2.6*	-2.3*	86	-2.5*	-2.0*
	93	81b	61*	65*	87	62*	70*
%	56*	58*	!9!	!11!	57*	!10!	!20!
	>-4*	>-4*	!4!	!58!	-4.9*	!53!	!-1.5!
	<40*	<40*	!93!	!91!	<40*	!92!	!78!
	msec msec %	QUARTER 1 msec 172 92 86 msec 521 .02 100 % 6 45 93 % 56* >-4* <40*	QUARTER 1 2 msec 172 429* 92 >-4* 86 <40*	QUARTER 1 2 3 msec 172 429* !187! 92 >-4* !.74! 86 <40*	$\begin{tabular}{ c c c c } \hline QUARTER \\ \hline 1 & 2 & 3 & 4 \\ \hline msec & 172 & 429^* & !187! & !193! \\92 & >-4^* & !.74! & !-39! \\ & 86 & <40^* & !88! & !88! \\ \hline msec & 521 & 749^* & !381! & !342! \\ .02 & -2.4^* & !.76! & !.98! \\ & 100 & 63^* & !111! & !114! \\ \hline \% & 6 & 8b & 75^* & 86^* \\45 & -1.2b & -2.6^* & -2.3^* \\ & 93 & 81b & 61^* & 65^* \\ \hline \% & 56^* & 58^* & !9! & !11! \\ & >-4^* & >-4^* & !4! & !58! \\ & <40^* & <40^* & !93! & !91! \\ \hline \end{tabular}$	$\begin{tabular}{ c c c c c c } \hline QUARTER & HALF \\ \hline 1 & 2 & 3 & 4 & 1 \\ \hline msec & 172 & 429^* & !187! & !193! & 342^* \\ $92 & $>-4^* & !.74! & !39! & $>-4^*$ \\ \hline 86 & $<40^* & !88! & !88! & $<40^*$ \\ \hline msec & 521 & 749^* & !381! & !342! & $631b$ \\ $.02 & -2.4^* & !.76! & !.98! & -1.2b$ \\ \hline 100 & $63^* & !111! & !114! & $81b$ \\ \hline \% & 6 & $8b & 75^* & $86^* & 7$ \\ $45 & -1.2b & -2.6^* & -2.3^* &86$ \\ \hline 93 & $81b & $61^* & $65^* & 87 \\ \hline \% & 56^* & $58^* & !9! & !11! & 57^* \\ $>-4^* & $>4^* & !.4! & !.58! & -4.9^*$ \\ \hline $<40^* & $<40^* & !93! & !91! & $<40^*$ \\ \hline \end{tabular}$	$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$

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

- 1. Excessive Commission Errors (>60% as indicated by the !! notations) may invalidate the other variables in quarters 3 and 4 by decreasing Omission Errors and Response Time, and increasing or decreasing Response Time Variability. Quarters 3 and 4 must be interpreted cautiously.
- 2. The excessive Commission Errors in quarters 3 and 4 are compatible with ADHD.
- 3. Omission Errors, Response Time, and Response Time Variability are significantly deviant from norm in half 1 and compatible with an attention deficit.
- 4. Response Time and Response Time Variability worsen significantly (>.5 std dev or >8 std score) from quarter 1 to 2, suggesting a 5 minute attention span (or 5 minute ability to inhibit) during a boring task.
- 5. Intervention should take #4 into account by breaking up long, boring tasks.
- 6. The intervention should take into account the excessive Commission Errors in half 2 by reducing excessive environmental stimulation and distractions.

Excessive Anticipatory Responses

Protocol 007 9 year old male with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER			HALF			TOTAL
		1	2	3	4	1	2	
RT Variability Standard	msec	[83]	!71!	[808]	[618]	[77]	[790]	[738]
Deviation		[.93]	!1.6!	[>-4]	[>-4]	[1.5]	[>-4]	[>-4]
Standard Score		[113]	!123!	[<40]	[<40]	[122]	[<40]	[<40]
Response Time	msec	[302]	!324!	[954]	[1619]	[315]	[1294]	[780]
Standard Deviation		[3.1]	!3!	[>-4]	[>-4]	[3.2]	[>-4]	[-3.7]
Standard Score		[146]	!145!	[<40]	[<40]	[147]	[<40]	[44]
Commission Errors	%	[22]	20*	[40]	[41]	[21]	[41]	[24]
Standard Deviation		[-3.5]	>-4*	[59]	[02]	[>-4]	[31]	[-2]
Standard Score		[47]	<40*	[91]	[99]	[<40]	[95]	[69]
Omission Errors	%	17	3	!58!	!53!	9	!55!	!40!
Standard Deviation		-1.1	0	!>-4!	!-4.1!	55	!>-4!	!-3.1!
Standard Score		83	100	!<40!	!<40!	91	!<40!	!53!
Anticipatory	%	[12%]	4%	[35%]	[32%]	8%	[33%]	[21%]
Correct Responses		14		48	46			
Incorrect Responses		5		9	6			

[] = Invalid Quarter

* = Significantly Deviant Result b = Borderline Result

- ! ! = Excessive Commission Quarter
- 1. Since excessive Anticipatory Responses (10%/quarter or more) in quarters 1, 2, and 3 could have significant effects on all variables in these quarters, this protocol must be interpreted cautiously. []s indicate excessive Anticipatory Responses.
- 2. To determine whether the quarters are valid, check the numbers of Anticipatory Responses in each affected quarter (Form 5). If the ratio of Anticipatory Responses for Correct Responses to Incorrect Responses is greater than 1:3.5 in quarters 1 or 2, or greater than 3.5 :1 in quarters 3 or 4, then that quarter is valid.

In this case, all the ratios are 14:5 (>than 1:3.5), 48:9 (>than 3.5:1), and 46:6 (>3.5:1) in quarters 1, 3 and 4, respectively. Thus, the protocol can be interpreted as valid as scored.

- Excessive Anticipatory Responses (10%/quarter or more) are generally seen in three cases:
 a) When the person has changed the rules and wants "to kill" the stimulus as quickly as possible
 - The observer should ask the boy about his "game plan"
 - b) When the person has ADHD, or
 - c) When the person is much faster than the expectable norm
- 4. Excessive Commission Errors (10% or more for a 9 years old) in quarter 2 may invalidate all other variables in that quarter.
- 5. Totals for all four variables are significantly deviant from the norm and compatible with an attention problem.
- 6. The boy is particularly inattentive, processes information slowly and variably in half 2 and is impulsive in half 1, when speed (Response Time) and Response Time Variability are quite good.

Adult ADD Pattern

Protocol 008

16 years old female with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF	TOTAL	
		1	2	3	4	1	2	
RT Variability Standard	msec	78	72	!116!	!96!	76	!106!	!107!
Deviation		.02	03	!92!	!.04!	.07	!33!	!35!
Standard Score		100	99	!86!	!100!	101	!95!	!94!
Response Time	msec	435	449	!352!	!351!	442	!352!	!372!
Standard Deviation		49	46	1.22!	!.27!	49	!.18!	!.13!
Standard Score		92	93	!103!	!104!	92	!105!	!101!
Commission Errors	%	2	0	58*	64*	1	61*	14*
Standard Deviation		99	.5	>-4*	>-4*	42	-4.1*	-3.6*
Standard Score		85	107	<40*	<40*	93	<40*	45*
Omission Errors	%	[17]	!3!	[58]	[53]	[9]	[55]	[40]
Standard Deviation		[-1.1]	!0!	[>-4]	[-4.1]	[55]	[>-4]	[-3.1]
Standard Score		[83]	!100!	[<40]	[<40]	[91]	[<40]	[53]

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

- 1. Excessive (50% or more in quarters 3 and 4 in a 13 + years old) Commission Errors may invalidate the other variables in quarters 3 and 4.
- 2. Commission Errors are compatible with adult pattern attention deficit.
- 3. Omission Errors are significantly high in quarters 3 and 4. We'd expect Omissions to be decreased when Commissions are high as in quarters 3 and 4. Thus, Notes to Clinician contains a notation to consider a neurological/neuropsychological assessment.

"Acquired" ADD, Secondary to a Head Injury

Protocol 002

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

	1988 Total	1990 Total
RT Variability Standard Deviation Standard Score	1 99	-2.1* 69*
Response Time Standard Deviation Standard Score	.3 105	-1.7* 75*
Commission Errors Standard Deviation Standard Score	.7 111	.3 105
Omission Errors Standard Deviation Standard Score	0 100	-1.8* 73*

[] = Invalid Quarter

* = Significantly Deviant Result

!! = Excessive Commission Quarter

b = Borderline Result

- 1. In 1988, all variables were within normal limits.
- 2. In 1990, Omission Errors, Response Time, and Response Time Variability are all significantly deviant and compatible with an attention deficit.
- 3. He should be re-evaluated at least yearly for several years to determine whether there is any change in his condition since there is potential for at least partial if not complete recovery.
- 4. A challenge test with 5 mg of methylphenidate normalized his T.O.V.A performance. Dosage should be evaluated every six months with off- and on-medication T.O.V.A.s, behavior ratings and history.

Neurological Pattern- Lapse Seizures

Protocol 020 10 years old male with clinical diagnosis of ADHD

ANALYSIS TABLE		QUARTER				HALF		TOTAL
		1	2	3	4	1	2	
RT Variability Standard	msec							
Deviation		94	-2.7*	-3.4*	-3*	-2.3*	-3.2*	-3.3*
Standard Score		85	58*	48*	55*	65*	51*	50*
Response Time	msec							
Standard Deviation		-2.8*	-3.3*	-2.5*	-2.9*	-3.1*	-2.8*	-2.9*
Standard Score		58*	50*	62*	56*	53*	58*	55*
Commission Errors	%							
Standard Deviation		.16	-2.6*	.03	.8	-1.1	.43	09
Standard Score		102	60*	100	112	83	106	98
Omission Errors	%							
Standard Deviation		-2.2*	-3.6*	77	>-4*	-3.1*	-2.0*	-2.3*
Standard Score		66*	46*	88	<40*	53*	70*	65*

[] = Invalid Quarter

! !!! = Excessive Commission Quarter

* = Significantly Deviant Result b = Borderline Result

1. Total, halves and quarter scores significantly deviant from norms and compatible with an attention deficit.

2. High (>-2 std dev) Omission Errors result in a Notes to Clinician advisory to consider a neurological/neuropsychological assessment. Response by response examination revealed both isolated and clustered Omissions in quarters 1, 2, and 4.

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

4. Lapse seizures were subsequently diagnosed.

VII. Pharmacotherapy Protocols

Selected protocols are presented to illustrate the use of the T.O.V.A. s to measure the effects of medication in the treatment of ADD

Protocol	Subject
P011	Factoring in the IQ
P010	Rule for Mixed Response to Medication in ADHD
P241	Adult With Traumatic ADHD
P002	Adult ADHD Pattern and Response to Medication
P003	Side Effect ("edgy") in an Adult With ADHD
P014	Prozac and MPH in an Adult With ADHD
P014	Prozac and MPH in an Adult With ADHD
P862	Coffee Effects With and Without Medication in ADHD

Factoring in the IQ

Protocol P011-9 years old male with clinical diagnosis of ADHD

	Adderall	
	0	10mg
RT Variability		
Standard Deviation	3	1.9
Standard Score	95	129
Response Time		
Standard Deviation	.38	1.3
Standard Score	106	120
Commission Errors		
Standard Deviation	.4	.45
Standard Score	106	107
Omission Errors		
Standard Deviation	.13	.6
Standard Score	102	109

[] = Invalid Quarter

! !!! = Excessive Commission Quarter

* = Significantly Deviant Result b = Borderline Result

- 1. Although he has a high IQ (>130), he has not done very well in school.
- 2. Baseline (no medication) results within normal limits, if assuming average IQ.
- 3. However, we would expect to obtain standard scores closer to or within one std dev of IQ. For an IQ of 130, subtract 15 (one std score representing 1 std dev), getting 115. Thus, the baseline is compatible with an attention deficit for this boy.
- 4. His Total Response Time and Response Time Variability significantly improve with 10 mg of Adderall. The minimal Commission and Omission Errors would not be expected to improve .
- 5. This is a classic case of ADHD. The T.O.V.A. is a "false negative" due to high IQ. The patient was challenged with medication because the clinician thought the child was ADHD. Given his high IQ, the youngster was achieving academically above grade level although he was often off task, distractible, and disruptive.

Rule for Mixed Medication Response in ADHD

Protocol P010-

13 years old male

	Methylphenidate				
	0 mg	5 mg	2.5mg		
RT Variability					
Standard Deviation	-1.5*	3	6		
Standard Score	78*	96	91		
Response Time					
Standard Deviation	-1.7*	-2.9*	-1.2		
Standard Score	75*	57*	82		
Commission Errors					
Standard Deviation	01	1.1	.9		
Standard Score	99	117	114		
Omission Errors					
Standard Deviation	03	.05	1.1		
Standard Score	96	108	117		
[] = Invalid Quarter		* = Significantly	Deviant Result		

!! = Excessive Commission Quarter

b = Borderline Result

- 1. Baseline (no medication) was compatible with an attention deficit with significantly deviant Response Times and Response Time Variabilities.
- 2. While Commission Errors and Response Time Variability improved with 5 mg, Response Time worsened.
- 3. The general rule is that with mixed results (some variables improve and some worsen), reduce dosage and retest. In this case, the best results were obtained with 2.5 mg MPH.

Note: Low doses in adolescents and adults are the rule when one is adjusting the dose of medication to the attention variables.

Note: Even a small increase in Commission Errors, especially in adolescents and adults, often signifies too much medication. Other indicators of too much medication are tiredness, yawning, jitteriness, feeling spacey, feeling jazzed, etc.

Adult With Traumatic ADHD

Protocol P241

53 year old male professional was in a serious car accident in which his son was killed. He was briefly unconscious and suffered numerous injuries including head trauma necessitating multiple surgical interventions. Neuropsychological testing failed to reveal any significant impairment except for mild to moderate "depression" and transitory mild memory impairment.

In spite of participating in grief counseling, he continued to complain two years later of continued depression with symptoms of distractibility, inability to complete tasks, impulsivity and frustration, and disorganization. A consulting psychiatrist, noting that traumatic ADD had the same symptom complex, reviewed the original neuropsychological testing and discovered that it did not include a CPT. In fact, the diagnosis of ADD was not previously considered. After the new workup, traumatic ADD was diagnosed, and a clinical trial of methylphenidate was initiated.

	Methylphenidate			
	0 mg October 1985	2.5 mg October 1985	0 mg July 1991	
RT Variability				
Standard Deviation	>-4*	1.4 1		
Standard Score	<40*	120	118	
Response Time				
Standard Deviation	>-4*	.23	1.2	
Standard Score	<40*	103	117	
Commission Errors				
Standard Deviation	>-4*	1.3	1.3	
Standard Score	<40*	120	120	
Omission Errors				
Standard Deviation	>-4*	0	0	
Standard Score	<40*	108	108	

[] = Invalid Quarter !! = Excessive Commission Quarter * = Significantly Deviant Result

b = Borderline Result

1. The baseline (no medication) testing in 1985 was compatible with an attention deficit, and there was an excellent response to a challenge dose 2.5 mg of methylphenidate.

2. He was followed twice a year with interim histories, behavior ratings, and baseline and on-medication (2.5 mg of methylphenidate) T.O.V.A.s. His baselines gradually improved over the following three years, and the dose of methylphenidate was reduced to 1.25 mg when he experienced side effects with 2.5 mg.

3. In 1991, his behavior rating and baseline T.O.V.A. normalized, and medication was discontinued. Follow-up assessments for the next two years revealed no evidence for ADD or "depression".

Note: Traumatic ADD is a common finding after accidents even though the person may not have been (or may not remember being) unconscious. Traumatic ADD responds quite well to very low doses of psychostimulants, and, in many cases, gradually improves.

Adult ADHD Pattern and Response to Medication

Protocol P002-33 years old male

	Methylphenidate		
	0 mg	5 mg	10 mg
RT Variability			
Standard Deviation	07	.66	.69
Standard Score	98	109	110
Response Time			
Standard Deviation	.83	.95	.78
Standard Score	112	114	111
Commission Errors			
Standard Deviation	-2.2*	-1.38*	.35
Standard Score	66*	79*	105
Omission Errors			
Standard Deviation	>-4*	>-4*	0
Standard Score	<40*	<40*	100
[] = Invalid Quarter	* = Significantly Deviant Result		

!! = Excessive Commission Quarter

b = Borderline Result

1. Omission scores, while statistically significant, were the result of one error/test. Thus, they are not considered clinically significant. In version 7.2+, the interpretation program would "ignore" one error, and record the error only in Form5.

2. The baseline (no medication) T.O.V.A. was compatible with adult profile attention deficit (deviant Commission Errors only).

3. There was significant improvement (>.5 std dev or >8 std score) in Commissions with 5mg, but Commissions were still deviant from the norm.

4. The response to 10 mg was significantly better than to 5 mg.

Side Effect ("Edgy") in an Adult With ADHD

Protocol P003- 32 years old female

	Methylphenidate		
	0 mg	5 mg	2.5mg
RT Variability			
Standard Deviation	>-4*	1.1	2.1
Standard Score	<40*	117	131
Response Time			
Standard Deviation	-2.8*	.9	.85
Standard Score	58*	113	113
Commission Errors			
Standard Deviation	3	.1	.3
Standard Score	97	102	105
Omission Errors			
Standard Deviation	.4	.6	.6
Standard Score	106	109	109

[] = Invalid Quarter

* = Significantly Deviant Result

- ! = Excessive Commission Quarter
- b = Borderline Result
- 1. The baseline (no medication) T.O.V.A. was compatible with an attention deficit disorder.
- 2. There was a good response to 5 mg of methylphenidate as indicated by improved behavior ratings, history, and the onmedication T.O.V.A. However, she reported feeling "edgy".
- 3. No side effects were experienced when the methylphenidate was reduced to 2.5 mg, and her T.O.V.A. performance was significantly better.

Prozac and MPH in an Adult With Obsessive-Compulsive Traits

Protocol P014-33 years old male

	Methylphenidate			
	None Total	40 mg Prozac Total	5 mg MPH and 40 mg Prozac Total	
RT Variability Standard Deviation Standard Score	96 86	-1.1 84	1.1 117	
Response Time Standard Deviation Standard Score	.6 109	.4 106	.23 103	
Commission Errors Standard Deviation Standard Score	>-4* <40*	>-4* <40*	.69 110	
Omission Errors # Standard Deviation Standard Score	1 >-4* <40*	1 >-4* <40*	1 >-4* <40*	

[] = Invalid Quarter

!! = Excessive Commission Quarter

* = Significantly Deviant Result b = Borderline Result

- 1. This man was being treated with Prozac with considerable improvement in his obsessive-compulsive symnptoms. However, he continued to have difficulty completing tasks, was distractible, and not well organized. Meeting diagnostic criteria for ADHD, his physician decided to try a psychostimulant to see if his symptoms improved.
- 2. Only one Omission Error a quarter statistically equals >-4 std. dev. for an adult and is considered clinically insignificant.
- 3. As measured by the T.O.V.A., there is no documented response to Prozac.
- 4. There is an excellent response when 5 mg of methylphenidate are added, including improvement of the obsessive compulsive traits.

Coffee Effects With and Without Medication in ADHD

Protocol P862- 46 years old female

	Medication				
	1 Cup of Coffee		No coffee for a week		
	None	2.5 mg Adderall	None	2.5 mg Adderall	1.25 mg Adderall
RT Variability					
Standard Deviation	.09	-1.36*	-1.77*	55	.93
Standard Score	101	79*	73*	92	114
Response Time					
Standard Deviation	.09	42	89	.58	1.42
Standard Score	101	94	87	109	121
Commission Errors					
Standard Deviation	.47	.47	.93	.47	.93
Standard Score	107	107	114	107	114
Omission Errors					
Standard Deviation	.50	<-4*	>-4*	.50	.50
Standard Score	108	<40*	<40*	108	108

[] = Invalid Quarter

* = Significantly Deviant Result

!! = Excessive Commission Quarter

b = Borderline Result

1. Patient presented with history and interview compatible with ADD. (IQ unknown but suspected to be high.)

2. First test was normal. She then revealed she had a cup of coffee 1 hour before the test.

3. Second test was given since 2.5 mg of Adderall had already been administered, and results were worse.

4. Patient returned and was re-administered baseline after 1 week without coffee. Baseline was consistent with ADD.

5. 2.5 mg of Adderall showed improvement, but patient reported being tired.

6. 1.25 mg of Adderall resulted in optimal response.

Appendices

- A. Testing Instructions
- **B. DSM Checklist**
- C. Visual Norms Summary Omissions Commissions Response Time Variability D Prime
- D. Auditory Norms Summary Omissions Commissions Response Time Variability D Prime

Appendix A. TESTING INSTRUCTIONS

TEST ADMINISTRATION

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

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

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

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

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

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

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

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

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

Administration of the Test

Overview

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

The T.O.V.A.-A. is the auditory stimulus based CPT. The subjects are presented with auditory targets and nontargets. The auditory target sound is <u>G above middle C</u>, and the nontarget sound is <u>middle C</u>. Like the visual stimulus based test, the test has two conditions, stimulus infrequent and stimulus frequent. The subjects are instructed to press the microswitch as quickly as possible after they hear the target stimulus. They are instructed to not press the switch (i.e., do nothing) when they hear the nontarget. The targets and nontargets are pre-designed to sound in two different conditions, stimulus infrequent and stimulus infrequent is defined by 36 targets and 126 nontargets per quarter in quarters 1 and 2. Stimulus frequent is defined by 126 targets, 36 nontargets per quarter in quarters, 3 and 4. The test is internally timed to last for 21.6 minutes. Testing is usually scheduled for a half hour for a complete session.

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

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

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

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

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

Slowly read (or paraphrase) the following:
"This test measures your ability to pay attention. Two different kinds of squares will flash on this computer screen. The squares will differ only in that one of them will have a small hole near the top (indicate with a picture or use DISPLAY STIMULI on screen), and one will have the hole near the bottom (indicate). We want you to press this button (indicate) every time you see the square with the hole near the top (indicate). (Find out which hand they use for writing.) I want you to hold this button in your writing hand with your thumb resting lightly on top, like this (indicate). Here... take the button. Let up when you hear the click; don't hold the button down very long. Push it down only once for each correct picture.

"Now we are going to flash the squares on the screen, and your job is to press the button AS FAST AS YOU CAN every time you see a square with a hole near the top (indicate). But the trick is that you are NOT to press the button when the hole is near the bottom (indicate). Remember to press the button as fast as you can but only for the square with the hole near the top. The whole idea of this test is for you to be as fast, but also as accurate as you can. Try not to make any mistakes. But, if you do make a mistake...don't get upset, don't worry. Everyone can make a mistake on this test. Try and press the button as fast as you can but only for the square with the hole in the top. Don't be too fast -- take enough time to see which picture it is. Don't guess. Once you've pressed the button, let up. Don't press it more than once when you see the correct signal. Any guestions...?

"Now we are going to have a short practice. After I press the button, you are going to see a dot appear in the middle of the screen. That's where the squares are going to appear. After the dot appears, the numbers 3...2...1... are going to appear and then the first square will flash on the screen. Remember, the whole idea is to be as fast AND accurate as you can be. Any questions...?"

Starting the Practice Test

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

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

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

Administering a Practice Test After the First Test

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

Administering the T.O.V.A.

After practice is over, slowly read the following:

"OK, now we are going to do the test for about 20 minutes. Do the best job you can. Also, you should know that your eyes are probably going to get a little tired. Even so, try and do the best job you can... press the button as quickly as you can but only for the square with the hole in the top.

"I'll be staying here while you do the test, but I can't talk to you once the test starts. Do you have any questions before we begin?

"Ready, here we go... start watching the screen." Start the test.

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

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

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

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

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

Slowly read (or paraphrase) the following:

"This test measures your ability to pay attention. Two different kinds of notes will be heard. The notes will differ only in that one of them will be higher in pitch (DEMONSTRATE TARGET NOTE) than the other (DEMONSTRATE NONTARGET NOTE). I want you to press this button (indicate) every time you hear this sound (DEMONSTRATE TARGET SOUND)." Find out which hand they use for writing. Then continue: "I want you to hold this button in your writing hand with your thumb resting lightly on top, like this (indicate). Here... take the button. Let up when you hear the click; don't hold the button down very long. Push it down only once for each correct note.

"Now we are going to play the notes, and your job is to press the button AS FAST AS YOU CAN every time you hear the high note (DEMONSTRATE). But the trick is that you are NOT to press the button when the low note is heard (DEMONSTRATE). Remember to press the button as fast as you can but only for the high note. The whole idea of this test is for you to be as fast, but also as accurate as you can. Try not to make any mistakes. But, if you do make a mistake...don't get upset, don't worry. Everyone can make a mistake on this test. Try and press the button as fast as you can but only for the high note (DEMONSTRATE). Don't be too fast -- take enough time to hear which note it is. Don't guess. Once you've pressed the button, let up. Don't press it more than once when you hear the correct note. Any questions...?

"Now we are going to have a short practice. When I press a key on the computer, the notes will begin. After I press the key, the numbers 3...2...1... are going to appear and then the first note will be heard. Remember, the whole idea is to be as fast AND accurate as you can be. Any questions...?"

Starting the Practice Test

Start the practice. The practice test lasts 3 minutes. Observe to be sure the subject is doing it correctly and use prompts freely early in the practice test. Instruct again if necessary. Rerun practice if necessary until subject demonstrates an understanding of the test instructions. If you wish, you can check practice results. If errors are excessive, repeat practice after discussing the instructions with the subject.

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

Administering a Practice Test After the First Test

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

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

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

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

"OK, now we are going to do the test for about 20 minutes. Do the best job you can. Also, you should know that you will probably get a little tired. Even so, try and do the best job you can... press the button as quickly as you can but only for the high note.

"I'll be staying here while you do the test, but I can't talk to you once the test starts. Do you have any questions before we begin?

"Ready, here we go... start listening " Start the test.

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

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

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

Appendix B.

DSM Checklist								
GENDER: Male	Female	Weight	Height	DOB:	DAT	E:		
ETHNICITY: Asian/Pa	cific Island	African American	Caucasian	Hispanic American	Native American	Other:		
SUBJECT or ID#: GRADE/YEARS OF EDUCATION:								

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 month	าs? YE	S NO	Don't know	
Have these behaviors been maladaptive and inconsist	ent wit	h developme	ent 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	al relationships? YES	NO	Don't kı	now	
Have these behaviors impaired acad	emic or work performanc	e? YES	NO	Don't kno	w
Has there ever been any other psych	niatric or psychological dia	agnosis b	oefore? YES	NO	Don't know
If so, what	and wh	nen			

Appendix C.

Visual Norms

Summary Omissions Commissions Response Time Variability D Prime

Visual Norms - Summary

Vears of Age	Omission Errors (%): Inattention	Commission Errors (%): Impulsivity	Response Time (msec)	Variability (SD, msec) [Mean + SD]	D PRIME: Hit Rate/ False Alarm Rate
A re 4	[Mean ± OD]	[Weart ± OD]	[Mean ± OD]		[Wear 1 OD]
Age 4 Male (N=24) Female (N=26)	28.81 <u>+</u> 20.51 33.38+21.06	17.34 <u>+</u> 12.54 10 75+7 46	783.42 <u>+</u> 87.71 826 69+104 27	330.08 <u>+</u> 65.98 325 46+91 67	1.68 <u>+</u> 0.69 1.86+0.84
Age 5	<u> </u>		020.00	020110_01101	
Male (N=66) Female (N=80)	14.17 <u>+</u> 11.90 14.95+12.92	10.27 <u>+</u> 6.92 6.91+7.05	723.69 <u>+</u> 147.40 767.90+126.78	262.94 <u>+</u> 63.33 260.4+55.69	2.59 <u>+</u> 0.65 2.93+0.98
Age 6		—			
Male (N=19) Female (N=23)	8.95 <u>+</u> 7.80 8.87 <u>+</u> 9.77	10.37 <u>+</u> 6.85 6.78 <u>+</u> 4.16	604.32 <u>+</u> 120.24 667.00 <u>+</u> 74.27	236.95 <u>+</u> 54.41 248.04 <u>+</u> 38.79	2.96±0.94 3.10±0.70
Age 7					
Male (N=61)	6.54+7.55	10.97+8.47	558.70+108.12	223.15+54.93	3.19±1.04
Female (N=61)	4.00+4.30	6.89 <u>+</u> 5.02	608.28 <u>+</u> 99.87	215.87 <u>+</u> 47.89	3.84±1.20
Age 8					
Male (N=36)	2.17+2.94	8.61+5.23	487.19+86.14	176.92+47.66	4.22±1.24
Female (N=38)	1.87+2.46	6.61+4.28	544.34+79.54	192.79+37.89	4.31±1.19
Age 9					
Male (N=57)	4.35+14.22	9.39+6.52	458.56+80.75	161.74+43.81	4.25±1.44
Female (N=55)	1.07+1.50	6.53+4.17	498.80+71.53	164.82+38.17	4.71±1.23
Age 10					
Male (N=33)	2.45+6.87	7.70+3.20	402.15+58.04	137.39+39.30	4.60±1.29
Female (N=34)	.53+.90	5.65+4.23	438.47+74.24	138.32+38.78	5.39±1.41
Age 11				<u> </u>	
Male (N=55)	1.93+7.28	8.69+5.34	379.33+66.01	123.82+33.70	4.69±1.48
Female (N=60)	.68+1.26	6.65+4.16	412.80+71.07	130.95+34.36	5.06±1.17
Age 12	-	-	-	=	
Male (N=37)	.68+1.15	6.34+3.82	389.92+73.81	125.05+37.09	4.97±1.15
Female (N=49)	.53+.92	4.59+4.16	410.29+80.96	122.33+40.89	5.34±1.26
Age 13					
Male (N=66)	.67+1.44	4.93+3.93	379.74+60.77	108.35+33.71	5.16±1.22
Female (N=69)	.55+1.39	3.81+2.85	379.71+56.85	103.09+29.61	5.14±1.14
Age 14					
Male (N=46)	.31+.47	3.97+3.31	383.43+65.82	104.70+35.07	5.32±1.05
Female (N=36)	.27 ¹⁰ +.65	2.95+2.60	383.36+62.93	100.39+34.64	5.71±1.12
Age 15					- -
Male (N=61)	.69+1.31	3.64+2.82	361.15+53.54	96.59+27.34	5.25±1.19
Female (N=58)	.41 <u>+</u> .82	3.45 <u>+</u> 3.39	374.41 <u>+</u> 61.85	90.93 <u>+</u> 22.71	5.63±1.42

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 6. H2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 9. T commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*

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

Visual Norms - Summary

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 6. H2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 9. T commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*

Visual Norms - Omissions (%)

Years of Age		Qua	arter	Н	Total		
	1	2	3	4	1	2	
Age 4 Male (N=24) Female (N=26)	32.75 <u>+</u> 18.04 41.56 <u>+</u> 27.96		27.68 <u>+</u> 22.54 31.04 <u>+</u> 20.30				28.81 <u>+</u> 20.51 33.38 <u>+</u> 21.06
Age 5 Male (N=66) Female (N=80)	16.09 <u>+</u> 12.60 15.96 <u>+</u> 16.26		13.62 <u>+</u> 12.61 14.66 <u>+</u> 13.83				14.17 <u>+</u> 11.90 14.95 <u>+</u> 12.92
Age 6 Male (N=19) Female (N=23)	4.84 <u>+</u> 5.58 7.91 <u>+</u> 11.24	9.53 <u>+</u> 9.07 9.26 <u>+</u> 12.23	7.21 <u>+</u> 7.79 7.52 <u>+</u> 7.73	12.11 <u>+</u> 11.24 10.39 <u>+</u> 12.42	7.11 <u>+</u> 6.61 8.61 <u>+</u> 11.52	9.58 <u>+</u> 8.66 8.96 <u>+</u> 9.88	8.95 <u>+</u> 7.80 8.87 <u>+</u> 9.77
Age 7 Male (N=61) Female (N=61)	5.10 <u>+</u> 11.19 3.97 <u>+</u> 6.62	7.98 <u>+</u> 12.13 3.70 <u>+</u> 4.18	5.18 <u>+</u> 6.41 3.38 <u>+</u> 4.51	8.10 <u>+</u> 9.60 4.97 <u>+</u> 5.80	6.46 <u>+</u> 11.32 3.74 <u>+</u> 4.32	6.59 <u>+</u> 7.57 4.11 <u>+</u> 4.82	6.54 <u>+</u> 7.55 4.00 <u>+</u> 4.30
Age 8 Male (N=36) Female (N=38)	1.89 ⁴ <u>+</u> 3.05 1.74 ⁴ <u>+</u> 2.34 ⁴	2.72 ⁴ <u>+</u> 4.05 2.34 ⁴ <u>+</u> 3.05	1.61 <u>+</u> 2.09 1.18 <u>+</u> 1.86	2.53 <u>+</u> 4.53 2.53 <u>+</u> 4.57	2.31 <u>+</u> 3.19 1.97 <u>+</u> 1.95	1.97 <u>+</u> 3.09 1.82 <u>+</u> 2.79	2.17 <u>+</u> 2.94 1.87 <u>+</u> 2.46
Age 9 Male (N=57) Female (N=55)	4.81 <u>+</u> 15.59 1.44 ⁴ <u>+</u> 3.70	3.51 <u>+</u> 13.29 1.33 ⁴ <u>+</u> 2.07 ⁴	4.42 <u>+</u> 16.36 .76 ² <u>+</u> 1.22	4.49 <u>+</u> 14.42 1.42 <u>+</u> 2.45	4.09 <u>+</u> 13.43 1.29 <u>+</u> 2.39	4.35+14.59 1.04 ⁶ ±1.60	4.35 <u>+</u> 14.22 1.07 <u>+</u> 1.50
Age 10 Male (N=33) Female (N=34)	3.42 ± 8.06 $.65^{4}\pm2.00^{4}$	3.36 <u>+</u> 9.08 .76 ⁴ +2.10	3.12 <u>+</u> 12.52 .41 ² +.78 ²	1.30 <u>+</u> 2.08 .68 ² +1.01	3.33 <u>+</u> 8.06 .71 <u>+</u> 1.71	2.18 <u>+</u> 7.00 .41 ⁶ <u>+</u> .78 ⁶	2.45 <u>+</u> 6.87 .53 <u>+</u> .90
Age 11 Male (N=55) Female (N=60)	1.75 ⁴ ±7.18 1.13 ⁴ ±3.15	2.55 <u>+</u> 8.17 1.02 ⁴ +2.05	2.04 <u>+</u> 10.61 .45 ² <u>+</u> .87	1.85 <u>+</u> 4.43 .75 ² <u>+</u> 1.32	2.07 <u>+</u> 7.67 1.00 <u>+</u> 2.22	1.91 <u>+</u> 7.30 .52 ⁶ +1.03 ⁶	1.93 <u>+</u> 7.28 .68 <u>+</u> 1.26
Age 12 Male (N=37) Female (N=49)	.53 ⁴ ±1.95 ⁴ .61 ⁴ ±1.39 ⁴	.98 ⁴ <u>+</u> 1.83 .83 ⁴ <u>+</u> 1.61 ⁴	.58 ² <u>+</u> .88 .44 ² <u>+</u> .85	.93 <u>+</u> 1.71 .57 ² <u>+</u> 1.49	.70 <u>+</u> 1.54 .72 <u>+</u> 1.27	$.72^{6}\pm1.24^{6}$ $.50^{6}\pm1.03^{6}$.68 <u>+</u> 1.15 .53 <u>+</u> .92
Age 13 Male (N=66) Female (N=69)	$.68^{4} \pm 1.97^{4}$ $.33^{4} \pm 1.05^{4}$.76 ⁴ +1.48 ⁴ .61 ⁴ +2.02	.56 ² ±1.43 .57 ² ±.92	.86 <u>+</u> 1.85 .63 ² +2.26	.71 <u>+</u> 1.50 .47 <u>+</u> 1.43	.67 ⁶ ±1.56 ⁶ .56 ⁶ ±1.41 ⁶	.67 <u>+</u> 1.44 .55 <u>+</u> 1.39
Age 14 Male (N=46) Female (N=36)	.37 ⁴ +1.12 ⁴ .08 ⁴ +.46 ⁴	.36 ⁴ ± .95 ⁴ .16 ⁴ ±.67 ⁴	.32 ² <u>+</u> .79 .41 ² <u>+</u> 1.03	.25 ² ±.53 ² .30 ² ±.77 ²	.35 ⁸ <u>+</u> .73 .10 ⁸ <u>+</u> .36 ⁸	.29 ⁶ <u>+</u> .53 ⁶ .31 ⁶ <u>+</u> .82 ⁶	.31+.47 .27 ¹⁰ ±.65
Age 15 Male (N=61) Female (N=58)	$.47^{4}\pm1.76^{4}$ $.29^{4}\pm1.00^{4}$	1.89 ⁴ <u>+</u> 6.04 .58 ⁴ <u>+</u> 1.14 ⁴	.66 ² ±1.07 .36 ² ±.72 ²	.39 ² <u>+</u> 1.24 .57 ² <u>+</u> 1.58	1.18 <u>+</u> 3.33 .42 <u>+</u> .78	$.53^{6} \pm 1.02^{6}$ $.40^{6} \pm .97^{6}$.69 <u>+</u> 1.31 .41 <u>+</u> .82

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 6. H2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 7. H2 commissions: norming group standard deviation values in this norming group standard deviation values in this norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 16 Male (N=22)	.63 <u>+</u> 1.11 .81 ⁶ +1.69	.63 ⁴ ±1.70 ⁴ .76 ² ±1.26 .87±2.27	.77 <u>+</u> 1.42
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Female (N=29)	.81 <u>+</u> 2.61 .70 ⁶ <u>+</u> 1.27 ⁶	$.77^{4}\pm2.34^{4}$ $.77^{2}\pm1.64$ $.63^{2}\pm1.15$.72 <u>+</u> 1.42
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 17 Male (N=18)	.23 ⁸ +.53 .29 ⁶ +.30 ⁶ .	$.00^4 + .00^4$ $.35^2 + .49^2$ $.22^2 + .46^2$.27 ¹⁰ +.30
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Female (N=18)	$.39+.80$ $.37^{6}+.90^{6}$	$.15^4 + .65^4$ $.13^2 + .30^2$ $.62^2 + 1.55$.38+.75
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 18 Male (N=32) Female (N=66)	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$.35 <u>+</u> .42 .35 <u>+</u> .80
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 19 Male (N=25) Female (N=54)	$.06^{8}\pm.28^{8}$ $.08^{6}\pm.20^{6}$.0 $.41\pm1.16$ $.62^{6}\pm2.23$	$\begin{array}{cccc} .11^4 \underline{+}.56^4 & .10^2 \underline{+}.26^2 & .06^2 \underline{+}.32^2 \\ .62^4 \underline{+}1.84^4 & .54^2 \underline{+}2.05 & .71^2 \underline{+}2.47 \end{array}$.07 ¹⁰ <u>+</u> .18 ¹⁰ .58 <u>+</u> 1.81
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 20 - 29 Male (N=19) Female (N=30)	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$.37 <u>+</u> .72 .55 <u>+</u> 1.21
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 30 - 39 Male (N=4) Female (N=22)	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$.00^{10} \pm .01^{10}$ $.14^{10} \pm .25^{10}$
Age 50 - 59	Age 40 - 49 Male (N=14) Female (N=19)	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$.02^{10} \pm .08^{10}$ $.06^{10} \pm .13^{10}$
Age 60 - 69	Age 50 - 59 Male (N=8) Female (N=16)	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$.19 ¹⁰ +.28 ¹⁰ .15 ¹⁰ +.32
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 60 - 69 Male (N=12) Female (N=24)	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$.10 ¹⁰ +.24 ¹⁰ .22 ¹⁰ +.31
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Age 70 - 79 Male (N=12) Female (N=39)	.69 <u>+</u> 1.26 1.69 <u>+</u> 2.56 1 .71 <u>+</u> 1.52 .73 ⁶ <u>+</u> 1.82	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1.47 <u>+</u> 2.22 .73 <u>+</u> 1.71
Age 80 and up Male (N=8) 3.13+3.77 3.47+4.39 2.58+1.93 1.88+2.61 3.30+3.92 2.23+2.15 2.47+2 Female (N=23) 1.57 ⁴ +3.63 1.21 ⁴ +2.34 ⁴ 1.83+3.11 2.83+5.82 1.39+2.78 2.33+3.73 2.12+3	Age 80 and up Male (N=8) Female (N=23)	3.30 <u>+</u> 3.92 2.23 <u>+</u> 2.15 2 1.39+2.78 2.33+3.73 2	3.47 ± 4.39 2.58\pm1.93 1.88\pm2.61 1.21 ⁴ \pm2.34 ⁴ 1.83±3.11 2.83±5.82	2.47 <u>+</u> 2.47 2.12+3.11

Visual Norms - Omissions (%)

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 6. H2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 9. T commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*

Visual Norms - Commissions (%)

Years of Age	Quarter					Total	
	1	2	3	4	1	2	
Age 4		-	Ŭ			-	
Male (N=24)	12.60+14.18		33.91+18.61				17.34+12.54
Female (N=26)	6.23+8.16		26.60+14.60				10.75+7.46
Age 5							
Male (N=66)	5.33+6.79		27.55+15.95				10.27+6.92
Female (N=80)	3.85 <u>+</u> 7.82		17.64+12.01				6.91 <u>+</u> 7.05
Age 6	_						_
Male (N=19)	4.26+5.49	3.05+4.77	29.74+16.47	39.95+18.07	3.63+5.16	34.84+16.58	10.37+6.85
Female (N=23)	2.39+3.87	1.91+3.33	20.17+11.73	27.70+14.26	2.00+3.25	23.96+11.52	6.78+4.16
Age 7							
Male (N=61)	4.61+7.57	3.66+8.57	31.38+18.61	41.16+18.24	4.03+7.86	36.25+17.33	10.97+8.47
Female (N=61)	2.72+4.67	1.39 <mark>+</mark> 2.33	21.05 <u>+</u> 14.55	28.98 <u>+</u> 16.67	1.95+3.46	25.02 <u>+</u> 14.41	6.89 <u>+</u> 5.02
Age 8							
Male (N=36)	3.72 <u>+</u> 4.60	1.72 <u>+</u> 2.84	24.81 <u>+</u> 12.98	35.42 <u>+</u> 17.19	2.58 <u>+</u> 3.74	30.08 <u>+</u> 13.91	8.61 <u>+</u> 5.23
Female (N=38)	1.92 <u>+</u> 2.55	.82 <u>+</u> 1.61	23.00 <u>+</u> 16.39	29.34 <u>+</u> 15.26	1.34 ⁵ <u>+</u> 1.95	26.18 <u>+</u> 14.80	6.61 <u>+</u> 4.28
Age 9							
Male (N=57)	3.60 <u>+</u> 4.30	2.35 <u>+</u> 4.15	28.14 <u>+</u> 17.83	37.82 <u>+</u> 21.11	2.89 <u>+</u> 4.11	32.74 <u>+</u> 18.82	9.39 <u>+</u> 6.52
Female (N=55)	1.89 <u>+</u> 2.94	1.02 <u>+</u> 1.79	20.15 <u>+</u> 13.54	30.24 <u>+</u> 16.28	1.38 <u>+</u> 2.31	25.24 <u>+</u> 14.08	6.53 <u>+</u> 4.17
Age 10							
Male (N=33)	1.97 <u>+</u> 1.40	.88 <u>+</u> 1.11	26.45 <u>+</u> 12.67	34.06 <u>+</u> 12.99	1.27 <u>+</u> 1.04	30.15 <u>+</u> 11.38	7.70 <u>+</u> 3.20
Female (N=34)	2.00 <u>+</u> 2.61	.76 ¹ <u>+</u> 1.21	18.59 <u>+</u> 14.88	22.71 <u>+</u> 15.56	1.26 <u>+</u> 1.83	20.59 <u>+</u> 14.08	5.65 <u>+</u> 4.23
Age 11							
Male (N=55)	2.62 <u>+</u> 2.65	1.65 <u>+</u> 2.12	28.67 <u>+</u> 19.01	36.18 <u>+</u> 19.40	2.09 <u>+</u> 2.27	32.42 <u>+</u> 18.49	8.69 <u>+</u> 5.34
Female (N=60)	2.05 <u>+</u> 2.17	1.07 <u>+</u> 1.40	21.65 <u>+</u> 14.81	28.22 <u>+</u> 16.88	1.42 <u>+</u> 1.73	24.85 <u>+</u> 14.71	6.65 <u>+</u> 4.16
Age 12							
Male (N=37)	1.15 <u>+</u> 1.51	.781 <u>+</u> 1.29	23.60 <u>+</u> 14.95	27.35 <u>+</u> 15.93	.91 ⁵ <u>+</u> 1.28 ⁵	25.50 <u>+</u> 14.01	6.34 <u>+</u> 3.82
Female (N=49)	.83 <u>+</u> 1.10	.56° <u>+</u> .86	16.16 <u>+</u> 15.25	21.15 <u>+</u> 18.78	.57° <u>+</u> .89°	18.70 <u>+</u> 16.50	4.59 <u>+</u> 4.16
Age 13					-		
Male (N=66)	1.57 <u>+</u> 2.16	.76 <u>'+</u> .89	17.80 <u>+</u> 14.09	19.22 <u>+</u> 17.18	1.15 <u>°+</u> 1.40	18.46 <u>+</u> 14.45	4.93 <u>+</u> 3.93
Female (N=69)	.77 ¹ <u>+</u> 1.05	.541 <u>+</u> .84	14.47 <u>+</u> 12.52	16.29 <u>+</u> 12.76	.64° <u>+</u> .86°	15.37 <u>+</u> 12.21	3.81 <u>+</u> 2.85
Age 14		,				1	
Male (N=46)	.78 <u>+</u> 1.08	.68 <u>1+</u> .90	15.36 <u>+</u> 12.96	15.30 <u>+</u> 14.33	.72 ⁵ <u>+</u> .85 ⁵	15.35 <u>+</u> 12.81	3.97 <u>+</u> 3.31
Female (N=36)	.58 ¹ +1.01	.37 ¹ +.67 ¹	10.98 <u>+</u> 9.18	12.48 <u>+</u> 11.78	.46° <u>+</u> .69°	11.77 <u>+</u> 9.92	2.95 <u>+</u> 2.60
Age 15		4			5 5	1	
Male (N=61)	.72 <u>+</u> 1.23	.45 <u>'+</u> .83	14.27 <u>+</u> 10.65	14.80 <u>+</u> 12.22	.56 <u>°+</u> .92°	14.56 <u>+</u> 10.74	3.64 <u>+</u> 2.82
Female (N-58)	.73' <u>+</u> 1.08	.24 <u>+</u> .54	13.38 <u>+</u> 14.04	14.89 <u>+</u> 13.89	.45 <u>°+</u> .66°	14.12 <u>+</u> 13.41	3.45 <u>+</u> 3.39

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

Visual Norms - Commissions (%)

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 9. T commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*

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

Visual Norms - Response Time (msec)

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

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

Visual Norms - Variability (msec)

Visual Norms - Variability (msec)

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

Years of Age		Qua	rter	Half		Total	
	1	2	3	4	1	2	
Age 4 Male (N=24) Female (N=26)	1.99 <u>+</u> 1.07 2.25 <u>+</u> 1.64		1.18 <u>+0</u> .63 1.38 <u>+</u> 0.86				1.68 <u>+</u> 0.69 1.86 <u>+</u> 0.84
Age 5 Male (N=66) Female (N=80)	3.18 <u>+</u> 1.15 3.78 <u>+</u> 1.67		1.99 <u>+</u> 0.86 2.40 <u>+</u> 1.05				2.59 <u>+</u> 0.65 2.93 <u>+</u> 0.98
Age 6 Male (N=19) Female (N=23)	5.05±1.68 4.31±1.39	4.70±2.24 4.85±1.90	2.37±0.96 2.91±1.34	1.74±1.03 2.22±0.95	4.45±1.79 4.62±1.56	2.02±0.97 2.40±0.91	2.96±0.94 3.10±0.70
Age 7 Male (N=61) Female (N=61)	4.77±1.59 5.40±1.74	4.59±1.89 5.77±1.95	2.77±1.43 3.53±1.40	2.18±1.44 2.84±1.34	4.44±1.62 5.31±1.82	2.37±1.20 3.06±1.31	3.19±1.04 3.84±1.20
Age 8 Male (N=36) Female (N=38)	5.47±1.66 5.98±1.55	5.94±1.99 6.41±1.85	3.78±1.28 4.14±1.30	3.43±1.44 3.65±1.33	5.41±1.79 5.64±1.66	3.64±1.36 3.74±1.29	4.22±1.24 4.31±1.19
Age 9 Male (N=57) Female (N=55)	5.52±1.86 6.36±1.67	6.06±1.85 6.43±1.50	3.79±1.48 4.35±1.31	3.27±1.58 3.84±1.45	5.49±1.75 6.05±1.64	3.54±1.46 4.01±1.33	4.25±1.44 4.71±1.23
Age 10 Male (N=33) Female (N=34)	5.66±1.59 6.63±1.21	6.70±1.72 7.21±1.72	4.07±1.21 4.88±1.35	3.74±1.30 4.34±1.43	5.86±1.65 6.73±1.51	3.83±1.31 4.65±1.32	4.60±1.29 5.39±1.41
Age 11 Male (N=55) Female (N=60)	6.21±1.56 6.34±1.42	6.30±2.04 6.79±1.72	4.15±1.48 4.61±1.20	3.67±1.62 4.09±1.30	6.01±1.88 6.43±1.49	3.84±1.57 4.43±1.17	4.69±1.48 5.06±1.17
Age 12 Male (N=37) Female (N=49)	7.04 <u>+</u> 1.46 7.09±1.50	6.96±1.71 7.18±1.42	4.35±1.44 4.93±1.39	4.26±1.49 4.84±1.50	6.62±1.47 7.04±1.51	4.22±1.41 4.64±1.29	4.97±1.15 5.34±1.26
Age 13 Male (N=66) Female (N=69)	6.60±1.53 7.30±1.38	6.92±1.64 7.39±1.35	4.82±1.45 4.80±1.58	4.72±1.66 4.89±1.45	6.31±1.53 6.98±1.40	4.61±1.43 4.53±1.33	5.16±1.22 5.14±1.14
Age 14 Male (N=46) Female (N=36)	7.24±1.06 7.72±1.04	7.19±1.37 7.75±1.13	5.08±1.17 5.29±1.48	5.17±1.39 5.47±1.64	6.77±1.20 7.45±1.07	4.83±1.14 5.06±1.26	5.32±1.05 5.71±1.12
Age 15 Male (N=61) Female (N-58)	7.41±1.47 7.31±1.36	7.34±1.53 7.66±1.36	4.84±1.64 5.20±1.58	5.08±1.38 5.23±1.88	6.92±1.55 7.10±1.44	4.68±1.32 5.10±1.58	5.25±1.19 5.63±1.42

Visual Norms - D Prime (Perceptual Sensitivity)

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

Visual Norms - D Prime (Perceptual Sensitivity)

	-		,		
	Omission Errors (%):	Commission Errors (%):	Response Time (msec)	Variability (SD, msec)	D PRIME: Hit Rate/False Alarm
Years of Age	Inattention [Mean ± SD]	Impulsivity [Mean ± SD]	[Mean ± SD]	[Mean ± SD]	Rate [Mean ± SD]
Age 6					
	18.00.00.82	10 42 44 64	775 60 107 05	200.01 .72.42	2.60.1.48
	18.90 <u>+</u> 20.82	10.43+14.64	775.63 <u>+</u> 127.05	309.01. <u>+</u> 73.42	2.09±1.48
Female (N=90)	19.05 <u>+</u> 20.51	8.38 <u>+</u> 13.27	806.51 <u>+</u> 117.35	309.98 <u>+</u> 61.16	2.82±1.32
Age 7					
Male (N=92)	12.20+18.97	6.58+8.13	701.82+127.34	266.41+70.79	3.35±1.42
Female (N=82)	15.03+21.43	5.41+7.95	752.50+137.70	272.92 + 67.98	3.56±1.69
Ago 8					
	6 50 12 15	4.45.4.24	662 21 100 48	240.00.05.20	4.02.1.20
	0.50 <u>+</u> 13.15	4.15+4.34	663.21 <u>+</u> 109.48	240.00+05.38	4.02±1.39
Female (N=108)	6.46 <u>+</u> 13.53	3.10 <u>+</u> 3.54	681.88 <u>+</u> 119.08	225.43 <u>+</u> 64.57	4.28±1.49
Age 9-					
Male (N=104)	4.49+11.32	3.07+3.89	640.90+107.58	215.02+66.30	4.41±1.30
Female (N=100)	4,19+9,42	2.64+2.29	636.17 ± 111.07	205.02 + 63.36	4.51±1.33
Age 10					
Mala (N=106)	2 25 9 29	2 22 1 2 82	588 62 102 15	190 29 54 41	5 06+1 49
$\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 $	2.33+0.30	2.32 <u>+</u> 2.03	505.03+93.13	100.20+34.41	5.00±1.40
Female (N=107)	1.50 <u>+</u> 3.12	1.51 <u>+</u> 1.44	585.33 <u>+</u> 98.77	171.90 <u>+</u> 59.36	5.42±1.37
Age 11					
Male (N=96)	.88 <u>+</u> 1.69	1.54 <u>+</u> 1.27	562.04 <u>+</u> 92.64	162.40 <u>+</u> 55.80	5.54±1.30
Female (N=104)	1.49+3.42	1.44+1.39	573.87+113.87	164.03+61.52	5.45±1.48
Age 12					
Male (N-87)	1 50+7 81	1 40+1 53	569 63+104 86	167 43+58 33	5 74+1 57
$F_{\text{remole}}(N = 0.7)$	74:4.20	1.40+1.00	50 <u>5</u> .0 <u>5</u> .10 <u>4</u> .00	101.45450.55	5.7411.57
Female (N=94)	.74 <u>+</u> 1.30	1.08 <u>+</u> 1.04	574.14 <u>+</u> 108.32	101.31 <u>+</u> 00.52	0.76±1.36
Age 13					
Male (N=98)	1.03 <u>+</u> 2.21	1.17 <u>+</u> 1.36	559.24 <u>+</u> 96.89	164.35 <u>+</u> 58.13	5.79±1.50
Female (N=91)	2.17 <u>+</u> 5.99	1.33 <u>+</u> 1.68	548.52 <u>+</u> 93.68	163.11 <u>+</u> 64.67	5.60±1.55
Age 14					
Male (N=100)	1 45+6 17	1 20+1 69	523 00+95 95	159 70+62 84	5 95+1 46
Female (N=101)	60+1 18	85+ 97	521 12+93 05	1/6 00+56 01	6.03+1.49
	.0 <u>9+</u> 1.10	.03 <u>+</u> .97	<u>521.12</u> <u>+</u> 55.05	140.3340.31	0.0311.43
Age 15					
Male (N=98)	.51 <u>+</u> 1.28	.88 <u>+</u> .93	510.76 <u>+</u> 111.05	148.95 <u>+</u> 62.30	6.15±1.32
Female (N=90)	1.47 <u>+</u> 7.16	1.13 <u>+</u> 2.35	517.72 <u>+</u> 106.38	150.68 <u>+</u> 64.76	5.88±1.55
Age 16					
Male (N=94)	72+1 40	71+ 79	511 30+109 41	144 78+53 66	6 14+1 44
Female (N=87)	78+1.90	68+1 16	400 07+100 84	135 79+57 39	6 5/+1 59
	. <u>//0_</u> 1.50		433.37 - 103.04	100:10_01:00	0.0411.00
Age 17	10.00	07 4 00	100.01.01.11		
Male (N=99)	.49 <u>+</u> .98	.67 <u>+</u> 1.29	480.81 <u>+</u> 84.41	132.75 <u>+</u> 49.76	6.4/±1.56
Female (N=107)	.84 <u>+</u> 2.58	.97 <u>+</u> 3.56	492.13 <u>+</u> 109.23	126.53 <u>+</u> 57.96	6.58±1.62
Age 18					
Male (N=101)	.43+1.78	.52+.71	477.90+88.76	127.39+47.52	6.65±1.39
Female (N=101)	55+1.38	38+ 53	492 42+98 42	125 11+50 23	6 81+1 44
Age 19			102.12 <u>1</u> 00.12	120.11.00.20	0.0121.11
	44:4.02	40 - 00	476 40 - 04 67	107.00 - 17.04	6 80 1 60
	.44 <u>+</u> 1.03	.49 <u>+</u> .90	476.40 <u>+</u> 94.67	127.09 <u>+</u> 47.34	0.89±1.00
Female (N=10)	.34 <u>+</u> .71	.56 <u>+</u> .76	450.59 <u>+</u> 90.54	128.72 <u>+</u> 60.26	7.00±1.62
Age 20 – 29Male (N=54)	1.22±3.26	1.571±1.59	490.33±127.47	119.28±62.97	5.88±1.31
Female (N=75)	.56±1.20	1.11±1.40	511.97±120.63	115.59±49.73	6.34±1.38

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 6. H2 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 7. H2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).*

Auditory Norms - Omissions (%)

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

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 3. Q3/Q4 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 4. Q1/Q2 comissions: norming group standard deviation values in this norming group were bounded at a minimum value of 2.778% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 6. H2 comissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 7. H2 commissions: norming group standard deviation values in this norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 9. T commissions: norming group standard deviation values in this norming group st

Auditory Norms - Commissions (%)

Years of Age		Q	uarter		ŀ	Total	
	1	2	3	4	1	2	
Age 6 Male (N=85) Female (N=90)	6.29 <u>+</u> 16.52 4.40 <u>+</u> 12.39	5.98 <u>+</u> 15.93 5.72 <u>+</u> 15.84	24.96 <u>+</u> 18.98 17.13 <u>+</u> 18.34	28.32 <u>+</u> 21.79 24.53 <u>+</u> 20.71	6.12 <u>+</u> 15.90 5.05 <u>+</u> 13.88	26.54 <u>+</u> 19.13 20.77 <u>+</u> 18.58	10.43 <u>+</u> 14.64 8.38 <u>+</u> 13.27
Age 7 Male (N=92) Female (N=82)	2.88 <u>+</u> 9.04 2.89 <u>+</u> 8.40	2.44 <u>+</u> 7.59 2.12 <u>+</u> 7.97	17.96 <u>+</u> 16.75 13.44 <u>+</u> 14.53	23.79 <u>+</u> 19.66 18.65 <u>+</u> 17.27	2.63 <u>+</u> 7.40 2.50 <u>+</u> 7.91	20.87 <u>+</u> 17.36 15.97 <u>+</u> 14.56	6.58 <u>+</u> 8.13 5.41 <u>+</u> 7.95
Age 8 Male (N=97) Female (N=108)	1.18 <u>+</u> 3.41 1.08 <u>+</u> 2.45	.81 <u>+</u> 3.46 .75 ¹ +2.46	13.96 <u>+</u> 12.61 9.20 <u>+</u> 11.36	17.31 <u>+</u> 16.05 12.69 <u>+</u> 13.50	.99 ⁵ <u>+</u> 3.38 .91⁵ <u>+</u> 1.92	15.63 <u>+</u> 13.43 10.94 <u>+</u> 11.82	4.15 <u>+</u> 4.34 3.10 <u>+</u> 3.54
Age 9 Male (N=104) Female (N=100)	.92+2.10 .70 ¹ ±1.56	$.62^{1}+2.09$ $.21^{1}+.42^{1}$	9.30 <u>+</u> 12.70 8.00 <u>+</u> 8.09	13.34 <u>+</u> 16.07 12.99 <u>+</u> 12.30	.77 ⁵ +1.96 .46 ⁵ +.82 ⁵	11.30 <u>+</u> 13.68 10.47 <u>+</u> 9.29	3.07 <u>+</u> 3.89 2.64 <u>+</u> 2.29
Age 10 Male (N=106) Female (N=107)	.54 ¹ ±1.41 .42 ¹ ±1.14	.33 ¹ ±.83 .10 ¹ ±.29 ¹	8.04 <u>+</u> 11.34 4.76 <u>+</u> 6.46	10.30 <u>+</u> 14.27 7.16 <u>+</u> 6.68	$.43^{5} \pm .92^{5}$ $.26^{5} \pm .59^{5}$	9.16 <u>+</u> 12.43 5.95 <u>+</u> 5.92	2.32 <u>+</u> 2.83 1.51 <u>+</u> 1.44
Age 11 Male (N=96) Female (N=104)	.45 ¹ <u>+</u> .68 ¹ .21 ¹ <u>+</u> .46 ¹	.15 ¹ ±.33 ¹ .15 ¹ ±.37 ¹	4.93 <u>+</u> 4.95 4.35 <u>+</u> 4.74	7.03 <u>+</u> 7.44 7.52 <u>+</u> 8.55	$.30^{5} \pm .40^{5}$ $.18^{5} \pm .34^{5}$	5.96 <u>+</u> 5.14 5.93 <u>+</u> 6.13	1.54 <u>+</u> 1.27 1.44 <u>+</u> 1.39
Age 12 Male (N=87) Female (N=94)	.40 ¹ ±.70 ¹ .29 ¹ ±.67 ¹	$.24^{1} \pm .74^{1}$ $.11^{1} \pm .30^{1}$	4.91 <u>+</u> 6.45 3.08 <u>+</u> 3.54	5.64 <u>+</u> 7.80 5.28 <u>+</u> 5.59	$.32^{5}\pm.66^{5}$ $.20^{5}\pm.38^{5}$	5.28 <u>+</u> 6.65 4.18 <u>+</u> 3.96	1.40 <u>+</u> 1.53 1.08 <u>+</u> 1.04
Age 13 Male (N=98) Female (N=91)	.31 ¹ ±.70 ¹ .30 ¹ ±.55 ¹	.11 ¹ ±.33 ¹ .12 ¹ ±.37 ¹	3.67 <u>+</u> 4.53 4.57 <u>+</u> 7.27	5.49 <u>+</u> 7.40 6.09 <u>+</u> 7.92	.21 ⁵ <u>+</u> .37 .21 ⁵ <u>+</u> .39	4.57 <u>+</u> 5.45 5.32 <u>+</u> 6.97	1.17 <u>+</u> 1.36 1.33 <u>+</u> 1.68
Age 14 Male (N=100) Female (N=101)	.25 ¹ ±.59 ¹ .18 ¹ ±.40 ¹	.28 ¹ <u>+</u> .82 .13 ¹ <u>+</u> .33 ¹	4.22 <u>+</u> 7.29 2.83 <u>+</u> 4.34	4.99 <u>+</u> 8.05 3.76 <u>+</u> 4.83	.27 ⁵ ±.58 ⁵ .15 ⁵ ±.27 ⁵	4.60 <u>+</u> 7.34 3.30 <u>+</u> 3.98	1.20 <u>+</u> 1.69 .85 <u>+</u> .97
Age 15 Male (N=98) Female (N=90)	.22 ¹ +.46 ¹ .14 ¹ +.49 ¹	.13 ¹ <u>+</u> .34 ¹ .10 ¹ <u>+</u> .33 ¹	3.22 <u>+</u> 4.18 3.98 <u>+</u> 9.18	3.54 <u>+</u> 4.31 5.36 <u>+</u> 11.70	.17 ⁵ + .29 ⁵ .12 ⁵ <u>+</u> .33 ⁵	3.38 <u>+</u> 3.67 4.67 <u>+</u> 10.23	.88 <u>+</u> .93 1.13 <u>+</u> 2.35
Age 16 Male (N=94) Female (N=87)	.17 ¹ <u>+</u> .40 ¹ .20 ¹ <u>+</u> .81	.13 ¹ ±.31 ¹ .07 ¹ ±.29 ¹	2.65 ³ <u>+</u> 3.81 2.11 ³ <u>+</u> 3.94	2.83 <u>+</u> 3.90 3.08 <u>+</u> 5.83	.15 ⁵ ±.25 ⁵ .14 ⁵ ±.44 ⁵	2.73 <u>+</u> 3.36 2.61 <u>+</u> 4.54	.71 <u>+</u> .79 .68 <u>+</u> 1.16
Age 17 Male (N=99) Female (N=107)	.15 ¹ +.39 ¹ .21 ¹ +.91	.09 ¹ <u>+</u> .25 ¹ .49 ¹ <u>+</u> 4.47	2.52 ³ <u>+</u> 6.93 2.86 <u>+</u> 8.05	2.99 <u>+</u> 6.85 3.59 <u>+</u> 8.38	.12 ⁵ <u>+</u> .25 ⁵ .35 ⁵ <u>+</u> 2.63	2.76 <u>+</u> 6.74 3.22 <u>+</u> 8.01	.67 <u>+</u> 1.29 .97 <u>+</u> 3.56
Age 18 Male (N=101) Female (N=101)	.12 ¹ <u>+</u> .32 ¹ .07 ¹ <u>+</u> .30 ¹	.05 ¹ <u>+</u> .20 ¹ .03 ¹ <u>+</u> .15 ¹	1.88 ³ <u>+</u> 3.19 1.16 ³ <u>+</u> 2.53 ³	2.25 ³ <u>+</u> 3.84 1.94 ³ <u>+</u> 2.89	.09 ⁵ ±.19 ⁵ .05 ⁵ ±.17 ⁵	2.06 <u>+</u> 3.16 1.55 <u>+</u> 2.29	.52 <u>+</u> .71 .38 <u>+</u> .53
Age 19 Male (N=22) Female (N=10)	.07 ¹ +.24 ¹ .16 ¹ +.33 ¹	.07 ¹ +.23 ¹ .08 ¹ +.25 ¹	2.08 ³ +5.15 2.32 ³ +3.78	1.99 ³ <u>+</u> 3.78 1.94 ³ <u>+</u> 2.94	.07 ⁵ <u>+</u> .16 ⁵ .12 ⁵ <u>+</u> .19 ⁵	2.03 <u>+</u> 4.17 2.12 <u>+</u> 3.27	.49 <u>+</u> .90 .56 <u>+</u> .76
Age 20-29 Male (N=54) Female (N=75)	.34 ¹ <u>+</u> .61 ¹ .23 ¹ <u>+</u> 1.14 ¹	.18 ¹ <u>+</u> .32 ¹ .78v <u>+</u> 3.75	6.26 <u>+</u> 7.34 4.40 <u>+</u> 3.10	6.39 <u>+</u> 7.35 4.33 <u>+</u> 5.95	.23 ⁵ <u>+</u> .33 ⁵ .18 ⁵ <u>+.</u> 59 ⁵	6.63 <u>+</u> 6.74 4.37 <u>+</u> 5.70	1.57 <u>+</u> 1.59 1.11 <u>+</u> 1.40

1. Q1/Q2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.794% (1 error / 126 stimuli).* 2. Q3/Q4 omissions : norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% (1 error / 36 stimuli).* 5. H1 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 1.389% 1 error / 72 stimuli).* 7. H2 commissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.397% (1 error / 252 stimuli).* 8. H1 omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 stimuli).* 10. T omissions: norming group standard deviation values in this norming group were bounded at a minimum value of 0.309% (1 error / 324 s

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

Auditory Norms - Response Time (msec)

Auditory Norms - Variability (msec)

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

Auditory Norms	- D Prime	(Perceptual	Sensitivity)
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Years of Age		Qua	irter	Half		Total	
	1	2	3	4	1	2	I
Age 6 Male (N=85) Female (N=90)	4.38±2.24 4.87±2.42	4.58±2.43 4.50±2.21	2.08±1.66 2.59±1.94	1.89±1.76 2.21±1.69	4.05±2.05 4.06±1.88	1.90±1.58 2.22±1.56	2.69±1.48 2.82±1.32
Age 7 Male (N=92) Female (N=82)	5.79±2.29 5.60±2.39	5.50±2.33 5.86±2.41	2.98±2.04 3.34±2.24	2.63±2.09 2.96±2.12	5.08±2.12 5.23±2.26	2.57±1.67 2.90±1.87	3.35±1.42 3.56±1.69
Age 8 Male (N=97) Female (N=108)	6.58±1.79 6.34±2.00	6.72 ± 2.07 6.74±2.02	3.77±1.99 4.38±2.23	3.48±1.98 4.01±2.06	5.97±1.89 5.98±1.98	3.26±1.59 3.79±1.78	4.02±1.39 4.28±1.49
Age 9 Male (N=104) Female (N=100)	6.93±1.76 7.03±1.89	7.15±1.80 7.19±1.62	4.38±1.88 4.52±1.94	4.03±2.27 4.05±1.76	6.49±1.75 6.50±1.72	3.76±1.57 3.92±1.55	4.41±1.30 4.51±1.33
Age 10 Male (N=106) Female (N=107)	7.41±1.52 7.54±1.37	7.47±1.61 7.71±1.24	4.99±2.10 5.80±1.95	4.89±2.06 5.09±1.81	6.94±1.64 7.22±1.42	4.47±1.74 4.93±1.59	5.06±1.48 5.42±1.37
Age 11 Male (N=96) Female (N=104)	7.58±1.27 7.80±1.35	7.92±1.08 7.69±1.38	5.74±1.94 5.80±2.02	5.37±1.71 5.26±1.81	7.36±1.34 7.41±1.43	5.04±1.51 5.07±1.72	5.54±1.30 5.45±1.48
Age 12 Male (N=87) Female (N=94)	7.64 <u>+</u> 1.30 7.89±1.11	7.68±1.54 7.84±1.34	6.04±1.99 6.34±1.91	5.88±2.11 5.69±1.96	7.26±1.52 7.47±1.35	5.52±1.95 5.41±1.60	5.74±1.57 5.78±1.38
Age 13 Male (N=98) Female (N=91)	7.69±1.36 7.61±1.45	7.94±1.16 7.75±1.39	6.16±1.88 5.91±2.01	5.88±2.10 5.47±2.09	7.40±1.40 7.36±1.59	5.46±1.77 5.14±1.74	5.79±1.50 5.60±1.55
Age 14 Male (N=100) Female (N=101)	7.80±1.29 7.95±1.13	7.75±1.41 7.84±1.20	6.19±2.05 6.47±1.89	6.14±1.91 6.20±1.86	7.43±1.48 7.54±1.34	5.64±1.78 5.73±1.76	5.95±1.46 6.03±1.49
Age 15 Male (N=98) Female (N=90)	7.95±1.10 8.11±1.03	8.08±1.02 7.96±1.18	6.51±1.79 6.36±2.01	6.25±1.80 5.81±2.33	7.74±1.14 7.78±1.26	5.81±1.57 5.57±1.91	6.15±1.32 5.88±1.55
Age 16 Male (N=94) Female (N=87)	8.01±.95 7.99±1.17	7.77±1.22 8.09±1.08	6.51±1.84 6.94±1.73	6.39±1.94 6.58±1.97	7.52±1.26 7.75±1.30	5.96±1.75 6.29±1.82	6.14±1.44 6.54±1.59
Age 17 Male (N=99) Female (N=107)	8.09±.96 8.05±1.09	8.01±1.07 7.96±1.21	6.80±1.91 6.99±1.82	6.73±1.87 6.72±1.90	7.75±1.20 7.76±1.30	6.22±1.85 6.41±1.82	6.47±1.56 6.58±1.62
Age 18 Male (N=101) Female (N=101)	8.08±1.10 8.30±0.67	8.25±0.75 8.28±0.78	7.04±1.72 7.35±1.44	6.99±1.74 6.86±1.87	7.94±1.10 8.15±0.90	6.53±1.70 6.58±1.70	6.65±1.39 6.81±1.44
Age 19 Male (N=22) Female (N=10)	8.36±0.55 8.16±0.78	8.25±0.71 8.34±0.59	7.13±1.88 7.02±2.17	7.14±1.72 7.28±1.77	8.14±0.74 8.05±0.78	6.65±1.79 6.90±2.00	6.89±1.60 7.00±1.62
Age 20-29 Male (N=54) Female (N=75)	7.72 <u>+</u> 1.31 8.12 <u>+</u> 1.11	7.97 <u>+</u> 1.23 7.97 <u>+</u> 1.15	5.60 <u>+</u> 1.72 6.23 <u>+</u> 1.67	5.65 <u>+</u> 1.83 6.32 <u>+</u> 1.77	7.46 <u>+</u> 1.35 7.80 <u>+</u> 1.23	5.36 <u>+</u> 1.51 5.9 <u>3+</u> 1.54	5.88 <u>+</u> 1.31 6.34 <u>+</u> 1.38