This study examined the influence of prenatal cocaine exposure on attention and response inhibition measured by continuous performance tests (CPTs) at ages 5 and 7 years. The baseline sample consisted of 253 cocaine-exposed and 223 non-cocaine-exposed children enrolled prospectively at birth and assessed comprehensively through age 7 years in the longitudinal Miami Prenatal Cocaine Study. This report includes a subsample of 415 children (219 cocaine-exposed, 196 non-cocaine-exposed) who completed at least one CPT assessment at ages 5 and/or 7 years. Prenatal cocaine exposure was measured by maternal self-report and maternal and infant bioassays. Deficits in attention and response inhibition are estimated in relation to prenatal cocaine exposure using generalized estimating equations within the general linear model. Results indicate cocaine-associated increases in omission errors at ages 5 and 7 as well as increases in response times for target tasks (i.e., slower reaction times) and decreased consistency in performance at age 7. There were no demonstrable cocaine-associated deficits in commission errors. Estimates did not change markedly with statistical adjustment for selected prenatal and postnatal covariates. Evidence supports cocaine-associated deficits in attention processing through age 7 years.


We compare the view that the effect of methylphenidate (MPH) is selective to individuals with attention-deficit/hyperactivity disorder (ADHD) with an alternative approach suggesting that its effect is more prominent for individuals with weak baseline capacities in relevant cognitive tasks. To evaluate these 2 approaches, we administered sustained attention, working memory, and decision-making tasks to 20 ADHD adults and 19 control subjects, using a within-subject placebo-controlled design. The results demonstrated no main effects of MPH in the decision-making tasks. In the sustained attention and working-memory tasks, MPH enhanced performance of both ADHD and non-ADHD adults to a similar extent compared with placebo. Hence, the effect of MPH was not selective to ADHD adults. In addition, those benefitting most from MPH in all 3 task domains tended to be individuals with poor task performance. However, in most tasks, individuals whose performance was impaired by MPH were not necessarily better (or worse) performers. The findings suggest that the administration of MPH to adults with ADHD should consider not only clinical diagnosis but also their functional (performance-based) profile.


Objectives: Attention deficit hyperactivity disorder (ADHD) is a common childhood problem requiring stimulant medications in a significant proportion of cases. The aim of this pilot study was to assess the effects of prolonged stimulant medication therapy on a continuous performance test, the Test of Variables of Attention (TOVA), which measures objectively features of ADHD. Methods: Eighteen children aged 8 to 16 years who were diagnosed with ADHD, based on the Diagnostic and Statistical Manual of Mental Disorders 4th edn criteria, were included in the study. Assessment on a continuous performance test (TOVA) was performed initially and the children were administered stimulant medications for at least 12 months. The medications were stopped for 1 week, followed by a repeat TOVA assessment which was compared to the initial TOVA assessment. Results: Follow up TOVA scores showed a significant improvement in mean commission errors (impulsivity) after the stimulant medication therapy. No significant improvement was found in omission errors (inattention), response time and variability. There was a significant positive correlation between commission and omission scores (P
value 0.0001). Conclusions: The results of this pilot study indicate that there is objective improvement in impulsivity in children with ADHD after a prolonged period of stimulant medication therapy. The study suggests that it would be useful to perform formal studies to investigate this further and also to assess the role of continuous performance test (TOVA) as a method for monitoring the need for ongoing therapy.


Introduction: The mucopolysaccharidoses (MPSs) are a group of rare genetic lysosomal disorders with progressive multisystem involvement. An MPS-specific physical symptom scale was developed and introduced a Physical Symptom Score (PSS) to quantify the somatic disease burden across MPS I, II and VI. Hypothesis: Somatic burden of disease in patients with attenuated MPS I, II and VI as measured by the PSS will be positively associated with age and negatively associated with neuropsychological functions [i.e. full scale intelligence quotient (FSIQ) and attention]. Materials and methods: Forty-eight patients with attenuated MPS I (n = 24), II (n = 14), and VI (n = 10) aged 6 to 32 years on enzyme replacement therapy who were enrolled in “Longitudinal Studies of Brain Structure and Functions in MPS Disorders” across seven centers. Somatic disease burden was measured by the PSS. Neuropsychological functions were measured by the Wechsler Abbreviated Scale of Intelligence (WASI) and Test of Variables of Attention (TOVA). Results: PSS was positively associated with age in attenuated MPS I (P < 0.001), MPS II (P < 0.01) and MPS VI (P < 0.05). There was a negative association of PSS with FSIQ in attenuated MPS I (P < 0.001) and in MPS VI (P < 0.001) but not with MPS II. Although attention scores were below average in all groups, a significant negative association between PSS and one measures of sustained attention (TOVA d prime) was found only in MPS VI. Conclusions: Physical Symptom Score increased with age in attenuated MPS I, II and VI, reflecting progressive somatic burden of disease despite treatment with enzyme replacement therapy. Furthermore, the association of increased somatic disease burden with decreased neurocognitive ability suggests that both measures reflect disease severity and are not independent.


BACKGROUND: Although thyroxin therapy clearly is beneficial to children with frank hypothyroidism there is little data on the effects of thyroxin in children with compensated or subclinical hypothyroidism. The objective of this study was to determine the effect of thyroxin therapy on cognitive function in children with compensated hypothyroidism. The hypothesis was that thyroxin therapy would change neuropsychological function. METHODS: Eleven patients with a history of subclinical hypothyroidism entered the study. At the start of the study, six out of the 11 were on thyroxin therapy, while 5 were off therapy. All patients underwent a battery of neuropsychological testing and thyroid function tests at the start of study. Based on the results of thyroid function tests, two of the 5 patients who were off thyroxin were started on thyroxin. All of the 6 patients who were on thyroxin were taken off thyroxin. All patients then underwent repeat neuropsychological testing and thyroid functions after an average of 91 days. RESULTS: Thyroxin therapy could not be shown to have an effect on neuropsychological function in this short term study. Our patients had attention problems as compared to the normal population. No significant differences were found between our subjects and normal population standards in verbal processing, visual processing, motor speed/coordination and achievement. CONCLUSION: In this small, short term study, thyroxin therapy could not be shown to affect neuropsychological function in children with compensated hypothyroidism. These children may have attention problems but appear to have normal verbal and visual processing, motor speed/coordination and achievement.

Attention Deficit Disorder is commonly treated with stimulant medications such as Ritalin (methylphenidate). However, this medication has short-term effects and numerous undesirable side effects including insomnia and loss of appetite. This study explores using EEG biofeedback, with its minimal side effects and long-term results, as an alternative to pharmacological treatments for ADD.


Introduction: The mucopolysaccharidoses (MPSs) are a group of rare genetic lysosomal disorders with progressive multisystem involvement. An MPS-specific physical symptom scale was developed and introduced a Physical Symptom Score (PSS) to quantify the somatic disease burden across MPS I, II and VI. Hypothesis: Somatic burden of disease in patients with attenuated MPS I, II and VI as measured by the PSS will be positively associated with age and negatively associated with neuropsychological functions [i.e. full scale intelligence quotient (FSIQ) and attention]. Materials and methods: Forty-eight patients with attenuated MPS I (n = 24), II (n = 14), and VI (n = 10) aged 6 to 32 years on enzyme replacement therapy who were enrolled in "Longitudinal Studies of Brain Structure and Functions in MPS Disorders" across seven centers. Somatic disease burden was measured by the PSS. Neuropsychological functions were measured by the Wechsler Abbreviated Scale of Intelligence (WASI) and Test of Variables of Attention (TOVA). Results: PSS was positively associated with age in attenuated MPS I (P b 0.001), MPS II (P b 0.01) and MPS VI (P b 0.05). There was a negative association of PSS with FSIQ in attenuated MPS I (P b 0.001) and in MPS VI (P b 0.001) but not with MPS II. Although attention scores were below average in all groups, a significant negative association between PSS and one measures of sustained attention (TOVA d prime) was found only in MPS VI. Conclusions: Physical Symptom Score increased with age in attenuated MPS I, II and VI, reflecting progressive somatic burden of disease despite treatment with enzyme replacement therapy. Furthermore, the association of increased somatic disease burden with decreased neurocognitive ability suggests that both measures reflect disease severity and are not independent.


BACKGROUND: Sensory integration dysfunction is a neurologic condition that can cause children to process environmental sensations in an inappropriate way. As a result, they may either seek out strong sensations or avoid even mild sensations. Some of the characteristics of these children may be hyperactivity, poor awareness of pain, high risk taking, listening to loud sounds, clumsiness, poor fine motor skills, poor gross motor skills, poor visual tracking, problems with sequencing, and problems with balance. Sensory integration dysfunction often is related to children with developmental disabilities, autism, and attention deficits. METHODS: Two children from the same family were examined for general eye examinations because of a history of sensory integration problems. J.H., an 11-year-old girl, and her 6-year-old half-brother, A.T., returned to the clinic for visual-perceptual testing: the Test of Variables of Attention (TOVA), the Developmental Eye Movement Test (DEM), and the Visagraph (Compevo AB, Stockholm, Sweden). The use of yoked prisms with these children was also explored. RESULTS: Both children showed oculomotility problems based on the DEM and Visagraph results. Whereas J.H. performed well on the visual-perceptual profile overall, A.T. showed problems in many areas such as reversals, visual spatial relations, visual sequential memory, visual form constancy, and attention. Both children were low hyperopes and showed positive postural and balance changes when tested with yoked prisms. CONCLUSIONS: Children with sensory integration dysfunction can have a number of signs and
symptoms that may bring them to the optometrist's office. It is important to thoroughly test their visual, perceptual, and oculomotor systems to determine the best way to help these patients. The use of vision therapy and yoked prisms can be beneficial treatment options for many of these patients.


Background. A subgroup of persons with anorexia nervosa (AN) have been proposed to have sociocommunicative problems corresponding to autism spectrum disorders [ASDs, i.e. DSM-IV pervasive developmental disorders (PDDs): autistic disorder, Asperger’s disorder, PDD not otherwise specified (NOS)]. Here, clinical problems, personality traits, cognitive test results and outcome are compared across 16 subjects (32%) with teenage-onset AN who meet or have met ASD criteria (AN+ASD), 34 ASD-negative AN subjects and matched controls from a longitudinal Swedish study including four waves of independent assessments from the teens to the early thirties. Method. The fourth wave included the Structured Clinical Interview for DSM-IV (SCID)-I and the SCID-II (cluster C, i.e. ‘anxious’ PDs) interviews, the Asperger Syndrome Diagnostic Interview, self-assessments by the Autism Spectrum Quotient and the Temperament and Character Inventory, neurocognitive tests by subscales from the Wechsler scales, continuous performance tests, Tower of London, and Happe’s cartoons. Results. The ASD assessments had substantial inter-rater reliability over time (Cohen’s k between 0.70 and 0.80 with previous assessments), even if only six subjects had been assigned a diagnosis of an ASD in all four waves of the study, including retrospective assessments of pre-AN neurodevelopmental problems. The AN+ASD group had the highest prevalence of personality disorders and the lowest Morgan–Russell scores. The non-ASD AN group also differed significantly from controls on personality traits related to poor interpersonal functioning and on neurocognitive tests. Conclusions. A subgroup of subjects with AN meet criteria for ASDs. They may represent the extreme of neurocognitive and personality problems to be found more generally in AN.


OBJECTIVE: To evaluate children with obstructive sleep apnea syndrome (OSAS) for features of attention deficit disorder (ADD) using an objective test of inattention and impulsivity: Test of Variables of Attention (TOVA) and then to determine whether tonsillectomy and adenoidectomy (T+A) results in an improvement in TOVA scores. STUDY DESIGN AND SETTING: This study was a prospective interventional comparative trial in a tertiary care children's hospital. Nineteen children ages 5 to 14 years with OSAS, and otherwise healthy, with a clinical indication for T+A. Preoperative and 2 months postoperative OSA-18, CBCL questionnaires, and TOVA scores were evaluated. RESULTS: The preoperative TOVA scores were in the abnormal range in 12/19 (63%) of the children. The mean preoperative TOVA score was -2.9 (+/- 3.1). The mean postoperative TOVA score was -0.4 (+/-2.8). The improvement in the TOVA scores was significant ( P < 0.0001, t -test). CONCLUSION: This preliminary data suggests that treatment of OSAS with T+A results in significant improvement in objective parameters of inattention and impulsivity. Significance These findings may be important in understanding the impact of OSAS and therapeutic interventions on behavioral problems in children.


PURPOSE: To determine the effects of dehydration (DEH) on attentional vigilance in male basketball players. METHODS: The Test of Variables of Attention (TOVA; Universal Attention Disorders) was
administered to 11 male basketball players (17-28 yr) at baseline (test 1), after walking (50% V O2max) in the heat (40 degrees C and 20% relative humidity) (test 2), and then after a simulated basketball game (test 3). Tests 2 and 3 were performed while subjects were either DEH (1-4%) or euhydrated (EUH). The TOVA consisted of target-infrequent and target-frequent conditions, simulating static and dynamic (such as a basketball game) environments, respectively. TOVA measures included errors of omission (OE) and commission (CE), response time (RT), and sensitivity. RESULTS: During the target-infrequent half of test 3, EUH resulted in significantly better sensitivity (+0.4+/–1.2 vs -0.9+/–1.3), faster RT (-6+/–20 vs +16+/–28), and fewer OE (-0.4+/–0.7 vs +1.3+/–2.4) compared with DEH. During the target-frequent half, EUH resulted in significantly fewer OE (-4+/–15 vs +5+/–7) and CE (-1.9+/–3.2 vs 0.6+/–1.4) in test 2 and greater sensitivity (+0.7+/–2.6 vs -0.7+/–1.1) and faster RT (-21+/–28 vs +5+/–31) than DEH in test 3. CONCLUSION: Vigilance-related attention of male basketball players was impaired by DEH, especially during the target-frequent condition of the TOVA. These results suggest that fluid replacement is essential to prevent the decline in vigilance that occurs with DEH in highly dynamic environments. Therefore, basketball players should be advised to maintain EUH for optimal concentration and attentional skills during competition.


The present study estimates the longitudinal effects of prenatal cocaine exposure on indicators of sustained attention processing at 3, 5 and 7 years of age in an urban sample of full-term African-American children (235 cocaine-exposed, 207 noncocaine-exposed). The sample was enrolled prospectively at birth, with documentation of prenatal drug exposure status through maternal interview, urine and meconium toxicology assays. Sustained attention was measured at age 3 years using a standardized measure of task persistence during a challenging task [G.A. Morgan, N.A. Busch-Rossnagel, C.A. Maslin-Cole and R.J. Harmon, Individualized Assessment of Mastery Motivation: Manual for 15-36 Month Old Children, 1992.], and at ages 5 and 7 years using omission error scores from computerized continuous performance tasks (CPT) [L. Greenberg, R. Leark, T. Dupuy, C. Corman, C. Kindschi, M. Cenedela, Test of Variables of Attention (T.O.V.A. and T.O.V.A.-A.), 22, Universal Attention Disorders, Los Alamitos, CA, 1996; C.K. Conners, Conners’ Continuous Performance Test (CPT), second ed., Multi-Health Systems, Canada, 1995.]. Findings from longitudinal GLM/GEE analyses of the three measured time points support a stable influence of prenatal cocaine exposure on indicators of sustained attention, after controlling for prenatal exposure to alcohol, marijuana, tobacco and over 20 additional medical and social-demographic covariates drawn from potentially confounding influences assessed at birth and later assessment visits (D=0.21; 95% CI=0.04, 0.38; P=.017). This effect was not mediated by fetal growth or gestational age and remained highly stable with increasing levels of covariate control. Separately, using the age 7 data, a structural equations model (SEM) was constructed combining all available self-report and bioassay data to measure magnitude of cocaine exposure in relationship to attention task performance. Results indicated a gradient of influence, with each standard deviation increase in the level of prenatal cocaine exposure relating to a 16% standard deviation increase in omission error scores at age 7. Overall findings support a stable cocaine-specific effect on indicators of sustained attention processing during the early childhood years. Results are discussed within the context of neurobiological and behavioral research linking prenatal cocaine exposure to long-lasting disruption of the brain systems subserving arousal and attention.

Cerebral malaria affects >785000 African children every year. We previously documented an increased frequency of cognitive impairment in children with cerebral malaria 6 months after their initial malaria episode. This study was conducted to determine the long-term effects of cerebral malaria on the cognitive function of these children. Children who were 5 to 12 years of age and presented to Mulago Hospital, Kampala, Uganda, with cerebral malaria (n = 44) or uncomplicated malaria (n = 54), along with healthy, asymptomatic community children (n = 89), were enrolled in a prospective cohort study of cognition. Cognitive testing was performed at enrollment and 2 years later. The primary outcome was presence of a deficit in ≥1 of 3 cognitive areas tested. At 2-year follow-up testing, 26.3% of children with cerebral malaria and 12.5% with uncomplicated malaria had cognitive deficits in ≥1 area, as compared with 7.6% of community children. Deficits in children with cerebral malaria were primarily in the area of attention (cerebral malaria, 18.4%, vs community children, 2.5%). After adjustment for age, gender, nutrition, home environment, and school level, children with cerebral malaria had a 3.67-fold increased risk for a cognitive deficit compared with community children. Cognitive impairment at 2-year follow-up was associated with hyporeflexia on admission and neurologic deficits 3 months after discharge. Cerebral malaria is associated with long-term cognitive impairments in 1 of 4 child survivors. Future studies should investigate the mechanisms involved so as to develop interventions aimed at prevention and rehabilitation.


Background: Several interventions to improve cognition in at risk children have been suggested. Identification of key variables predicting cognition is necessary to guide these interventions. This study was conducted to identify these variables in Ugandan children and guide such interventions. Methods: A cohort of 89 healthy children (45 females) aged 5 to 12 years old were followed over 24 months and had cognitive tests measuring visual spatial processing, memory, attention and spatial learning administered at baseline, 6 months and 24 months. Nutritional status, child’s educational level, maternal education, socioeconomic status and quality of the home environment were also measured at baseline. A multivariate, longitudinal model was then used to identify predictors of cognition over the 24 months. Results: A higher child’s education level was associated with better memory (p=0.03), attention (p=0.005) and spatial learning scores over the 24 months (p = 0.05); higher nutrition scores predicted better visual spatial processing (p = 0.002) and spatial learning scores (p = 0.008); and a higher home environment score predicted a better memory score (p = 0.03). Conclusion: Cognition in Ugandan children is predicted by child’s education, nutritional status and the home environment. Community interventions to improve cognition may be effective if they target multiple socioeconomic variables.


Background: The contribution of different cognitive abilities to academic performance in children surviving cerebral insult can guide the choice of interventions to improve cognitive and academic outcomes. This study’s objective was to identify which cognitive abilities are associated with academic performance in children after malaria with neurological involvement. Methods: 62 Ugandan children with a history of malaria with neurological involvement were assessed for cognitive ability (working memory, reasoning, learning, visual spatial skills, attention) and academic performance (reading, spelling, arithmetic) three months after the illness. Linear regressions were fit for each academic score with the five cognitive outcomes entered as predictors. Adjusters in the analysis were age, sex, education, nutrition, and home environment. Exploratory factor analysis (EFA) and structural equation models (SEM) were used to determine the nature of the association between cognition and academic performance. Predictive residual sum of squares was used to determine which combination of cognitive scores was needed to
predict academic performance. Results: In regressions of a single academic score on all five cognitive outcomes and adjusters, only Working Memory was associated with Reading (coefficient estimate = 0.36, 95% confidence interval = 0.10 to 0.63, p = 0.01) and Spelling (0.46, 0.13 to 0.78, p = 0.01), Visual Spatial Skills was associated with Arithmetic (0.15, 0.03 to 0.26, p = 0.05), and Learning was associated with Reading (0.06, 0.00 to 0.11, p = 0.05). One latent cognitive factor was identified using EFA. The SEM found a strong association between this latent cognitive ability and each academic performance measure (P < 0.0001). Working memory, visual spatial ability and learning were the best predictors of academic performance. Conclusion: Academic performance is strongly associated with the latent variable labelled “cognitive ability” which captures most of the variation in the individual specific cognitive outcome measures. Working memory, visual spatial skills, and learning together stood out as the best combination to predict academic performance.


Malaria is a leading cause of ill health and neuro­disability in children in sub-Saharan Africa. Impaired cognition is a common outcome of malaria with neurological involvement. There is also a possibility that academic achievement may be affected by malaria with neurological involvement given the association between cognitive ability and academic achievement. This study investigated the effect of malaria with neurological involvement on cognitive ability, behaviour and academic achievement. This prospective case-control study was carried out in Kampala City, Uganda between February 2008 and October 2010. Sixty-two children with a history of malaria with neurological involvement were followed up and given assessments for cognitive ability (working memory, reasoning, learning, visual spatial skills and attention), behaviour (internalizing and externalizing problems) and academic achievement (arithmetic, spelling and reading) three months after the illness. Sixty-one community controls recruited from the homes or neighbouring families of the cases were also given the same assessments. Tests scores of the two groups were compared using analysis of covariance with age, sex, level of education, nutritional status and quality of the home environment as covariates. This study was approved by the relevant ethical bodies and informed consent sought from the caregivers. Children in the malaria group had more behavioural problems than the community controls for internalizing problems (estimated mean difference = -3.71, 95% confidence interval (CI), = -6.34 to -1.08, p = 0.007). There was marginal evidence of lower attention scores (0.40, CI = -0.05 to 0.86, p = 0.09). However, excluding one child from the analyses who was unable to perform the tests affected the attention scores to borderline significance (0.32, CI = 0.01 to 0.62, p = 0.05). No significant differences were observed in other cognitive abilities or in academic achievement scores. Malaria with neurological involvement affects behaviour, with a minimal effect on attention but no detectable effect on academic achievement at three months post discharge. This study provides evidence that development of cognitive deficits after malaria with neurological involvement could be gradual with less effect observed in the short term compared to the long term.


Background CogState is a widely used computer-based cognitive test whose validity has not been addressed in resource poor settings. We examined the construct, concurrent and convergent validity of CogState, test-retest reliability and the effect of sociodemographic variables on CogState outcomes in school age children. Methods Two hundred and thirty Ugandan children (54% male) with mean age 6.99 years (SD = 1.67, range 5-13?years) were assessed using CogState, the Kaufman Assessment Battery for Children, 2nd edition (KABC-II) and the Test of Variables of Attention (TOVA) at baseline and 8?weeks later. Correlations were run between CogState and the KABC-II and TOVA to evaluate its concurrent and convergent validity. Factor analysis was used to evaluate construct validity of CogState.
Correlations between baseline and 8-weeks CogState scores were used to determine the test-retest reliability while general linear models were used to assess associations with sociodemographic factors. Results: Significant correlations were observed between CogState’s One Card Learning, One Back Memory and Card Detection with the TOVA and between CogState’s Maze Chase and One Back Memory with KABC-II’s Simultaneous Processing. CogState had a three-factor structure with Processing Speed, Processing Accuracy and Maze Chase and Maze Learning. CogState had low to moderate test-retest reliability in Ugandan children with correlations ranging from 0.32 to 0.57. Age, sex and education were associated with CogState outcomes. Conclusions: CogState is a valid and reliable test battery for rapid computer-based neurocognitive assessment in Ugandan children and can thus be used in this cultural context.


OBJECTIVE: The purpose of this investigation was to study the acute effects of caffeine on learning, performance, and anxiety in normal prepubertal children. METHOD: Twenty-one children were evaluated in a double-blind, placebo-controlled crossover design. Subjects were studied during four sessions, 1 week apart, under the following conditions: baseline, placebo, 2.5 mg/kg caffeine, and 5.0 mg/kg caffeine. Subjects were randomized to order of placebo and the two dosages of caffeine. Dependent measures included tests of attention, manual dexterity, short-term memory, and processing speed. Anxiety rating scales were also administered. Saliva samples were analyzed for caffeine levels. RESULTS: Caffeine improved performance on two of four measures of the Test of Variables of Attention and on a test of manual dexterity in the dominant hand. There was a trend toward increased current level of self-reported anxiety after caffeine on a visual analogue measure of anxiety. Children reported feeling significantly less “sluggish” after caffeine ingestion than after placebo ingestion. CONCLUSIONS: In a small sample size, there was indication that caffeine enhanced performance on a test of attention and on a motor task. Children also reported feeling less “sluggish” but somewhat more anxious. Because caffeine is so widely available and frequently consumed by children, these results are important and need replication.


OBJECTIVE: Caffeine is widely consumed by children around the world. The purpose of this study was to determine whether children manifest withdrawal effects after cessation of caffeine intake. METHOD: Thirty normal children completed the single-blind, within-subjects, repeated-measures study with weekly sessions. Subjects were tested four times: (1) baseline (on regular caffeine diet); (2) on caffeine (approximately 120 to 145 mg/day); (3) during withdrawal (24 hours after discontinuation of caffeine taken for 13 consecutive days); and (4) at return to baseline. Subjects were evaluated with self-report measures of symptoms and objective measures of attention, motor performance, processing speed, and memory. RESULTS: During caffeine withdrawal, there was a significant deterioration on response time of a visual continuous performance test of attention. This finding is consistent with caffeine withdrawal. The deterioration in response time appeared to persist for 1 week. CONCLUSIONS: Twenty-four hours after children discontinued caffeine, there was a decrease in performance on reaction time of a task requiring sustained attention. Further work is indicated to determine whether children manifest caffeine withdrawal effects after cessation of caffeine intake.

This present article provides a case study showing the application of neurofeedback and biofeedback training with heart rate variability (HRV) training to a 27-year-old man, Mike, who suffered a severe traumatic brain injury (TBI) in a motor vehicle accident. The study demonstrates the use of single-site neurofeedback training, metacognitive strategies, and low-resolution brain electromagnetic tomography (LORETA) z-score training along with HRV. A review of the initial assessment and subsequent progress updates included an examination of continuous performance tests, such as test of variables of attention, integrated visual and auditory continuous performance test, and single-channel electroencephalography results, HRV statistics, and 19-channel quantitative electroencephalogram results. The client demonstrated significant improvements on all measures posttraining with marked improvement in five areas: memory, sleep and energy level, academics, mood and irritability, and mental sharpness. Working with clients such as Mike supports the view that one- and two-channel neurofeedback and LORETA z-score neurofeedback, combined with HRV training, are promising interventions for clients with TBIs.


Recent literature has emphasized the need to examine executive functions (EF) in children using multiple sources, including both parent rating and performance-based measures. Computerized Go/No-Go tests, including commercially available continuous performance tests (CPTs), represent one of the most commonly used methods of assessing inhibitory control - a variable central to the executive function construct. We examined the relationship between parent ratings of inhibitory control and CPT performance in two mixed clinical samples. Experiment 1 examined 109 children ages 6-18 using the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) and the Conners' CPT-II (Conners, 2000). In this sample, ratings on the BRIEF Inhibit scale (mean T-score = 62.3) were significantly higher than the CPT-II commissions score (mean T-score = 50.7; p < .0001); and the BRIEF and CPT-II scores were not highly correlated (r = -.12). Experiment 2 examined a sample of 131 children ages 7-18 using the BRIEF and the Tests of Variables of Attention (TOVA; Greenberg, 1996). In this sample, parent ratings on the BRIEF Inhibit scale (mean T-score = 56.8) were similar to TOVA commissions scores (mean T-score = 58.6; p = .33), although still poorly correlated (r = -.02). Factor analyses exploring covariance between BRIEF scales CPT-II variables (Experiment 1) and between BRIEF and TOVA (Experiment 2) yielded similar findings. In both experiments, all eight BRIEF scales loaded on a single factor, with no overlap with either the CPT-II or the TOVA. In mixed outpatient clinical samples, the BRIEF appears to measure different elements of inhibitory control than those assessed by computerized continuous performance tests.


The emergence of the sociocultural perspective in cross-cultural psychology has discouraged the adaptation of standardized tests in nonindustrialized settings. Yet, cognitive assessments are needed for monitoring the effects of nutritional, health, and educational interventions. Forty-seven Lao children 5 to 12 years of age completed the Kaufman Assessment Battery for Children (K-ABC), the Tactual Performance Test (TPT), and the computerized Tests of Variables of Attention (TOVA). TPT performance measures were related to physical (nutritional) development, whereas the K-ABC global cognitive ability indicators were sensitive to parental education and quality of home environment. TOVA performance was related to K-ABC global performance and TPT memory, suggesting that these measures are at least partially undergirded by attentional ability. Sociocultural concerns aside, these findings suggest that validated neuropsychological and cognitive assessments can be adapted that effectively tap basic and universal brain–behavior traits.
BACKGROUND: HIV-subtype D is associated with more rapid disease progression and higher rates of dementia in Ugandan adults compared with HIV-subtype A. There are no data comparing neuropsychological function by HIV subtype in Ugandan children. DESIGN: One hundred and two HIV-infected antiretroviral therapy (ART) naive Ugandan children 6-12 years old (mean 8.9) completed the Kaufman Assessment Battery for Children, second edition (KABC-2), the Test of Variables of Attention (TOVA), and the Bruininks-Oseretsky Test for Motor Proficiency, second edition (BOT-2). Using a PCR-based multiregion assay with probe hybridization in five different regions (gag, pol, vpu, env, gp-41), HIV subtype was defined by hybridization in env and by total using two or more regions. Analysis of covariance was used for multivariate comparison.

RESULTS: The env subtype was determined in 54 (37 A, 16 D, 1 C) children. Subtype A and D groups were comparable by demographics, CD4 status, and WHO stage. Subtype A infections had higher log viral loads (median 5.0 vs. 4.6, P = 0.02). Children with A performed more poorly than those with D on all measures, especially on KABC-2 Sequential Processing (memory) (P = 0.01), Simultaneous Processing (visual-spatial analysis) (P = 0.005), Learning (P = 0.02), and TOVA visual attention (P = 0.04). When adjusted for viral load, Sequential and Simultaneous Processing remained significantly different. Results were similar comparing by total HIV subtype. CONCLUSION: HIV subtype A children demonstrated poorer neurocognitive performance than those with HIV subtype D. Subtype-specific neurocognitive deficits may reflect age-related differences in the neuropathogenesis of HIV. This may have important implications for when to initiate ART and the selection of drugs with greater central nervous system penetration.


Twenty-nine Senegalese children with a history of cerebral malaria (CM) performed more poorly on the Kaufman Assessment Battery for Children (K-ABC) Simultaneous Processing domain and on the Test of Variables of Attention (TOVA) attention capacity indicators in comparison with a matched control group. Thus, CM can disrupt neuropsychological integration during critical developmental periods, impacting on global neurological integrity, attentional vigilance, perceptual acuity, and subsequent development of visual-spatial processing and memory foundational to global cognitive ability. A subsequent structural equation model confirmed that rural children are at greater risk for CM, subsequent attention deficits, and other developmental risk factors in addition to the CM impact on K-ABC performance. We document CM as one of a host of developmental risk factors within the complex web of poverty in sub-Saharan Africa, which limit children's ability to achieve their full intellectual potential and, thus, extend the human cost of the disease beyond general measures of mortality and morbidity.


OBJECTIVE—This study was conducted to assess prospectively the frequency of cognitive deficits in children with cerebral malaria. METHODS—Cognitive testing in the areas of working memory, attention, and learning was performed for Ugandan children 5 to 12 years of age with cerebral malaria (n = 44), children with uncomplicated malaria (n = 54), and healthy community children (n = 89) at admission and 3 and 6 months later. RESULTS—Six months after discharge, 21.4% of children with cerebral malaria had cognitive deficits, compared with 5.8% of community children. Deficits were seen in the areas of
working memory (11.9% vs 2.3%) and attention (16.7% vs 2.3%). Children with cerebral malaria had a 3.7-fold increased risk of a cognitive deficit, compared with community children, after adjustment for age, gender, nutritional status, school level, and home environment. Among children with cerebral malaria, those with a cognitive deficit had more seizures before admission (mean: 4.1 vs 2.2) and a longer duration of coma (43.6 vs 30.5 hours), compared with those without a deficit. Children with uncomplicated malaria did not have an increased frequency of cognitive deficits.

CONCLUSIONS—Cerebral malaria may be a major cause of cognitive impairment in children in sub-Saharan Africa. Cognitive deficits in children with cerebral malaria are more likely for those who have multiple seizures before effective treatment for cerebral malaria.


BACKGROUND: Using the Kaufman Assessment Battery for Children (K-ABC) Conant et al. (1999) observed that visual and auditory working memory (WM) span were independent in both younger and older children from DR Congo, but related in older American children and in Lao children. The present study evaluated whether visual and auditory WM span were independent in Ugandan and Senegalese children. METHOD: In a linear regression analysis we used visual (Spatial Memory, Hand Movements) and auditory (Number Recall) WM along with education and physical development (weight/height) as predictors. The predicted variable in this analysis was Word Order, which is a verbal memory task that has both visual and auditory memory components. RESULTS: Both the younger (8.5 yrs) Ugandan children had auditory memory span (Number Recall) that was strongly predictive of Word Order performance. For both the younger and older groups of Senegalese children, only visual WM span (Spatial Memory) was strongly predictive of Word Order. Number Recall was not significantly predictive of Word Order in either age group. CONCLUSIONS: It is possible that greater literacy from more schooling for the Ugandan age groups mediated their greater degree of interdependence between auditory and verbal WM. Our findings support those of Conant et al., who observed in their cross-cultural comparisons that stronger education seemed to enhance the dominance of the phonological-auditory processing loop for WM.


ABSTRACT Background. A group of 27 patients with brain injury were treated by electroencephalographic (EEG) NeuroBioFeedback under drug-free conditions. They were studied for distribution in classes of major syndromes for evaluation of treatment efficiency and rehabilitation rates with respect to associated EEG and other physiological changes. Methods. A total of 48 clinical symptoms were listed, each present in at least one patient. Classes of clinical signs have been computed using both medical and statistical criteria. Claimed and presented chief complaints, secondary complaints and all associated signs were incorporated in multivariate analysis. Results. Substantial intersection of medical and statistical distributions was observed. This provided a classification of symptoms into six classes representing the following syndromes of impaired functions: Q1 = motor; Q2 = language; Q3 = cognitive; Q4 = psychosocial; Q5 = pain-related; Q6(a & b) = neuropsychiatric; Q7 = metabolic. Membership of a patient in a defined clinical class was based on a numerical index computed from: (a) a weighted coefficient for the patient's chief and secondary complaints, and (b) an index for both symptoms represented in the class and symptoms not represented in the class. Patients were unambiguously distributed in all classes except Q7. Conclusions. Using anon-selected group of head injured patients, this work provides a rationale for the membership of each patient in a set of classes of syndromes determined by the whole set of clinical signs specifically exhibited by this group of patients. Class-average rehabilitation rates ranged from 59% up to 87% following an average 23 to 132 treatment sessions, depending on syndromes.

Six middle school students diagnosed with attention deficit/hyperactivity disorder were selected for sensorimotor rhythm (SMR) training with EEG biofeedback. The subjects were evaluated following a 72-hour drug-free period with the WISC-III Digit Span subtest and the Test of Variables of Attention (TOVA). Five of the subjects received 20 sessions of EEG biofeedback and one of the subjects received nine sessions of EEG biofeedback. The subjects were evaluated again following a 72-hour drug-free period. Five of the six subjects improved on their combined Digit Span, TOVA Inattention, and TOVA Impulsivity scores. These results supported previous findings that EEG biofeedback can be effective in the treatment of attention deficit/hyperactivity disorder. More importantly, this study demonstrated that EEG biofeedback could be used in an actual school setting. Recommendations for implementing an EEG biofeedback program in the schools were provided.


This paper sheds light on a hidden epidemic that is the precursor to widespread disease: mild-moderate cognitive impairment (MCI). Although it is commonly considered to be a consequence of the normal aging process, cognitive decline frequently begins as early as 30, starting with a slowing of processing speed that then affects memory and attention, and leads to numerous diseases including obesity and depression. Decades pass in this impaired state before the patient experiences the first clinical symptoms of dementia. The Brain Evaluation and Assessment Method (BEAM) for diagnosing cognitive impairment will be introduced, along with a new paradigm for “dementia” and how it develops. Potential methods for diagnosing, preventing, and reversing cognitive decline and the myriad diseases associated with it will be discussed.


Fluorodeoxyglucose (FDG) Positron Emission Topography (PET) brain hypometabolism (HM) correlates with diminished cognitive capacity and risk of developing dementia. However, because clinical utility of PET is limited by cost, we sought to determine whether a less costly electrophysiological measure, the P300 evoked potential, in combination with neuropsychological test performance, would validate PET HM in neuropsychiatric patients. We found that patients with amnestic and non-amnestic cognitive impairment and HM (n=43) evidenced significantly reduced P300 amplitudes, delayed latencies, and neuropsychological deficits, compared to patients with normal brain metabolism (NM; n = 187). Data from patients with missing cognitive test scores (n=57) were removed from the final sample, and logistic regression modeling was performed on the modified sample (n = 173, p = .000004). The logistic regression modeling, based on P300 and neuropsychological measures, was used to validate membership in the HM vs. NM groups. It showed classification validation in 13/25 HM subjects (52.0%) and in 125/148 NM subjects (84.5%), correlating with total classification accuracy of 79.8%. In this paper, abnormal P300 evoked potentials coupled with cognitive test impairment validates brain metabolism and mild/moderate cognitive impairment (MCI). To this end, we cautiously propose incorporating electrophysiological and neuropsychological assessments as cost-effective brain metabolism and MCI indicators in primary care. Final interpretation of these results must await required additional studies confirming these interesting results.

The goal of this study was to determine if impairments detected by the test of variables of attention (TOVA) may be used to predict early attention complaints and memory impairments accurately in a clinical setting. We performed a statistical analysis of outcomes in a patient population screened for attention deficit hyperactivity disorder or attention complaints, processing errors as measured by TOVA and the Wechsler Memory Scale (WMS-III) results. Attention deficit disorder (ADD) checklists, constructed using the Diagnostic and Statistical Manual of Mental Disorders 4th Edition criteria, which were completed by patients at PATH Medical, revealed that 72.8% of the patients had more than one attention complaint out of a total of 16 complaints, and 41.5% had more than five complaints. For the 128 males with a significant number of ADD complaints, individuals whose scores were significantly deviant or borderline (SDB) on TOVA, had a significantly greater number of attention complaints compared with normals for omissions (P < 0.02), response time (P < 0.015), and variability (P < 0.005), but not commissions (P > 0.50). For males, the mean scores for auditory, visual, immediate, and working memory scores as measured by the WMS-III were significantly greater for normals versus SDBs on the TOVA substest, ie, omission (P < 0.01) and response time (P < 0.05), but not variability or commissions. The means for auditory, visual, and immediate memory scores were significantly greater for normals versus SDBs for variability (P < 0.045) only. In females, the mean scores for visual and working memory scores were significantly greater for normals versus SDBs for omissions (P < 0.025). The number of SDB TOVA quarters was a significant predictor for “impaired” or “normal” group membership for visual memory (P < 0.015), but not for the other three WMS-III components. For males, the partial correlation between the number of attention complaints and the number of SDB TOVA quarters was also significant (r = 0.251, P < 0.005). For the 152 females with a significant number of attention complaints, no significant differences between SDBs and normals were observed (P > 0.15). This is the first report, to our knowledge, which provides evidence that TOVA is an accurate predictor of early attention complaints and memory impairments in a clinical setting. This finding is more robust for males than for females between the ages of 40 and 90 years.


A review of the literature in both animals and humans reveals that changes in sex hormone have often been associated with changes in behavioral and mental abilities. Previously published research from our laboratory, and others, provides strong evidence that P300 (latency) event-related potential (ERP), a marker of neuronal processing speed, is an accurate predictor of early memory impairment in both males and females across a wide age range. It is our hypothesis, given the vast literature on the subject, that coupling growth hormones (insulin-like growth factor-I, IGF-I) and insulin-like growth factor binding protein 3 (IGF-BP3)), P300 event-related potential and test of variables of attention (TOVA) are important neuroendocrinological predictors of early cognitive decline in a clinical setting. To support this hypothesis, we utilized structural equation modeling (SEM) parameter estimates to determine the relationship between aging and memory, as mediated by growth hormone (GH) levels (indirectly measured through the insulin-like growth factor system), P300 latency and TOVA, putative neurocognitive predictors tested in this study. An SEM was developed hypothesizing a causal directive path, leading from age to memory, mediated by IGF-1 and IGF-BP3, P300 latency (speed), and TOVA decrements. An increase in age was accompanied by a decrease in IGF-1 and IGF-BP3, an increase in P300 latency, a prolongation in TOVA
response time, and a decrease in memory functioning. Moreover, independent of age, decreases in IGF-1 and IGF-BP3, were accompanied by increases in P300 latency, and were accompanied by increases in TOVA response time. Finally, increases in P300 latency were accompanied by decreased memory function, both directly and indirectly through mediation of TOVA response time. In summary, this is the first report utilizing SEM to reveal the finding that aging affects memory function negatively through mediation of decreased IGF-1 and IGF-BP3, and increased P300 latency (delayed attention and processing speed).


Delayed P300 latency identifies dementia better than the Mini-Mental Status Exam and, in some cases, the Wechsler Memory Scale (WMS-III). The purpose of this study was to determine whether the outcome of an objective Test of Variables of Attention (TOVA) correlates with the findings of an electrophysiologic test—P300 latency—in patients 40 y of age or older. Adult attention deficit disorder may be an important premorbid marker of memory dysfunction or dementia. In males, the means for P300 latency and age-adjusted P300 latency were significantly greater for patients classified as SD-BL (significantly deviant or borderline: TOVA<-1.0) than for those categorized as normal (TOVA≥0) for attention failure (ie, omissions [P<.010] and commissions [P<.005]) but not for response time or for variability. Males with >2 SD-BL quarters had significantly delayed P300 latency and age-adjusted P300 latency compared with males who had 0 SD-BL quarters (P<.020) and 1 SD-BL quarter (P<.005). In females, the means for P300 latency and age-adjusted P300 latency were significantly delayed for those grouped as SD-BL than for those labeled normal for response time (P<.001) and variability (P<.010), but not for omissions or for commissions. Females with >2 SD-BL quarters had significantly delayed P300 latency and age-adjusted P300 latency compared with females who had 0 SD-BL quarters (P<.005) and 1 SD-BL quarter (P<.010). Results suggest that TOVA abnormalities may be an indicator of delayed P300 and attention disorder. Recent research correlates TOVA abnormalities with impaired WMS scores of early dementia. Coupling of TOVA assessment findings with results of P300, Mini-Mental Status Exam, and WMS-III may allow for enhanced accuracy in the diagnosis and evaluation of the complex pathway of failing attention, memory, and cognition that leads to dementia.


The relationship between 27 different measures of hyperactive, impulsive, and inattentive behavior, including those considered to be more objective and those considered more influenced by social factors, is examined using a normal sample of 219 Mexican children, ages 6 to 12. Measures were based on activity monitoring by accelerometry, ethological observation of attentional and movements states in the classroom, cognitive testing using the TOVA continuous performance test (CPT), and parents' and teachers' reports on ratings scales and symptom checklists. Factor analysis was used to examine to what degree these different measures are reporting similar underlying constructs (factors) of hyperactivity and inattention. Parent and teacher ratings appear to be describing underlying constructs that are distinct from those described by the other measures, but measures based on CPT, observation, and activity monitoring did not factor together either, nor more highly correlate to each other. Analysis combining all the measures showed that parent and teacher ratings factored together based on who was reporting the behavior, rather than the behavior being reported. The findings underscore that each type of measurement of hyperactivity, impulsivity, and inattention measures a different aspect of a complex behavioral phenomenon, rather than some better measuring than others the same underlying factor.

The maturation lag model explains inattention and impulsivity in Attention Deficit Hyperactivity Disorder (ADHD) as delayed maturation along a normal developmental trajectory. The concept of a cross-culturally uniform developmental trajectory is tested by a comparison of the performance of 212 Mexican school children on the Test of Variable Attention (TOVA) with the performance of populations previously studied. An observed pattern of decreasing errors of omission (indicating improving ability to sustain attention) with increasing age did confirm the predictions of the existing developmental trajectory model, although the shape of this change was linear rather than curvilinear. A predicted age-related decrease in errors of commission (indicating improving impulse control) was not observed. Gender differences in attentional and impulse control measures among Mexican children, aged 6–12 years, were not significant, in contrast to the findings of previous US studies in which boys performed poorly compared with girls. Mexican children made significantly more errors of omission and commission than American children, indicating greater degrees of characteristic inattentive and impulsive behaviours in childhood. These results indicate that the assumption of a uniform developmental trajectory of these behaviours should be carefully considered before it is applied to understanding children’s behaviour in culturally diverse settings.


Attention Deficit Hyperactivity Disorder (ADHD) has often been conceptualized as arising executive dysfunctions (e.g., inattention, defective inhibition). However, recent studies suggested that cognitive inefficiency may underlie many {ADHD} symptoms, according to reaction time and processing speed abnormalities. This study explored whether a non-timed measure of cognitive inefficiency would also be abnormal. A sample of 23 {ADHD} subjects was compared to 23 controls on a test that included both egocentric and allocentric visual memory subtests. A factor analysis was used to determine which cognitive variables contributed to allocentric visual memory. The {ADHD} sample performed significantly lower on the allocentric but not egocentric conditions. Allocentric visual memory was not associated with timed, working memory, visual perception, or mental rotation variables. This paper concluded by discussing how these results supported a cognitive inefficiency explanation for some {ADHD} symptoms, and discussed future research directions.


This study compared the psychomotor performance and driving ability of patients with chronic pain managed with stable regimens of opioid analgesics with that of normal healthy volunteers. The hypothesis was that patients with chronic pain on stable opioid analgesic regimens operate their automobiles safely with proficiency equal to normal volunteer controls. Patients were evaluated for errors while driving their own automobile through a predetermined route in the community, including variable residential and highway conditions, and for speed and accuracy on repeated trials through a 5-station obstacle course that evaluated forward and reverse driving, turning, and parallel parking. Patients also completed the Test of Variables of Attention and the Digit Symbol Substitution Test. No significant differences were observed among groups in driving performance in the community and on the obstacle course or on the Test of Variables of Attention. Results on dependent measures within the opioid group generally were not correlated with morphine equivalent daily opioid doses, which averaged 118 mg
(median 40 mg). Many patients with chronic pain, even if treated with potent analgesics such as morphine and hydromorphone, show comparable driving ability as normals.


We investigated the relationship of serum nitric oxide (NO) and asymmetrical dimethylarginine (ADMA) levels with cognitive functioning in patients with major depressive disorder (MDD). 41 MDD patients (Beck depression scale scores>16) and 44 controls were included in the study. Rey verbal learning and memory test, auditory consonant trigram test, digit span test, Wisconsin card sorting test, continuous performance task (TOVA), and Stroop test scores were found to be impaired in patients with major depressive disorder when compared to healthy controls. There was no significant difference between patient and control groups in terms of serum NO and ADMA. Serum NO levels were correlated with TOVA test error scores and Stroop test time scores, whereas serum ADMA levels were negatively correlated with TOVA test error scores. Metabolic detriments especially in relation to NO metabolism in frontal cortex and hypothalamus, psychomotor retardation, or loss of motivation may explain these deficits.


Introduction: EEG biofeedback was conducted on site in an elementary school. Method: An experimental group of eight children ages 8-10 completed 35-47 sessions of EEG biofeedback training over a six-month period. Four participants in the experimental group were diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) and four were not diagnosed with ADHD. Eight children in the waitlist control group were matched to the experimental group on age, grade, teacher, and diagnosis. None of the 16 participants were medicated for ADHD. Results: Attention abilities as measured by the Test of Variables of Attention showed the experimental group of children with ADHD reduced errors of commission and anticipation, indicating a reduction in impulsivity. Teacher reports using the McCarney Scale indicated improvements in attention but no changes in impulsivity and hyperactivity. Discussion: Several confounds require exploration before attribution of changes are assigned to neurofeedback. Whether the effects are due to the neurofeedback protocols, attendance at individual sessions away from the classroom, the attention of the technician, or the excitement of a special program cannot be determined with this study. It will be necessary to have a placebo group in order to separate systematically the variables in the training program.


Fibromyalgia (FMS) is a chronic, painful disorder often associated with measurable deficiencies in attention. Since EEG biofeedback (EEG-BF) has been used successfully to treat attention problems, we reasoned that this modality might be helpful in the treatment of attention problems in FMS. We also speculated that improvement in central nervous system (CNS) function might be accompanied by improvement in FMS somatic symptoms. We studied fifteen FMS patients with attention problems, demonstrated by visual and auditory continuous performance testing (CPT), while completing 40 or more EEG-BF sessions. Training consisted of a "SMR protocol" that augmented 12-15 Hz brainwaves (sensory motor rhythm; SMR), while simultaneously inhibiting 4-7 Hz brainwaves (theta) and 22-30 Hz brainwaves (high beta). Serial measurements of pain, fatigue, psychological distress, morning stiffness, and tenderness were also obtained. Sixty-three FMS patients who received standard medical care, but who
did not receive EEG-BF, served as controls. Visual, but not auditory, attention improved significantly (P < 0.008). EEG-BF treated subjects also showed improvement in tenderness, pain and fatigue. Somatic symptoms did not change significantly in controls. Visual attention parameters and certain somatic features of FMS appear to improve with an EEG-BF SMR protocol. EEG-BF training in FMS deserves further study.


This study was designed to confirm the presence of a lateralizing deficit in visual-spatial attention in children with ADHD, to further characterize the nature of this deficit and to specify the likely hemispheric locus of dysfunction. Two versions of the covert orienting of attention procedure which evaluated separately endogenous and exogenous cuing effects were administered to 20 unmedicated children aged 9-12 with ADHD and 20 matched controls. Both groups also underwent thorough psychiatric assessment and testing using the TOVA and the Wisconsin Card Sorting Task (WCST). Children with ADHD showed an asymmetrical performance deficit characterized by a loss of costs on controlled (endogenous) attentional orienting to invalidly cured left visual field targets. The degree of cost asymmetry correlated negatively with the number of categories sorted on the WCST. It was concluded that unmedicated children with ADHD show an asymmetrical performance deficit on the covert orienting procedure characterized by a disruption of right hemispheric attentional mechanisms. This deficit may be related to diminished right hemispheric frontal-striatal catecholamine activity.


Objective—To establish executive function (EF) structure/organization and test a longitudinal developmental cascade model linking processing speed (PS) and EF skills at 8-years of age to academic achievement outcomes, both at 8- and 16-years, in a large sample of children/adolescents with surgically-repaired dextro-transposition of the great arteries (d-TGA). Method—Data for this study come from the 8-(n = 155) and 16-year (n = 139) time points of the Boston Circulatory Arrest Study and included WISC-III, Trail Making Test, Test of Variables of Attention, and WIAT/WIAT-II tasks. Results—A 2-factor model (Working Memory/Inhibition and Shifting) provided the best fit for the EF data, \( \chi^2(3) = 1.581, p = .66, \text{RMSEA} = 0, \text{CFI} = 1, \text{NNFI} = 1.044 \). Working Memory/ Inhibition and Shifting factors were not correlated. In the structural equation model, PS was directly related to both EF factors and Reading at 8 years, and was indirectly related to Math and Reading achievement, both concurrently and longitudinally, via its effects on Working Memory/ Inhibition. Shifting at 8 years was significantly associated with Math (but not Reading) at 16 years. Conclusions—The academic difficulties experienced by children and adolescents with d-TGA may be driven, at least in part, by underlying deficits in processing speed and aspects of executive function. Intervention efforts aimed at bolstering these abilities, particularly if implemented early in development, may prove beneficial in improving academic outcomes and, perhaps by extension, in reducing the stress and diminished self-confidence often associated with academic underachievement.


The Continuous Performance Test (CPT), such as the Test of Variable Attention (TOVA), is widely used in the assessment of ADHD with other behavioral ratings and observations. Since some clinicians argue that CPTs measure psychomotor speed function rather than sustained attention, a correlation study between PIQ of WISC-III and TOVA was conducted to find out if a significant relationship of any kind
existed. Forty children with ADHD were studied, and the results indicated that there was no correlation between TOVA and PIQ of WISC-III.


This study was conducted to identify attention deficit hyperactivity disorder (ADHD) in Korean juvenile delinquents. Intelligence tests (KEDI-WISC, K-WAIS), the Test of Variables of Attention (TOVA), the Teacher Report Form (TRF), the Youth Self-Report (YSR), and the Rosenberg Self-Esteem Scale were administered to 98 incarcerated Korean adolescents (the delinquent group) and 84 adolescent nondelinquents (the control group). The groups were compared, and significant differences were found for ADHD; 42.4% of the adolescents in the delinquent group were identified as having ADHD, in comparison to 11.9% of the adolescents in the control group. Delinquent adolescents and adolescents with ADHD were found to have lower IQ scores, poorer TOVA performance, more severe problem behaviors, and lower self-esteem than nondelinquent adolescents and adolescents without ADHD. Delinquent adolescents with ADHD consistently fared the worst on assessments of intelligence, TOVA performance, problem behaviors, and self-esteem.


The following study was conducted to evaluate the correlation between intelligence and a Continuous Performance Test (CPT) that assesses Attention Deficit Hyperactivity Disorder (ADHD) in children. Characteristics of attention in gifted children with ADHD were also investigated. A sample of 177 elementary school students was studied, and their attention was measured with the Test of Variables of Attention (T.O.V.A.). About 9.4%Y of the gifted children were identified with ADHD using the T.O.V.A., Child Behavior Check List (CBCL), and Teacher's Report Form (TRF). Significant positive correlations were found between intelligence (KEDIWISC) and omission error, commission error, and response time (RT) variability on the T.O.V.A. That is, children with a high level of intelligence made fewer omission and commission errors and responded more consistently on the T.O.V.A. than children with lower intelligence. No significant correlation was found between intelligence and response time. Overall, gifted children performed better on the T.O.V.A. than nongifted children. Specifically, with the exception of response time and response time variability, gifted children with ADHD performed better on tasks of omission error, commission error, and response sensitivity than nongifted children with ADHD. Further discussions are suggested based on the results mentioned above.


It has been well studied that depression is associated with muscle rigidity and chronic pain. However, few studies have examined the differences of electromyography (EMG) response to cognitive stressor between patients with major depressive disorder (MDD) and the healthy control. We conducted a cross-sectional and case-control (sex and age) study to observe the (EMG) change under the test of variables of attention (TOVA) which is a computerized test of attention. Forty-five patients with (MDD) and the same number of matched subjects participated. Screening of mental illness was carried out through the Mini-International Neuropsychiatric Interview. The (EMG) of neck muscle was recorded before (2 minutes, rest condition) and during the subject performed (TOVA) (about 22 minutes, (TOVA) condition). Raw data were processed to calculate the typical time and frequency domain (EMG) parameters. (MDD) patients had lower electromyographic activity (EA) and root mean square (RMS) than control group in both the rest and (TOVA) condition. (MDD) patients had higher (EA) and root (RMS) than control group in both the rest and (TOVA) condition. (MDD) group had higher median frequency (MF) and
mean power frequency (MPF) than controls in both the rest and (TOVA) condition. (MDD) group had significant change between rest and (TOVA) in the above four parameters. However, health control group did not have this difference between two conditions. The result showed significant muscle rigidity change in (MDD) patient when their condition shifted from relaxation to stress. This might be the reason why (MDD) patients suffer from severe chronic pain.


We examined the cross-sectional relationship between environmental tobacco smoke exposure, continuous performance test (CPT) measures, and attention deficit hyperactivity disorder (ADHD) or learning disability symptoms in school-aged children.


OBJECTIVE: Attention-deficit/hyperactivity disorder (ADHD) is a complex neurodevelopmental disorder with a strong genetic component. Brain-derived neurotrophic factor (BDNF), which participates in the differentiation and survival of dopaminergic and noradrenergic neurons, could play a role in ADHD development. We aimed to explore the relationships between ADHD and BDNF gene polymorphism. METHODS: We conducted a case-control analysis of 202 ADHD subjects and 159 controls, performed a transmission disequilibrium test on 151 trios, and compared the results of a continuous performance test (CPT) according to the genotype of the three single nucleotide polymorphisms (rs11030101, rs6265, rs16917204) in the BDNF gene. RESULTS: In the case-control analysis, the AA genotype of the BDNF rs11030101 polymorphism was significantly associated with ADHD only in girls (p=0.024, odds ratio=3.00). The T-G-G haplotype was significantly less frequent (p=0.005) and A-G-G was more frequent (p=0.048) in girls with ADHD than in control girls (global p=0.027). A multivariate analysis of variance for commission errors on the CPT showed a significant main effect for the rs11030101 genotype (p=0.026) and an interaction effect of the rs11030101 genotype and gender (p=0.032) in ADHD probands. CONCLUSION: These results provide preliminary evidence for a gender-specific association between BDNF and ADHD in the Korean population.


OBJECTIVE: The present study investigated whether teacher ratings and parent ratings of inattentive or hyperactive/impulsive symptoms were differently associated with intelligence or cognitive performance in Korean children. METHODS: Six hundred sixty-seven children were recruited from nine schools in five Korean cities. The teachers and parents of 580 of these children (9.0+/−0.7 years old, 333 boys and 306 girls) completed the Korean version of the Attention-Deficit/Hyperactivity Disorder Rating Scales (K-ARS), and the children completed the abbreviated form of the Korean Educational Development Institute-Wechsler Intelligence Scales (KEDI-WISC) and a neurocognitive battery consisting of the continuous performance test, the Children’s Color Trails Test, and the Stroop Color-Word Test. Diagnosis of full-syndrome and subthreshold attention-deficit/hyperactivity disorder (ADHD) were based on the Diagnostic Interview Schedule for Children Version-IV (DISC-IV). RESULTS: The level of agreement between teacher and parent ratings was low (r=0.21-0.26) in children with full-syndrome and subthreshold ADHD and low to moderate (r=0.31-0.41) in the normative sample. Teacher-rated ARS
showed significant correlations with most sub-scores of KEDI-WISC and the neurocognitive battery both in the normative sample (r=-0.50-0.37) and in children with full-syndrome and subthreshold ADHD (r=-0.26-0.29). Correlations between parent-rated ARS and cognitive tests were lower and were found in fewer subscales of tests. CONCLUSION: These results suggest the importance of considering the teacher's report of a child's school functioning during the assessment of ADHD.


Neurobiological and pharmacological research has suggested that dysregulation of the central noradrenergic systems might be involved in the pathophysiology of attention deficit hyperactivity disorder (ADHD). Previous studies have demonstrated that the norepinephrine transporter gene (SLC6A2) is associated with ADHD. The aims of this study were to examine the association of the SLC6A2 G1287A and -3081(A/T) polymorphisms with ADHD in Korean children and adolescents, and to determine the relationships of the genotypes of these two polymorphisms with continuous performance test results and the Junior Temperament and Character Inventory profiles of ADHD. In a case-control study, we assessed 186 ADHD probands and 150 normal controls; 109 trios were studied in a family-based association analysis. There were no significant differences in the genotype or allele frequencies of the SLC6A2 G1287A and -3081(A/T) polymorphisms between the ADHD and control groups (p > 0.05). In the transmission disequilibrium test analyses, there was no evidence for biased transmission of any of the alleles of the SLC6A2 G1287A and -3081(A/T) polymorphisms. In the haplotype analyses of these two polymorphisms, the global and individual chi(2) tests showed no significant associations between any of the haplotypes and ADHD. There were no significant differences with respect to the continuous performance test results and the Junior Temperament and Character Inventory profiles in the ADHD probands according to the genotypes of the SLC6A2 G1287A and -3081(A/T) polymorphisms. Our findings do not support SLC6A2 as a major genetic susceptibility factor in ADHD.


Previous studies have demonstrated that the Mspl and Dral polymorphisms at the alpha-2A-adrenergic receptor gene (ADRA2A) are associated with ADHD. However, few studies have been designed to ascertain the association between the ADRA2A genotypes and the performance on neurocognitive measures in ADHD. The aims of this study were to examine the association of the ADRA2A Mspl and Dral polymorphisms with ADHD in Korean subjects, and to determine the relationship between the genotypes of these two polymorphisms and the candidate endophenotypes, as measured by the continuous performance test (CPT). In a case-control study, we assessed 186 ADHD probands and 150 normal controls. One hundred eight trios were studied in a family based association analysis. The transmission disequilibrium test (TDT) analysis showed preferential transmission of the C allele of the Dral polymorphism (chi(2) = 5.88, P = 0.015). In the haplotype analyses, a trend of over-transmission of haplotype C/C was observed (chi(2) = 3.80, P = 0.051). The homozygous subjects for the C allele (C/C genotype) at the Dral polymorphism showed a trend toward a higher mean T-score with respect to the response time variability profiles of the CPT than did those with the other genotypes (C/T + T/T genotypes; P = 0.042). The homozygous subjects for the G allele (G/G genotype) at the Mspl polymorphism showed a tendency to have a lower mean T-score with respect to the response time variability profiles of the CPT (P = 0.068). The results of this study provide important evidence for the involvement of the ADRA2A Mspl and Dral polymorphisms in the etiology of ADHD in Korean subjects. In
addition, our results provide evidence for the possible role of these two polymorphisms in ADHD symptom expression, such as increased response time variability.


To study cognitive and emotional impairments in patients with anxiety-phobic disorders (APDs), to comparatively analyze the clinical manifestations of acute (less than one-year) and protracted (1-to-5-year) forms of this disease, and to evaluate the efficacy of noofen used to treat this pathology.


To study clinical/psychological characteristics of neurasthenia and residual asthenia and to assess the efficacy of noofen and adaptol in the treatment of these disorders.


This study examined the performance of 198 Veteran research participants deployed during Operation Enduring Freedom, Operation Iraqi Freedom, and/or Operation New Dawn (OEF/OIF/OND) on four measures of performance validity: the Medical Symptom Validity Test (MSVT), California Verbal Learning Test: Forced Choice Recognition (FCR), Reliable Digit Span (RDS), and TOVA Symptom Exaggeration Index (SEI). Failure on these performance validity tests (PVTs) ranged from 4% to 9%. The overall base rate of poor performance validity, as measured by failure of the MSVT in conjunction with an embedded PVT (FCR, RDS, SEI), was 5.6%. Regression analyses revealed that poor performance validity predicted cognitive test performance and self-reported psychological symptom severity. Furthermore, a greater prevalence of traumatic brain injury (TBI), Post-Traumatic Stress Disorder (PTSD), co-morbid TBI/PTSD, and other Axis I diagnoses, was observed among participants with poor effort. Although poor performance validity is relatively uncommon in a research setting, these findings demonstrate that clinicians should be cautious when interpreting psychological symptoms and neuropsychological test performance of Veteran participants who fail effort measures.


Summary: Children with attention deficit hyperactivity disorder (ADHD) may have a component of sleep apnea causing arousal and contributing to ADHD behavior during the day. Twenty non-ADHD children between 4 and 16 years of age were compared with 18 children with ADHD with use of nocturnal polysomnography (PSG) and psychometric tests. The psychometric testing confirmed that the control group were normal and that the ADHD children fulfilled the diagnostic criteria for ADHD. The PSG showed normal arousal indexes for the ADHD group (9.8 ± 3.9/hr) and controls (10.2 ± 3.1/hr), and normal apnea/hypnea indexes for the ADHD group (1.0 ± 2.4/hr) and controls (0.6 ± 0.9/hr). The sleep architecture was not significantly different between groups. There were no sleep abnormalities in the ADHD children that could be responsible for, or contributing to, the disorder.

Although psychostimulants are frequently used to treat children with attention deficit disorders (ADD), there are few reliable and objective means of predicting and determining treatment outcome. In addition to behavioral ratings, continuous performance tests (CPT) are increasingly being used by clinicians to determine treatment effects. Two experiments are reported in which the Test of Variables of Attention (T.O.V.A.), a computerized visual CPT developed specifically for use with ADD, is the dependent variable to determine its usefulness to assess outcome of methylphenidate (MPH) treatment of children with ADD and to predict (by means of a single challenge dose) which children would be MPH responders. The findings clearly support the use of the T.O.V.A. as part of the clinician’s database.


To assess the relationship between the Test of Variables of Attention (TOVA) and race/ethnicity, 40 Caucasian, 40 Asian, and 20 Hispanic children between the ages of 8 and 10, were administered the TOVA and the attention factor from the Child Behavior Checklist (CBCL). Gross annual income and years of parent education were used as covariates to partial out variance due to socioeconomic status. All of the children who were participants in the study attended the same elementary school and lived in the same neighborhood. Consent forms were given to all of the children in the 2nd, 3rd, and 4th grades and those parents who agreed to participate were then included in the study and assigned to the appropriate race/ethnic group. Results indicated that there was a significant difference between the three groups on total percentage of omission errors (inattention). Post hoc analysis indicated that the Hispanic group made significantly more errors of omission than the Caucasian group and significantly more errors of omission than the Asian group. This difference remained even after the covariates representing socioeconomic status were removed. There was a significant difference between groups on variability (a measure of consistency), but the difference did not remain after inclusion of the covariates. However, the covariates removed a negligible amount of variance, and a loss of power was seen as responsible for not achieving significant differences between groups on variability. There were no significant differences between groups on omission errors, response time, or the attention factor on the CBCL. In the current study there was evidence that the TOVA may not measure attention in the same way for different race/ethnic groups. The Hispanic group was shown to be less attentive, as defined by increased omission errors on the TOVA, compared to the Asian group and the Caucasian group. There was also evidence that the three groups differed in terms of consistency in responding. Thus, the current study provides the first empirical evidence that the TOVA cannot be assumed to be a culture free test. The results were further explained using tenets from the philosophy of science known as constructionism. It is asserted that attention is a hypothetical construct that cannot be dispassionately observed. Thus, any operational definition of attention, like the TOVA, is created within subsystems of culture, values, economy, and politics that guide the scientific process. In this way, no single measure of attention, however objective it may appear, can accurately measure attention for individuals across various culture and ethnic groups.


Case-control studies comparing ADHD with typically developing individuals suggest that anatomical asymmetry of the caudate nucleus is a marker of attention deficit hyperactivity disorder (ADHD). However, there is no consensus on whether the asymmetry favors the right or left caudate nucleus in ADHD, or whether the asymmetry is increased or decreased in ADHD. The current study aimed to clarify this relationship by applying a dimensional approach to assessing ADHD symptoms that, instead of
relying on clinical classification, utilizes the natural behavioral continuum of traits related to ADHD. Structural T1-weighted MRI was collected from 71 adults between 18 and 35 years and analyzed for caudate asymmetry. ADHD-like attentional symptoms were assessed with an objective measure of attentional problems, the ADHD score from the Test of Variables of Attention (TOVA). Impulsivity, a core feature in ADHD, was measured using the Barratt Impulsiveness Scale, a self-report measure that assesses attentional, non-planning, and motor features of impulsivity. We found that larger right relative to left caudate volumes correlated with both higher attentional impulsiveness and worse ADHD scores on the TOVA. Higher attentional impulsiveness also correlated with worse ADHD scores, establishing coherence between the objective measure and the self-report measure of attentional problems. These results suggest that a differential passage of information through frontal-striatal networks may produce instability leading to attentional problems. The findings also demonstrate the utility of a dimensional approach to understanding structural correlates of ADHD symptoms.

Debaun, M. R., Schatz, J., Siegel, M. J., Koby, M., Craft, S., Resar, L., … Noetzel, M. (1998). Cognitive screening examinations for silent cerebral infarcts in sickle cell disease, 50(6), 1678-1682. In children with sickle cell disease (SCD), silent cerebral infarcts are the most frequent cause of neurologic injury. We determined the sensitivity and specificity of selective neurocognitive measures when separating children with silent cerebral infarcts and SCD from sibling controls. Additionally, we tested the validity of the same cognitive measures to identify patients with overt strokes. METHODS: We examined performance on a neuropsychologic battery containing measures of attention/executive, spatial, language, memory, and motor functioning for seven children with SCD and silent cerebral infarct, 21 children with SCD and overt stroke, and 17 normal siblings. Diagnosis of cerebral infarct was based on results of MRI. RESULTS: Measures from the attention and executive domains were the most useful for identifying children with silent cerebral infarct. The Test of Variables of Attention was the most robust measure and yielded a sensitivity rate of 86% and a specificity rate of 81%. This measure also showed a sensitivity rate of 95% in identifying overt stroke. CONCLUSIONS: Brief cognitive screening measures, if properly constructed, may be an effective means of identifying children with silent cerebral infarct. Future prospective studies should be pursued to assess the utility of cognitive screening for silent cerebral infarcts in SCD.


Deveci, E., Ozan, E., Kirpinar, I., Oral, M., Daloglu, A., Aydin, N., & Ozturk, A. (2013). Neuro cognitive functioning in young high-risk offspring having a parent with bipolar I disorder. Turk. J. Med. Sci., 43(1), 110–117. Aim: To investigate attention, memory, verbal-linguistic ability, and executive functions in symptom-free young offspring having a parent with bipolar I disorder (BD1O) in comparison with healthy controls (CO). Materials and methods: Thirty symptom-free BD1O and 37 CO were recruited. The groups (both all participants and those ≥11 years of age) were well-matched for age, sex, IQ, and years of education. The neurocognitive battery included the Rey Auditory Verbal Learning and Memory Test, Controlled Word Association Test, Digit Span Test, Trail Making Test, Auditory Consonant Trigram Test, Wisconsin Card Sorting Test, Stroop Test, and Test of Variables of Attention. Results: The BD1O group demonstrated impairments in psychomotor speed, focused attention, verbal attention, phonemic verbal fluency, short-term memory, and learning functions and performed marginally worse in divided attention, information processing, and working memory. No group difference was found in sustained attention, executive functions, or alternating attention. Conclusion: Divided attention, information processing, and working memory seem to be important in evaluating the cognitive pathology before the onset of affective psychopathology.

Aim: The aim of this study was to determine the role of the Test of Variables of Attention (TOVA), a computer-based continuous performance test (CPT), in assessing suspected attention-deficit/hyperactivity disorder (ADHD), a pervasive cause of disability in children and adolescents. One hundred and fifty children and adolescents referred to a community-hospital-based neurology clinic for suspected ADHD underwent a comprehensive clinical evaluation by a pediatric neurologist in addition to the TOVA test. Retrospective chart data were analyzed separately for children aged 6–12 years (n=101) and adolescents (13–18 years) (n=49). Parents and teachers completed (DSM-IV-TR, 2000) questionnaires for children 6–12 years old. The correlation between the neurologist’s impression of the presence of attention deficit and the TOVA scores was good in the younger group (r=0.28, p≤0.001) and weaker in the older group (r=0.29, p≤0.05). On nonparametric analysis, the neurological evaluation did not distinguish between low and high TOVA scorers in the older group. The neurologist’s impression correlated more closely with the DSM-IV parents ratings (r=0.29, p≤0.01) than the teachers’ (r=0.08, p≤0.05). The TOVA correlated well with clinical assessment of ADHD and has added value in the evaluation of ADHD in adolescents, for whom standardized rating scales are lacking. In younger children, an experienced clinician can usually reach an accurate diagnosis based on accepted clinical criteria, including parent and teacher reports.


Background Seasonal Allergic Rhinitis (SAR) can cause Daytime Sleepiness (DS) and impair Cognitive Performance (CP). Methods: We evaluated the effects of Fluticasone Furoate (FF) 110 mcg given in the morning on Nasal Symptoms (NS), DS, and CP in adults with symptomatic SAR during an allergy season. 40 adults ages 18 to 55 with a history of SAR and positive allergy skin tests to seasonal allergens. After a 1 week placebo (PL) run in, they randomly received either FF (21) or identical appearing PL (19) for 2 weeks. They recorded nasal symptom score (NSS) and Eppworth daytime sleepiness score (EDDS) for the 21 days, performed a TOVA test (Computerized test of cognitive performance) at day 7 and 21, and completed a nocturnal rhinoconjunctivitis quality of life questionnaire (NRQLQ) at days 7, 14 and 21. Average daily weekly scores, comparing week 1 baseline to week 3 were used for evaluation of NSS, and EDDS/TOVA omissions, commissions and reaction times were compared, as was NRQLQ (day 7 and day 21). Results: Mean total NSS (TNSS) instantaneous decreased from BL 12.88 to 10.84 in the FF group, and increased in PL group from 12.64 to 13.74 (P diff ¼ .04). TNSS reflective decreased from 12.99 to 11.20 (FF group) and increased from 13.53 to 14.02 in PL. (P diff ¼ NS). The mean EDSS decreased from 13.83 to 10.76 (P ¼ 0.03) in FF group, and from 13.29 to 12.80 with PL (P d¼ NS). TOVA commission errors decreased by 7.13 (FF) vs 1.4 (PL) (P d¼ 0.05). Omission increased in PL from 2.33 to 5.75, and 1.54 to 1.58 (FF) (P d¼ NS). Reaction time increased in both groups 363 to 391 milliseconds (FF), 387 to 412 milliseconds (P ¼ NS). The FF reported a minimal clinical importance difference of 0.5 or greater on all 16 questions of NRQLQ, the PL group only in 10. (Mean change 1.01 (FF) vs .63 (PL) P ¼ 0.004). Conclusions: Treatment of symptomatic SAR with intranasal FF decrease daytime sleepiness, less nocturnal sleep disturbance, and improved cognitive performance.

Testing for ADHD in adults is difficult. Questionnaire data (self-reports) are used by mental health professionals to diagnose this condition. Other family members may also complete questionnaires and a thorough developmental history is obtained verifying childhood symptoms for the ADHD adult, but this information is subjective. Objective laboratory measures, such as continuous performance tests (CPTs), are available to aid in the diagnosis. The present study examined the use of two CPTs, the Gordon Diagnostic System (GDS) (Gordon, 1987) and the Test of Variables of Attention (TOVA) (Greenberg, 1991), in diagnosing adults with ADHD. The results of the two CPTs were compared between adults with a preliminary diagnosis of ADHD and a control group who had no ADHD symptoms. To determine if differences existed in patterns of results between the two groups and in outcomes between the CPTs for either group. The findings showed that the ADHD (n = 60) and non ADHD (n = 30) groups differed on the TOVA, but no differences were found between the two groups on the Gordon. When the two tests were compared regarding their ability to diagnose ADHD, no differences were found between the TOVA and GDS. The discriminant function analysis showed that TOVA scores including response time standard scores, TOVA scores for ADHD, response time variability were stronger predictors of ADHD than individual scores on the GDS. The WAIS-R vocabulary score was a stronger predictor of ADHD than the block design. Ancillary findings were also reported on the sensitivity and specificity of the two CP Ts based on their outcomes. It appeared that the GDS had better sensitivity than the TOVA, while the specificity levels appeared to be similar. The lack of a gold standard for diagnosing ADHD provides a cautionary note in the use of CPTs. Mental health professionals who work with ADHD adults should consider using the CPT as part of their diagnostic protocol, but should not rely on their results to provide a basis for diagnosis.


Compared to attention deficit hyperactivity disorder (ADHD) in children, relatively little is known about the clinical characteristics of adults with persistent ADHD. We elected to use established tests with age-corrected norms to compare the battery of psychological and neuropsychological tests conducted on outpatients admitted to our Adult ADHD clinic. ADHD patients scored significantly higher than norms on the TPQ novelty seeking and harm avoidance scales and MMPI-2 scales F, 2, 4, 7, and 8. Further, these patients were impaired on the California verbal learning test, the attentional capacity test, and the omissions and variability subtests of the test of variables of attention. Adult ADHD had high comorbidity with current depressive disorder, antisocial personality disorder, and alcohol and drug abuse/dependence. High correlations were found between patients' and independent observers' reports of ADHD symptom severity. Implications for further research are discussed.


Continuous performance tests are instruments which require the test subjects to be, at all times or continuously, attentive to the task presented. In this way lapses or gaps in attention, which can detrimentally affect learning, can be quantified against some standard or norming group. Continuous performance tests (CPT) have been utilized for forty (40) years. Only within the past fifteen (15) years have the format, administration, scoring and norms been standardized as the result of the advancement in computer technology. None of the three commercially produced CPT’s include ethnic or socio-economic status information in their normative data. No significant information with regard to possible ethnic or cultural differences in CPT performance is currently available. As the application of
CPT's moves from the research lab to clinics, hospitals, and schools, its potential impact on children, especially minorities, also increases. This research involves the statistical comparison of the original suburban Anglo norming of a commercially available CPT, the Tests of Variables of Attention (T.O.V.A.), with a stratified random sampling of an ethnically diverse urban population. Forty (40) boys and forty-three (43) girls between the ages of 8 years 0 months, to 9 years 11 months, were selected from Florida's Dade County Public Schools for inclusion in this study. Results suggest no significant differences in the performance profile of the current research population relative to the original standardization sample. A discussion of minor incongruencies and possible causative factors is included. These findings support the use of the T.O.V.A. as a school based screening instrument, and as part of a multimodal learning problem assessment battery in ethnically diverse urban settings.


BACKGROUND: Children with impulsive behavior and poor self regulation have been shown to have low parasympathetic tone. High vagal tone is associated with attention to novel stimuli. OBJECTIVE: To study if Heart Rate Variability, an index of vagal tone, is a mediator of attention. METHOD: 77 children who performed a Continuous Performance test (TOVA test) had their EKG recorded for Heart Rate Variability Measurements. Subjects were assigned to groups according to their performance on the TOVA test and a general linear model for repeated measures applied. Pearson Correlations were applied for TOVA scores and HRV Values at four epochs. RESULTS: No individual correlations were found between Attention Scores and HRV. However, there was a significant group difference showing that good performers had a higher "vagal" tone than poor performers. CONCLUSION: The parasympathetic system as measured through HRV is not a mediator of attention. HRV may be an indicator of better health and ability to self regulate.


In contrast to studies of adult psychiatric patients, there was no striking difference between vigilance task performance by 11 newly diagnosed, previously untreated adolescent schizophrenics and that of 58 nonpsychotic adolescent comparison subjects. Neuroleptic treatment failed to improve the performance of the schizophrenic subjects. Sedation, a frequent side effect, was associated with significant prolongation of reaction time and an increase in error rate. Attentional characteristics of adolescent schizophrenics appear to resemble those of other disturbed children. Their response to neuroleptics appears to be limited and the deleterious effects of sedation on attention may well outweigh any clinical benefit attributable to sedation. Findings are discussed in terms of methodology and age-related characteristics.


The ability and or inability to sustain attention is an important factor that has become one of the leading causes of referrals to pediatric neuropsychologists. The purpose of the present study was to examine the relationship between the Luria-Nebraska Neuropsychological Battery-Third Edition (LNNB-III) and the 2 stimulus versions of the Test of Variables of Attention, the TOVA (visual) and TOVA-A (auditory) in an
attempt to examine the impact of sustained attention on neuropsychological test performance. Participants were 44 children referred for neuropsychological evaluation, which included the LNNB-III, TOVA, and TOVA-A. The average age was 10.39 years (SD=2.55) and average education was 4.86 years (SD=2.33). The sample was predominantly male (75%) and right-handed (97.2%). Fifty-one percent of the sample was Black. Significant correlations (p < 0.001) were found between subtest scores of the visual and auditory portions of the TOVA and the nonverbal subtests of the LNNB-III ranging from 0.410 to 0.801. The LNNB-III Motor Coordination scale correlated highest with the Response Time Total scores from the TOVA (0.572) and TOVA-A (0.503). The LNNB-III Complex Tactile scale was most highly correlated with the TOVA-A Post Commissions score (0.549). Purposeful Movement was correlated with the TOVA Anticipatory Response (0.581) and D-Prime (-0.410) scales. The Trails subtest correlated with the auditory (0.450) and visual (0.487) Response Time Total scores and the auditory Commission Errors Total (0.480) and Post-Commissions score (0.502). Non-verbal Auditory correlated most highly with the Commission Errors Total and Post-Commission scores from both versions, as well as the TOVA DPrime (-0.451) and TOVA-A Response Time Total (0.431). Verbal scores and memory scores were not correlated with the TOVA scores. The implication of these findings in understanding and evaluating neuropsychological data are discussed.


It is, by now, well established that mold toxins (mycotoxins) can cause significant adverse health effects. In this study, 15 subjects who developed an attention deficit disorder (ADD) and slowing of reaction time at the time of exposure to mold toxins were identified. Deficits in attention span and reaction time were documented not only by taking a careful history, but also by performing a Test of Variables of Attention (TOVA). The TOVA test provides an objective measure of these two variables. It was found that mold-exposed subjects show statistically significant decreases in attention span and significant increases in reaction time to stimuli compared to controls. After ten sessions of hyperbaric oxygen treatment (HBOT), a statistically significant improvement was seen in both measures. This preliminary study suggests promising outcomes in treating mold-exposed patients with hyperbaric oxygen.


Neurofeedback (NFB) is an operant conditioning procedure, by which the subject learns to control his/her EEG activity. On one hand, Learning Disabled (LD) children have higher values of theta EEG absolute and relative power than normal children, and on the other hand, it has been shown that minimum alpha absolute power is necessary for adequate performance. Ten LD children were selected with higher than normal ratios of theta to alpha absolute power (theta/alpha). The Test Of Variables of Attention (TOVA) was applied. Children were divided into two groups in order to maintain similar IQ values, TOVA values, socioeconomical status, and gender for each group. In the experimental group, NFB was applied in the region with highest ratio, triggering a sound each time the ratio fell below a threshold value. Noncontingent reinforcement was given to the other group. Twenty half-hour sessions were applied, at a rate of 2 per week. At the end of the 20 sessions, TOVA, WISC and EEG were obtained. There was significant improvement in WISC performance in the experimental group that was not observed in the control group. EEG absolute power decreased in delta, theta, alpha and beta bands in the experimental group. Control children only showed a decrease in relative power in the delta band. All changes observed in the experimental group and not observed in the control group indicate better cognitive performance and the presence of greater EEG maturation in the experimental group, which suggests that changes were due not only to development but also to NFB treatment.
OBJECTIVE: Previous researchers have discussed visual/spatial working memory in relation to math learning, but findings have been inconsistent. Studies to date have not included sustained visual attention as a control, which might remove variance attributable to global processes. The current study examined the contribution of visual sequencing memory on calculation with sustained visual attention (and reading achievement) controlled in a sample of children enrolled in general education classrooms. METHOD: 51 children (ages 6-14, mean age = 10.1) completed WJ-III Calculation subtest, TOWRE, WRAML Finger Windows, and TOVA visual. Regression analyses testing the influence of Finger Windows on Calculation with reading and TOVA omissions controlled was conducted. RESULTS: Overall, the model including all variables accounted for 33.8% of the variance in mathematics calculation (R(2) = .338, p < .001). RESULTS showed that when controlling for reading skill and global visual sustained attention, visual sequential memory accounted for a significant amount, 6.2%, of variance in mathematics calculation (beta = .261, p = .041, change R(2) = .062). Sustained visual attention contributed 7.5% of the variance in mathematics learning to the model (beta = .278, p = .026). CONCLUSION(S): Previous work has contrasted visual/verbal working memory, but has not accounted for the global influence of attention overall. This study suggests that both global visual attention and specific visual sequencing memory contribute to mathematics learning roughly equally in children without specific learning disability. It may be that in children with mathematics challenges, one or the other of these systems may be implicated.
Increases in plasma blood glucose levels modulate memory, mood, and, to some extent, attention in adults. Participants in the present study were administered glucose (10, 100, and 500 mg/kg, or 50 g) or placebo (23.7 mg saccharin) shortly prior to completing the test of variables of attention (TOVA), a continuous performance test (CPT) commonly used to assess attention for diagnostic purposes. There were significant increases in blood glucose levels for the 500 mg/kg and 50 g groups, but only the 100 mg/kg group showed significant changes in behavior in comparison to the saccharin group. Specifically, the 100 mg/kg group performed worse on measures of commission errors, post-commission responses, and post-commission response time variability. There were no differences among the groups on other major variables of attention, including omission errors, response time, and response time variability. The results of this study demonstrate that large doses of glucose which increase blood glucose levels do not influence attention, but that a moderate dose (100 mg/kg) selectively impairs measures of impulsivity or disinhibition. Practitioners and researchers should maintain an awareness of dietary effects on attention and continue to examine micronutrients as potential confounds on diagnostic tests of cognition and behavior.


The current choice of treatment for the remediation of attentional and behavioural difficulties among primary school children with special educational needs (SEN) is, increasingly, pharmacological. If neurofeedback can regulate brain arousal states and thereby improve attention, behaviour and readiness to learn, there may be a case for incorporating it into the special needs provision of mainstream primary schools, thus avoiding the use of potentially damaging stimulant medication as a means of controlling behaviour and promoting inclusion. An experimental design was used, employing the TOVA test as a pre-/post-test measure of attention and the TOVA rating scale as parental pre/post measure of behaviour, plus qualitative feedback as a post-treatment measure of attention/behaviour. Results indicate that neurofeedback may make an important impact on emotions and affect of the SEN individual, leading to improved behaviour and improved attentional capability; quality time spent on a no-failure task of any kind on a one-to-one basis may be beneficial to children with SEN, affecting their personal belief system and behaviour; incorporating neurofeedback as part of the school-based special needs provision is feasible and practicable.


*Ability of the Test of Variables of Attention (TOVA) to distinguish between referred children with attention-deficit/hyperactivity disorder (ADHD) and other (OTHER) clinical diagnoses were studied. The ADHD group differed from the OTHER group on TOVA variables and most measures from the Revised Conners Teacher Rating Scale (RCTRS) and ADD-H Comprehensive Teacher's Rating Scale (ACTeRS). The criteria of any one TOVA variable > 1.5 standard deviations from age and sex adjusted means correctly identified 80% of the sample with attention deficit disorders and 72% of the sample without attention deficit disorder. Cases misclassified by teacher ratings were often correctly classified by the TOVA and conversely. The TOVA makes a unique and important contribution to diagnostic evaluations.*


*Oculomotor behavior and parameters are known to be affected by the allocation of attention and could potentially be used to investigate attention disorders. We explored the oculomotor markers of*
Attention-deficit/hyperactivity disorder (ADHD) that are involuntary and quantitative and that could be used to reveal the core-affected mechanisms, as well as be used for differential diagnosis. We recorded eye movements in a group of 22 ADHD-diagnosed patients with and without medication (methylphenidate) and in 22 control observers while performing the test of variables of attention (t.o.v.a.). We found that the average microsaccade and blink rates were higher in the ADHD group, especially in the time interval around stimulus onset. These rates increased monotonically over session time for both groups, but with significantly faster increments in the unmedicated ADHD group. With medication, the level and time course of the microsaccade rate were fully normalized to the control level, regardless of the time interval within trials. In contrast, the pupil diameter decreased over time within sessions and significantly increased above the control level with medication. We interpreted the suppression of microsaccades and eye blinks around the stimulus onset as reflecting a temporal anticipation mechanism for the transient allocation of attention, and their overall rates as inversely reflecting the level of arousal. We suggest that ADHD subjects fail to maintain sufficient levels of arousal during a simple and prolonged task, which limits their ability to dynamically allocate attention while anticipating visual stimuli. This impairment normalizes with medication and its oculomotor quantification could potentially be used for differential diagnosis.


Event-related potentials (ERPs) were recorded from children of schizophrenic parents, children of parents with affective disorders, and children of parents without a history of psychiatric illness. ERPs were elicited during two versions of the continuous performance test (CPT), which differed in their level of processing complexity. The data were recorded from electrodes located at midline frontal, central, parietal, and occipital scalp sites. Diagnostic assessments of the parents were performed using the Schedule for Affective Disorders and Schizophrenia-Lifetime Version and Research Diagnostic Criteria. Clinical assessments of the children were made with a modified version of the Global Assessment Scale. ERP amplitudes for six electrophysiological events were compared among groups for target and nontarget stimuli using analyses of variance of both factor score and baseline to peak measures. There was one isolated between-group finding: frontal negative slow wave recorded at FZ was of greater magnitude in the high risk (HR) than in either the psychiatric (PC) or normal control (NC) groups. Since only a small percentage of children at risk will eventually develop schizophrenia, ERP amplitude deviance and frequency distribution analyses were also performed and compared among groups. ERP component amplitudes did not distinguish the groups when each component was considered separately. Deviance analyses, using a combination of the amplitudes of the six ERP components, also did not provide evidence of a deviant subgroup within any of the three groups. There appeared to be no relationship between ERP component amplitudes and behavioral adjustment in adolescence. Some evidence of a relationship between deviant attentional functioning and ERP component amplitude was found, but the pattern of findings within the attentionally deviant HR subgroup was opposite to that found for the HR group as a whole and more consistent with the pattern found for the NC group.


The purpose of this study was to compare teacher and student perceptions of social skills and problem behaviors in subgroups of adolescents with LD. The Test of Variables of Attention--T.O.V.A. was administered to all students in the sample in order to form four subgroups: (a) students with learning disabilities and elevated levels of inattention/impulsivity (LD/ADD), (b) students with learning disabilities and average levels of attention/impulsivity (LD/nADD), (c) normally-achieving students with elevated levels of inattention/impulsivity (NA/ADD), and (d) normally-achieving students with average levels of
attention/impulsivity (NA/nADD). The Social Skills Rating System--SSRS-T was used to measure teacher-perceptions of Social Skills, Problem Behaviors, and Academic Competence of all students in the sample (N=87). Separate 2 x 2 MANOVAS, with ADD (ADD, nADD) and ED (LD, NA) representing group types were performed for Social Skills and Problem Behaviors. Results of Social Skills showed that students with ADD received significantly lower ratings than the nADD students on cooperation and self-control. Students with LD were rated significantly lower than their NA peers on all three dependent variables: cooperation, assertion, and self-control. Results of Problem Behaviors revealed that the ADD groups exhibited more externalizing problem behaviors than the nADD groups; the students with LD exhibited more externalizing and internalizing problem behaviors than their NA peers. On Academic Competence, results of a 2 x 2 ANOVA indicated that students with ADD and students with LD were seen as less academically competent than the N/ADD and NA groups respectively. The Social Skills Rating System--SSRS-S was administered to all students to measure self-perceptions of their social skills. Self-ratings only differentiated students with ADD from those with nADD on one factor: cooperation. Discrepancies in perceptions between members of each group type (ADD, ED) and their teachers were found utilizing two separate 2 x 2 ANOVAS. The largest discrepancy existed between students with LD and their teachers. The finding that students with LD do not match the social skills behaviors that their regular education teachers expect of them is discussed for current mainstreaming practices. Also discussed is the confounding nature of achievement on social skills functioning. Future research utilizing other assessment methods, multiple settings, and different age-levels is suggested.


Inconsistent differences in the corpus callosum (CC) structure between dyslexic readers (DRs) and typical readers (TRs) have been reported. We examine differences in CC splenium microstructure and the association of splenium microstructure with reading related skills. Nine DRs and eighteen TRs completed a reading skills battery and diffusion tensor imaging (DTI). DRs had higher splenium fractional anisotropy (FA) and axial diffusivity (LA) as compared to TRs. Retrieval of orthographic information from the language lexicon was negatively associated with FA and LA within both reading groups. Phonological awareness was positively associated with splenium FA and LA in TDs but not DRs. This study suggests two white matter pathways that may be differentially associated with reading skills in the CC splenium.


Clinical trials have suggested that neurofeedback may be efficient in treating attention-deficit/hyperactivity disorder (ADHD). We compared the effects of a 3-month electroencephalographic feedback program providing reinforcement contingent on the production of cortical sensorimotor rhythm (12-15 Hz) and beta activity (15-18 Hz) with stimulant medication. Participants were N = 34 children aged 8-12 years, 22 of which were assigned to the neurofeedback group and 12 to the methylphenidate group according to their parents' preference. Both neurofeedback and methylphenidate were associated with improvements on all subscales of the Test of Variables of Attention, and on the speed and accuracy measures of the d2 Attention Endurance Test. Furthermore, behaviors related to the disorder were rated as significantly reduced in both groups by both teachers and parents on the IOWA-Conners Behavior Rating Scale. These findings suggest that neurofeedback was efficient in improving some of the behavioral concomitants of ADHD in children whose parents favored a nonpharmacological treatment.

Background. Valid, reliable, accessible, and cost-effective computer-training approaches can be important components in scaling up educational support across resource-poor settings, such as sub-Saharan Africa. The goal of the current study was to develop a computer-based training platform, the Michigan State University Games for Entertainment and Learning laboratory’s Brain Powered Games (BPG) package that would be suitable for use with at-risk children within a rural Ugandan context and then complete an initial field trial of that package. Methods. After game development was completed with the use of local stimuli and sounds to match the context of the games as closely as possible to the rural Ugandan setting, an initial field study was completed with 33 children (mean age = 8.55 ± 2.29 years, range 6–12 years of age) with HIV in rural Uganda. The Test of Variables of Attention (TOVA), CogState computer battery, and the Non-Verbal Index from the Kaufman Assessment Battery for Children, 2nd edition (KABC-II) were chosen as the outcome measures for pre- and post-intervention testing. The children received approximately 45 min of BPG training several days per week for 2 months (24 sessions). Results. Although some improvements in test scores were evident prior to BPG training, following training, children demonstrated clinically significant changes (significant repeated-measures outcomes with moderate to large effect sizes) on specific TOVA and CogState measures reflecting processing speed, attention, visual-motor coordination, maze learning, and problem solving. Conclusions. Results provide preliminary support for the acceptability, feasibility, and neurocognitive benefit of BPG and its utility as a model platform for computerized cognitive training in cross-cultural low-resource settings.


Attention-deficit hyperactivity disorder (ADHD) affects 3% to 7% of school-age children. Approximately 30% of the children with ADHD also have comorbid anxiety or oppositional defiant disorder. Methylphenidate is the drug of choice for the medical treatment of such cases. When compared with children with ADHD alone, children with comorbid anxiety or oppositional defiant disorder may show worsening of the global attention score in response to methylphenidate and not only a “reduced response,” as reported in previous studies. This study included 1122 children diagnosed as ADHD, of which 174 were diagnosed with comorbid anxiety and 141 with comorbid oppositional defiant disorder. All patients performed the Test of Variables of Attention before and after methylphenidate administration. A normal distribution (Gaussian distribution) of reaction to methylphenidate, as measured by the global ADHD score in children diagnosed as pure ADHD, was found. These findings were in contrast to children with ADHD and comorbid anxiety or oppositional defiant disorder who showed a bimodal distribution and hence represent a distinct population. In both groups with comorbid disorders, there was a larger subgroup in which significant worsening of global ADHD score occurred after methylphenidate administration (P < .05). Children with ADHD and comorbid anxiety or oppositional defiant disorder might represent clinically distinct populations in which inattention is secondary to those disorders; therefore, methylphenidate may be an inappropriate treatment for such children.


The efficacy of modafinil in comparison with methylphenidate in treatment of pediatric attention-deficit hyperactivity disorder (ADHD) has not been thoroughly investigated. This study compared the effect of modafinil versus methylphenidate on continuous attention task in children with ADHD, using the Test of Variables of Attention. Twenty-eight participants completed a baseline test followed by administration of a
single dose of either methylphenidate or modafinil, after which the test was repeated. The test was performed a third time, after each subject received a dose of the medication not previously administered. Comparison of scores showed mean baseline, postmethylphenidate, and postmodafinil scores of –2.04, 0.017, and 0.09, respectively. No difference was found between improvements observed with either medication (P < .05). Adverse events for both agents were mild and self-limited, including abdominal pain, diarrhea, and hyposomnia. The authors conclude that modafinil is as effective as methylphenidate.


Abstract Attention Deficit Hyperactivity Disorder (ADHD) is one of the disorders causing the greatest impact, conditioning academic learning, quality of concentration, and capacity for self-regulation and control. The Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV-TR) establishes the most commonly accepted criteria for diagnosis (Inattentive: ADHD-I, Hyperactive/impulsive: ADHD-HI, and Combined: ADHD-C), but currently, diverse studies disagree about whether to address it as a continuum with different degrees of intensity (subtype structure) or as specific disorders (counterposed profiles). Prior research has tested the hypothesis of differential categories with performance measures and cortical activation. The goal proposed herein is to confirm these results, incorporating a new measure, near-infrared hemisencephalography (nir-HEG), in order to control cortical activation through levels of blood oxygenation. For this purpose, we used a sample of 205 children between 8 and 13 years (105 control group, 28 with ADHD-I, 35 with ADHD-HI, and 37 with ADHD-C), administering a continuous performance test (TOVA), quantified electroencephalogram (Q-EEG), and nir-HEG. Results reflect the counterposed profiles hypothesis instead of the degrees of intensity, although the latter is more habitual and generalized.


We investigated performance-derived measures of executive control, and their relationship with self- and informant reported executive functions in everyday life, in treatment-naive adults with newly diagnosed Attention Deficit Hyperactivity Disorder (ADHD).


This poster session depicts the research conducted to determine the clinical usefulness of the VIRTEST as an objective predictor and measure of response to methylphenidate in the treatment of attention deficit disorders (ADD). The VIRTEST is a continuous performance test programmed for use with the Apple Ile that uses two easily discriminated visual stimuli in two test conditions: one (signal infrequent) in which the target signal occurs infrequently in comparison to nonsignal stimuli; the second (signal frequent) in which the target signal occurs more frequently than nontargets. There are four VIRTEST output variables: errors of omission, errors of commission, response times, and their standard deviations. Subjects tested include 60 children and teenagers referred because of inattention and later diagnosed as having ADD using clinical interviews and Conners Abreviated Teacher's Questionnaires (CPTQ-A). The subject sample was grouped into three cells according to methylphenidate response (Group I responders; Group
II responders but without CPTQ-A changes; and Group II, non-responders). VIRTEST scores showed significant improvement on drug for groups I and II, and no changes on drug for Group III, validating clinical impressions, in spite of CPTQ-A score changes.


**Abstract**—Developmental normative data for 775 children aged 6–16 are presented for the Test of Variables of Attention (T.O.V.A.), a 23-minute fixed-interval visual Continuous Performance Test with minimal language demands and no left-right discrimination. The target is presented on 22.5% and 77.5% of the trials during the first 2nd second halves, respectively, T.O.V.A. indices include omission and commission errors, response time standard deviations, and anticipatory responses. Attention and impulse control developed in a non-linear manner, changing rapidly in early childhood and leveling off during later childhood and adolescence.


Sustained attention measures have received considerable interest in the diagnosis of ADHD. It is assumed by many in clinical work that deficits in sustained attention will predict test performance, particularly on tests, which are speeded or require high levels of concentration. This study investigated the relationship between the Test of Variable Attention (TOVA) and the Wechsler Intelligence Scale for Children-Third Edition (WISC-III). Participants were 43 children referred for neuropsychological evaluation, which included the TOVA and WISC-III as part of a comprehensive battery. The average age was 10.68 years (S.D. =2.55) and average education was 5.14 years (S.D. =2.07). Participants were primarily male (71.4%), right-handed (96.4%), and Caucasian (78.6%). The largest diagnostic groups included psychiatric disorders (22.2%) and neurological disorders (40.7). The results revealed many significant correlations (p < 0.01) between the subtests of the WISC-III and the TOVA (visual and auditory) measurements. At least 1 measure on the TOVA Visual Scale correlated with each scale on the WISC-III with correlations ranging from -0.390 to 0.760. The highest correlated pairs included D-Prime with Arithmetic (0.760), post commission with Information (-0.474), multiple response with Similarities (-0.500), variability with Coding (-0.521) response time total with Object Assembly (-0.609), commission with Similarities (-0.482) and omission with Vocabulary (-0.459). The Auditory TOVA produced correlations with the WISC-III ranging from -0.627 to 0.397. The highest correlations included omission with Block Design (-0.582), commission with Picture Completion (-0.550), response time total with Similarities (-0.620), variability with Arithmetic (-0.627), and post commission with Picture Completion (-0.556). These results support a general factor relating the 2 tests but do not support the idea that poor scores on the TOVA lead specifically to poor scores in those tests requiring sustained attention and concentration. The results indicate the need to revise our understanding of these scores and their impact on test performance.


The effects of the EEG–biofeedback (EEG–BFB) procedure, aimed at increasing the sensorimotor (12–15 Hz) and β1(15–18 Hz) rhythms on the psychological and electrophysiological parameters of attention, were studied using the methods of scalp recording of evoked potentials in the bi-stimulus paradigm Go/No-Go and a psychological attention test (Test of Variables of Attention).

We compared the effect of sex and attention-deficit-hyperactivity disorder (ADHD) subtyping in groups of females and males. One hundred and one females with ADHD (mean age 10y 4mo [SD 2y 8mo]; range 5y-18y) were classified according to subtype by Diagnostic and Statistical Manual of Mental Disorders (4th edn) criteria (inattentive [ADHD-I]; combined [ADHD-C]) and balanced by subtype to 101 males (mean age 10y 5mo [SD 2y 9mo]; range 5y 4mo-17y 6mo). All children underwent IQ and reading assessment, and 109 underwent the continuous performance task (Test Of Variables of Attention [TOVA]). Parents completed the Conners' Abbreviated Rating Scale (ABRS), the Child Behavior Checklist (CBCL), learning disability questionnaires, and reported use and efficacy of methylphenidate. Teachers completed the Swanson, Kotkin, Agler, M-Flynn, and Pelham (SKAMP) rating scale. Sex differences were found only on the CBCL; females were more impaired on the attention (p<0.001) and somatization (p=0.028) subscales but not for IQ, other questionnaires, TOVA scores, methylphenidate treatment, or demographics. Females with ADHD-C, but not males, had significantly higher T-scores than females with ADHD-I on social, attention, delinquent, and aggressive behaviours. Regardless of sex, children with ADHD-C had higher scores on all CBCL subscales (p=0.047), ABRS (p<0.001), and SKAMP (p=0.03) than children with ADHD-I. The results support the supposition that ADHD in females is the same disorder as in males. ADHD subtyping was the important determinant of ADHD core symptoms; females with ADHD were found to have significant risk of psychopathology.


We earlier reported benefits for creativity in rehearsed music performance from alpha/theta (A/T) neurofeedback in conservatoire studies (Egner & Gruzelier, 2003) which were not found with SMR, Beta1, mental skills, aerobics or Alexander training, or in standby controls. Here the focus was the impact on novice music performance. A/T and SMR training were compared in 11-year old school children along with non-intervention controls with outcome measures not only of rehearsed music performance but also of creative improvisation, as well as sustained attention and phenomenology. Evidence of effective learning in the school setting was obtained for A/T and SMR/beta2 ratios. Preferential benefits from A/T for rehearsed music performance were replicated in children for technique and communication ratings. Benefits extended to creativity and communication ratings for creative improvisation which were shared with SMR training, disclosing an influence of SMR on unrehearsed music performance at a novice level with its greater cognitive demands. In a first application of A/T for improving sustained attention (TOVA), it was found to be more successful than SMR training, with a notable reduction in commission errors in the children, 15/33 of whom had attention indices in the ADHD range. Phenomenological reports were in favour of neurofeedback and well-being benefits. Implementing neurofeedback in the daily school setting proved feasible and holds pedagogic promise.


Purpose. The Test of Variables of Attention (TOVA ®) quantitatively measures visual attention using computer generated stimuli. It could be critical in evaluating children having ADHD (Attention Deficit Hyperactivity Disorder) because deficits in visual function can mimic ADHD. Vision Therapy (VT) can improve visual function deficits. Methods. We recruited subjects diagnosed with ADHD and had them use a VT tool, the Eyeport ®. We compared optometric and TOVA ® findings before and after training, and
made observations on subjects. Results. There were significant changes after Eyeport® Training. We also became aware of relevant psychosocial circumstances of many ADHD children. Conclusion. Training with the Eyeport® improved visual attention in subjects previously diagnosed with ADHD.


This is a case report of an adult female patient with ADHD, temporal seizure disorder, and Borderline Personality Disorder treated with 30 weekly sessions of SMR neurofeedback and carbamazepine. Post treatment measures showed improvements in T.O.V.A., self report and QEEG. Both neurofeedback and carbamazepine showed the most effect in early treatment. Progress continued after discontinuance of the drug.


This is a preliminary report on the safety and efficacy of 1.5 ATA hyperbaric oxygen therapy (HBOT) in military subjects with chronic blast-induced mild to moderate traumatic brain injury (TBI)/post-concussion syndrome (PCS) and post-traumatic stress disorder (PTSD). Sixteen military subjects received 40 1.5 ATA/60 min HBOT sessions in 30 days. Symptoms, physical and neurological exams, SPECT brain imaging, and neuropsychological and psychological testing were completed before and within 1 week after treatment. Subjects experienced reversible middle ear barotrauma (5), transient deterioration in symptoms (4), and reversible bronchospasm (1); one subject withdrew. Post-treatment testing demonstrated significant improvement in: symptoms, neurological exam, full-scale IQ (+14.8 points; p<0.001), WMS IV Delayed Memory (p=0.026), WMS-IV Working Memory (p=0.003), Stroop Test (p<0.001), TOVA Impulsivity (p=0.041), TOVA Variability (p=0.045), Grooved Pegboard (p=0.028), PCS symptoms (Rivermead PCSQ: p=0.0002), PTSD symptoms (PCL-M: p<0.001), depression (PHQ-9: p<0.001), anxiety (GAD-7: p=0.007), quality of life (MPQoL: p=0.003), and self-report of percent of normal (p<0.001), SPECT coefficient of variation in all white matter and some gray matter ROIs after the first HBOT, and in half of white matter ROIs after 40 HBOT sessions, and SPECT statistical parametric mapping analysis (diffuse improvements in regional cerebral blood flow after 1 and 40 HBOT sessions). Forty 1.5 ATA HBOT sessions in 1 month was safe in a military cohort with chronic blast-induced PCS and PTSD. Significant improvements occurred in symptoms, abnormal physical exam findings, cognitive testing, and quality-of-life measurements, with concomitant significant improvements in SPECT.


We conducted a double-blind placebo study to investigate the claim that hyperbaric oxygen treatment (HBO) improves the cognitive status of children with cerebral palsy (CP). Of 111 children diagnosed with CP (aged 4 to 12 years), only 75 were suitable for neuropsychological testing, assessing attention, working memory, processing speed, and psychosocial functioning. The children received 40 sessions of HBO or sham treatment over a 2-month period. Children in the active treatment group were exposed for 1 hour to 100% oxygen at 1.75 atmospheres absolute (ATA), whereas those in the sham group received only air at 1.3 ATA. Children in both groups showed better self-control and significant improvements in auditory attention and visual working memory compared with the baseline. However, no statistical difference was found between the two treatments. Furthermore, the sham group improved significantly on eight dimensions of the Conners’ Parent Rating Scale, whereas the active treatment group improved only on one dimension. Most of these positive changes persisted for 3 months. No improvements were observed in either group for verbal span, visual attention, or processing speed.
Tourette Syndrome (TS) in children is associated with various neurobehavioral disorders including attention deficit hyperactivity disorder (ADHD). Children with TS and ADHD show some difficulties with neuropsychological tasks, but we do not know if children with TS alone have neuropsychological deficits. To assess specific cognitive differences among children with TS and/or ADHD, we administered a battery of neuropsychological tests, including 10 tasks related to executive function (EF), to 10 children with TS-only, 48 with ADHD-only, and 32 with TS + ADHD. Children in all groups could not efficiently produce output on a timed continuous performance task [Test of Variables of Attention (TOVA) mean reaction time and reaction time variability]. Children with TS-only appeared to have fewer EF impairments and significantly higher perceptual organization scores than children with TS + ADHD or ADHD-only. These findings suggest that deficiencies in choice reaction time and consistency of timed responses are common to all three groups, but children with TS-only have relatively less EF impairment than children with TS + ADHD or ADHD-only.

It is almost self-evident that test results will be unreliable and misleading if those undergoing assessments do not make a full effort on testing. Nevertheless, objective tests of effort have not typically been used with young adults to determine whether test results are valid or not. Because of the potential economic and/or recreational benefits of obtaining the diagnosis of attention deficit hyperactivity disorder (ADHD) or a learning disability (LD), concerns have been raised regarding the ease with which unimpaired young adults can feign either of these disorders to gain access to test accommodations, stimulant medication, or disability benefits. Much evidence has been presented recently regarding the need for symptom validity tests (SVTs) in assessment of college-aged students seeking diagnoses of LD and/or ADHD. Four cases are presented here in which intelligence and other test scores of young adults greatly underestimated their actual abilities, owing to poor effort that sometimes went undetected. Selected effort tests for use with young adults are discussed. Objective testing of effort is recommended to avoid misinterpreting invalid test data, which is why the use of effort tests is now standard practice in forensic neuropsychology.

Seventeen 10-12-year-old boys were tested with a CPT, namely, the Test of Variables of Attention (T.O.V.A.™), while EEG was simultaneously recorded. Pearson Product Moment correlations were computed between each of four T.O.V.A. parameters (i.e., errors of omission (%EO), commission (%EC), reaction time (RT), and reaction time variability (RTV)) and EEG parameters (i.e., delta (.5-4 hertz), theta (4-8 hertz), and alpha (8-12 hertz); and sites C3, C4, CZ, P3, P4, PZ, FZ, O1, O2). Alpha was significantly (p < .05) positively correlated with all T.O.V.A. parameters except RT, while delta and theta showed significant (p < .05) negative correlations with %EO, %EC, and RTV. There were no significant correlations with RT in any bands or sites. Utilizing multiple stepwise regression, strong predictive relationships were found to exist for %EO and %EC, using the EEG bands of alpha and delta as independent variables. Results suggest that delta and alpha bands bear an important relationship with the construct of attention.
OBJECTIVE: Gender differences among children with ADHD are not well understood. The continuous performance test (CPT) is the most frequently used direct measure of inattention and impulsivity. This meta-analysis compared CPT performance between boys and girls with and without ADHD. METHOD: All peer-reviewed ADHD studies published between 1980 and 2010 that used a CPT and enabled gender comparison were included. Gender differences in commission (impulsivity) and omission (inattention) errors were analyzed. RESULTS: Included studies comprised a sample of 772 boys and 325 girls with ADHD. Findings show that boys were significantly more impulsive than girls, but no difference with inattention was found. Within-gender analysis revealed that the difference among boys with and without ADHD was significantly larger than the difference among girls with and without ADHD. CONCLUSION: The results indicate that gender is a significant moderating factor in the assessment of core ADHD symptoms when using CPTs.
admissions to an adolescent inpatient unit were examined. The severity of suicidal behavior was measured with the Childhood Suicide Potential Scale (CSPS), and impulse control was measured with the self report Plutchik Impulse Control Scale (ICS) and with the Test of Variables of Attention (TOVA), a continuous performance test (CPT). The TOVA is used to diagnose adolescents with attention deficit disorder. RESULTS: There was a significant but low correlation between the two measures of impulsivity. Only the TOVA commission and omission errors differentiated between adolescent suicide attempters and nonattempters. CONCLUSIONS: Computerized measures of impulsivity may be a useful way to measure impulsivity in adolescent suicide attempters. Impulsivity appears to play a small role only in nondepressed suicidal adolescents, especially boys.


To assess obstructive sleep apnea syndrome (OSAS) and periodic limb movement disorder (PLMD) in children with attention deficit/hyperactivity disorder (ADHD) compared with a control group. The ADHD was diagnosed based on Diagnostic and Statistical Manual, version IV (DSM-IV) criteria on successively seen elementary school children aged 6-12 years referred to a psychiatric clinic for suspected ADHD. A standardized interview (Kiddie-SADS-E), parents and teacher questionnaires, neuropsychological testing, and nocturnal polysomnography were completed for each child. Eighty-eight children (77 boys) with ADHD and 27 controls were involved in the study. Fifty children with ADHD (56.8%) had an apnea-hypopnea index (AHI) >1 event h(-1) and 17 (19.3%) had an AHI >5 event h(-1). Nine children (10.2%) had a periodic limb movement index (PLMI) >5 events h(-1). There is one child with AHI >1 and one with a PLMI > 5 in the control group. In the test of variables of attention (TOVA), the response time was significantly worse in ADHD with sleep disorders than those without them. The child behavior checklist (CBCL) showed a significant difference between groups in the hyperactivity subscale. The diagnostic criteria for ADHD based on DSM-IV do not differentiate between children with or without sleep disorders. Evaluation of sleep disorders should be considered before starting drug treatment for ADHD.


BACKGROUND: Children diagnosed with attention-deficit/hyperactivity disorder (ADHD), based on Diagnostic and Statistical Manual of Mental Disorders, Fourth edition (DSM-IV) criteria, may also have obstructive sleep apnea (OSA), but it is unclear whether treating OSA has similar results as methylphenidate (MPH), a commonly used treatment for ADHD. METHODS: This study enrolled 66 school-age children, referred for and diagnosed with ADHD, and 20 healthy controls. Polysomnography (PSG) performed after ADHD diagnosis showed the presence of mild OSA. After otolaryngological evaluation, parents and referring physicians of the children could select treatment of ADHD with MPH, treatment of OSA with adenotonsillectomy or no treatment. Systematic follow-up was performed six months after initiation of treatment, or diagnosis if no treatment. All children had pre- and post-clinical interviews; pediatric, neurologic, psychiatric and neurocognitive evaluation; PSG; ADHD rating scale, child behavior checklist (CBCL) filled out by parents and teacher; test of variables of attention (TOVA); and the quality of life in children with obstructive sleep disorder questionnaire (OSA-18). RESULTS: ADHD children had an apnea-hypopnea index (AHI)>11 considered abnormal is detrimental to children with ADHD. Recognition and surgical treatment of underlying mild sleep-disordered breathing (SDB) in children with ADHD may prevent unnecessary long-term MPH usage and the potential side effects associated with drug intake.

This study attempted to determine the acute effects of methylphenidate (MPH) on cognitive performance using the Test of Variables of Attention (TOVA) in children with attention deficit/hyperactivity disorder (ADHD). The study subjects comprised 57 children diagnosed with ADHD aged 6–13 years. Diagnoses of ADHD and other comorbid psychiatric disorders were based on Diagnostic and Statistical Manual of Mental Disorders-fourth edition criteria following a standard interview with the Schedule for Affective Disorder and Schizophrenia for School-Age Children, epidemiologic version. The subjects’ performance on the TOVA was compared before and 1 h after administration of MPH. After administration of MPH, commission scores, response time and ADHD scores improved significantly, however, there were no significant changes in omission scores, response time variability, or response sensitivity. The authors concluded that administration of one dose of MPH (0.5–1.0 mg/kg) produced more effects on impulsivity than on attention deficiency in children with ADHD, and that the second half section of the TOVA could be more sensitive than the first half in determining the acute effects of MPH therapy in children with ADHD. However, the effects of different MPH doses on the TOVA results need further investigation.


Methylphenidate (MPH), a psychostimulant, is the most widely administered drug for the pharmacological management of patients with attention deficit hyperactivity disorder (ADHD). This study attempts to determine whether sustainable improvements occur in neurocognitive function among ADHD patients following 12-month treatment with MPH, at drug-free status. Whether age groups, gender or ADHD subtypes differ in neurocognitive performance during MPH treatment is also examined. Study participants consisted of 103 ADHD patients (mean age: 9.1 ± 1.9 years old) who were drug naïve or drug free for at least 6 months. The patients were prescribed oral short-acting MPH at each dose range of 0.3-1.0 mg/kg daily. During 12 months of the study, the patients underwent the test of variables of attention (TOVA) at the baseline, month 6 and month 12. Patients were instructed to not intake MPH for one week before the second and the third TOVA. Seventy five patients completed the study. Results of this study indicated that although commission errors and response sensitivity (d') significantly improved during MPH treatment for 12 months, omission errors, response time, response time variability and ADHD score did not. While younger ADHD patients (<9 y/o) performed better in response time, response time variability, d' and ADHD score than older ones (≥9 y/o), the latter more significantly improved in response time than the former during 12 months of treatment. Additionally, boys improved more than girls in omission error and d'. Moreover, although ADHD subtypes significantly differed in ADHD score during the treatment, MPH treatment and ADHD subtypes did not interact with each other for all TOVA indices. ADHD patients significantly improved in impulsivity and perceptual sensitivity, determined as TOVA, during MPH treatment for 12 months. Age and gender, yet not ADHD subtypes, appear to influence the MPH treatment effects in some indices of TOVA. A future study containing a comparison group is suggested to confirm whether the neurocognitive improvements are attributed to long-term effects of MPH or natural maturation of patients.


ABSTRACT. Background: Poor self-regulation of arousal is central to the behavioral difficulties experienced by children with traumatic caretaker attachment histories. EEG biofeedback teaches children to self-regulate brain rhythmicity, which may in turn affect global improvements in the areas of attention,
aggression, impulse control, and trust formation. Research literature reports successful use of neurofeedback for children with ADHD, autism, asthma, stroke, and migraine. This study extends current research by investigating the effectiveness of neurofeedback in reducing behavioral problems commonly observed in abused/neglected children. **Methods:** Treatment records of twenty adopted children with histories of removal from their biological home by Child Protective Services were obtained from a private neurofeedback practice. All of the children were assessed prior to treatment using the Child Behavior Checklist (CBCL) and the Test of Variables of Attention (TOVA) and again after 30 sessions of individualized qEEG-guided neurofeedback. **Results:** T-test analysis of pre- and post- scores on the CBCL showed significant changes in the areas of externalizing problems, internalizing problems, social problems, aggressive behavior, thought problems, delinquent behavior, anxiety/depression, and attention problems (\( p < .05 \)). TOVA omission error, commission error, and variability scores also significantly following neurofeedback training (\( p < .05 \)). Some pre-treatment qEEG patterns common to this group of children were identified. **Conclusions:** The CBCL and TOVA score improvements observed in this study indicate that neurofeedback is effective in reducing behavioral, emotional, social, and cognitive problems in children with histories of neglect and/or abuse.


**ABSTRACT:** Attention deficits are commonly associated with TS, but little is known about the attentional mechanisms impaired in TS and whether they share common features with ADD. In this study, we investigated several aspects of attention that are believed to be mediated by different neuroanatomic loci, to determine 1) if TS and ADD share common patterns of attention deficit and 2) to learn more about possible brain-behavior relationships in TS. To date, ten children with TS and 5 with ADD have been studied. All had normal IQ's. Each received a behavioral test battery which included the Test of Variables of Attention (TOVA), Cancellation, Verbal Fluency, Trailmaking, and Williams Inhibition Test (which tests the Stroop effect). Six TS children had abnormal TOVA results indicative of ADD. Two additional TS subjects diagnosed with ADD had been given medication the morning of testing, and did not have abnormal TOVA's. TS and ADD groups had similar results for all tests except Trails, in which TS subjects took longer to complete the task than did ADD, and Cancellation, in which TS subjects completed the search for random targets faster than did ADD. These preliminary results suggest that children with TS may have subcortical dysfunction (based on Trailmaking results), whereas children with ADD may have more frontal lobe dysfunction (based on motor planning problems reflected by the Cancellation task). A larger number of subjects will be needed to further substantiate these findings.


The study addressed the issue of arithmetic deficiencies in children with Tourette syndrome (TS) as well as explanations for such deficiencies. A total of 47 children with TS were assigned to three subgroups based on a composite attention score from the Test of Variables of Attention (TOVA). These children, along with 17 normal controls between 8 and 16 years of age, were tested on standardized measures of IQ, attention, visuospatial ability, and arithmetic achievement. The children also were administered an experimental calculation task with two levels of structure. Children with TS scored below controls on tests of IQ, attention, and arithmetic achievement but not visuospatial ability. The TS subgroup with the greatest impairment of attention accounted for most of the differences in arithmetic achievement. Regression analysis, based on the 47 children with TS, indicated that IQ and TOVA scores were the best predictors of arithmetic achievement. Likewise, the experimental calculation task indicated that the poor performance of some children with TS could be attributed to deficient attention. Irrespective of structure, children in the TS subgroup with the greatest attentional impairment made more attention (but not visuospatial) errors than did controls on the experimental task. Thus, on both the standardized and the
experimental tasks, poor arithmetic skill was found only in children with TS who had significant attentional deficits.


Abstract: Pagophagia (compulsive ice chewing) has long been associated with iron deficiency anemia, but prior attempts to account for this craving have been unsatisfactory. We hypothesize that chewing ice triggers vascular changes that lead to preferential or increased perfusion of the brain. This would result in increased alertness and processing speed in anemic patients, but not in healthy controls who are already at ceiling, and would explain why anemic individuals crave ice. Preliminary support for this hypothesis was found in two studies. In Study 1, non-anemic subjects reported very low rates of pagophagia (only 4%) while anemic subjects reported significantly higher rates (56%). In Study 2, chewing ice dramatically improved response time on a neuropsychological test, but only for anemic individuals. In a small randomized controlled trial, iron deficient anemic subjects and healthy controls were assigned to chew ice or drink tepid water and then took a continuous performance test that measures response time, response time variability, errors of impulsivity and errors of inattention. In the water condition, anemic subjects performed significantly worse than healthy controls. Chewing ice had no effect on the performance of healthy controls, but significantly improved the performance of anemic patients. Potential explanations include activation of the dive reflex, which would lead to peripheral vasoconstriction and preferential perfusion of the brain or, alternatively, sympathetic nervous system activation, which would also increase blood-flow to the brain.


The Test of Variables of Attention (TOVA) is a continuous performance test that assesses attention, impulsivity, and processing speed. Continuous performance tests are used in the assessment of attention-deficit/hyperactivity disorder (ADHD) in children and adults. TOVA norms are based on a morning administration, and any TOVA administered after 1:00 p.m. is flagged as potentially invalid. Whereas the testing time recommendations make sense for pediatric samples, it is unclear whether they are appropriate for young adults, who typically show significant phase delay in their diurnal rhythms. The current study explores the impact of time of day on TOVA performance in young adults with ADHD. Participants were randomly assigned to either morning or afternoon administration. We found no significant diurnal variation in TOVA performance. We also found no interaction between diurnal preference and time of day of administration. Night owls endorsed more inattention symptoms on a self-report measure than more intermediate individuals but actually made significantly fewer omission (inattention) errors on the TOVA. Self-reported symptoms of inattention showed moderate, significant correlations with various TOVA performance indices. Self-reported symptoms of hyperactivity and impulsivity, however, showed no relationship to TOVA performance. These results suggest that the TOVA can be administered to adults with ADHD outside of the hours recommended in the manual without significantly compromising the interpretative validity of test score interpretation. Thus, a TOVA report that is consistent with ADHD should not be dismissed simply because it was administered in the late afternoon.


The Test of Variables of Attention (TOVA) is a continuous performance test (CPT) that assesses attention, impulsivity, and processing speed. CPTs are used in the assessment of
attention-deficit/hyperactivity disorder (ADHD) in children, but more young adults are being assessed for ADHD as well. The TOVA norms are based on a standardization sample that was tested early in the day, and any TOVA administered after 1:00 p.m. will be flagged as potentially invalid. Whereas the testing time recommendations make sense for pediatric samples, it is unclear whether they are appropriate for young adults in college, who typically show significant phase delay in their diurnal rhythms. In addition, many college students consume large amounts of caffeine, and it is unclear how caffeine consumption affects TOVA performance. The current study examined the impact of time of day, self-reported diurnal preference, and caffeine consumption on TOVA performance in a double-blind, placebo-controlled experiment with healthy college students. There was evidence of diurnal variation on average response time and impulsivity but not on overall ADHD score, with participants tested in the afternoon responding faster but making more commission errors than did participants tested in the morning. Caffeine consumption led to significantly faster response times, but only for participants who typically consumed relatively little caffeine. We conclude that the TOVA can be administered to young adults outside the recommended time constraints without compromising the validity of test score interpretation but that the caffeine consumption of participants should be closely monitored.


OBJECTIVE: To examine the performance differences on the Test of Variables of Attention (TOVA) among different IQ level groups. METHOD: The present study examined the results of the TOVA with 138 elementary students aged 6 to 10 years who were assigned to one of four different groups based on their scores from the Wechsler Nonverbal Scale of Ability (WNV; low average: IQ 129). The latter two groups were combined. RESULTS: On all TOVA measures (response time, response time variability, errors of omission and commission, and ADHD scores), intellectual functioning significantly influenced performance. CONCLUSION: The results of the present study indicate that performance on the TOVA was affected by intellectual functioning.


Objective: To examine the diurnal assumptions of the Test of Variables of Attention (TOVA). Method: The present study assessed 122 elementary students aged 5.5 to 10.0 years who were randomly assigned to one of four different groups based on time of administration (M-M: Morning–Morning, M-A: Morning–Afternoon, A-M: Afternoon–Morning, and A-A: Afternoon–Afternoon). Morning administration occurred between 8:00 and 10:00 a.m., and afternoon administration occurred between 1:00 and 3:00 p.m. Results: Reliability was consistent across groups, and there were no significant differences between groups. Classification of the students into ADHD or non-ADHD groups was similar across groups, and the children who were identified as ADHD with the Vanderbilt ADHD Diagnostic Teacher Rating Scale were consistently classified as ADHD on the TOVA regardless of time of day. Conclusion: The results of the present study indicate that the psychometric values of the TOVA remain intact whether its administration was in the morning or afternoon.


To assess the frequency and severity of specific cognitive deficits in children with neurofibromatosis type 1 (NF1) in a large unbiased cohort.

Boys diagnosed with ADHD by specialist pediatricians and stabilized on medication were randomly assigned to a 20-session yoga group (n = 11) or a control group (cooperative activities; n = 8). Boys were assessed pre- and post-intervention on the Conners’ Parent and Teacher Rating Scales–Revised: Long (CPRS-R:L & CTRS-R:L; Conners, 1997), the Test of Variables of Attention (TOVA; Greenberg, Cormna, & Kindschi, 1997), and the Motion Logger Actigraph. Data were analyzed using one-way repeated measures analysis of variance (ANOVA). Significant improvements from pre-test to post-test were found for the yoga, but not for the control group on five subscales of the Conners’ Parents Rating Scales (CPRS): Oppositional, Global Index Emotional Lability, Global Index Total, Global Index Restless/Impulsive and ADHD Index. Significant improvements from pre-test to post-test were found for the control group, but not the yoga group on three CPRS subscales: Hyperactivity, Anxious/Shy, and Social Problems. Both groups improved significantly on CPRS Perfectionism, DSM–IV Hyperactive/Impulsive, and DSM–IV Total. For the yoga group, positive change from pre- to post-test on the Conners’ Teacher Rating Scales (CTRS) was associated with the number of sessions attended on the DSM–IV Hyperactive-Impulsive subscale and with a trend on DSM–IV Inattentive subscale. Those in the yoga group who engaged in more home practice showed a significant improvement on TOVA Response Time Variability with a trend on the ADHD score, and greater improvements on the CTRS Global Emotional Lability subscale. Results from the Motion Logger Actigraph were inconclusive. Although these data do not provide strong support for the use of yoga for ADHD, partly because the study was under-powered, they do suggest that yoga may have merit as a complementary treatment for boys with ADHD already stabilized on medication, particularly for its evening effect when medication effects are absent. Yoga remains an investigational treatment, but this study supports further research into its possible uses for this population. These findings need to be replicated on larger groups with a more intensive supervised practice program.


This study examined the relation of middle ear effusion (MEE) in the first three years of life to central auditory processing at age seven. Ears were examined on a regular basis frequently in the home over the first three years and a count of days with bilateral MEE was used to quantify ear status. Central auditory processing was assessed with SCAN, Screening Test for Auditory Processing Disorders. With a sample of 76 children studied prospectively from birth there were significant correlations between MEE and all four SCAN measures. A possible link between SCAN and attention problems was also examined using the Test of Variables of Attention (TOVA). Three of 16 possible correlations were significant, suggesting a weak relation between attention and SCAN.


Objective—The goal of this study was to investigate auditory function in individuals with deficits in musical pitch perception. We hypothesized that such individuals have deficits in non-speech areas of auditory processing. Design—We screened 865 randomly selected individuals to identify those who scored poorly on the Distorted Tunes Test (DTT), a measure of musical pitch recognition ability. Those who scored poorly were given a comprehensive audiologic examination, and those with hearing loss or other confounding audiologic factors were excluded from further testing. Thirty-five individuals with tune deafness constituted the experimental group. Thirty-four individuals with normal hearing and normal DTT scores, matched for age, gender, handedness, and education, and without overt or reported psychiatric disorders made up the normal control group. Individual and group performance for pure tone frequency
discrimination at 1000 Hz was determined by measuring the difference limen for frequency (DLF). Auditory processing abilities were assessed using tests of pitch pattern recognition, duration pattern recognition and auditory gap detection. In addition, we evaluated both attention and short- and long-term memory as variables that might influence performance on our experimental measures. Differences between groups were evaluated statistically using Wilcoxon non-parametric tests and t-tests as appropriate. Results—The DLF at 1000 Hz in the group with tune deafness was significantly larger than that of the normal control group. However, approximately one third of participants with tune deafness had DLFs within the range of performance observed in the control group. Many individuals with tune deafness also displayed a high degree of variability in their inter-trial frequency discrimination performance which could not be explained by deficits in memory or attention. Pitch and duration pattern discrimination, and auditory gap detection ability were significantly poorer in the group with tune deafness than the normal control group. Approximately one third of our participants with tune deafness displayed evidence of attention deficit with hyperactivity disorder (ADHD) on the Test of Variables of Attention (TOVA). TOVA scores were significantly correlated with gap detection scores, but not significantly correlated with any of the other experimental measures, including the DTT, DLF and auditory pattern discrimination tests. Short- and long-term memory was not significantly related to any of the experimental measures. Conclusions—Individuals with tune deafness identified by the DTT have poor performance on many tests of auditory function. These include pure tone frequency discrimination, pitch and duration pattern discrimination, and temporal resolution. Overall, reduction in performance does not appear to derive from deficits in memory or attention. However, because of the prevalence of ADHD in those with tune deafness, this variable should be considered as a potentially confounding factor in future studies of tune deafness and its characteristics. Pure tone frequency discrimination varied widely in individuals with tune deafness, and the high degree of inter-trial variability suggests that frequency discrimination may be unstable in tune deaf individuals.


Abstract Introduction . It has been suggested that the behavioral manifestations of attention deficit hyperactivity disorder (ADHD) are secondary to neurological abnormalities and are characterized as low brain wave disorders. ADHD children produce higher amounts of theta (5-7 Hz) and less beta (13-21 Hz) brain wave activity than normals. Many researchers are testing the therapeutic effectiveness of AudioVisual Entrainment (AVE) as a treatment for a variety of low arousal brain disorders. AVE is the repetitive and intermittent presentation of light and sound. AVE affects electroencephalographic (EEG) output in that brain wave output can be suppressed or enhanced at specific frequencies. Procedure. Thirty-four elementary students from two different schools were given AVE over the course of seven weeks. Participants were given the Test of Variables of Attention (TOVA) before and after participation. A second group of eight participants were in a special reading (SPALDING) class. All of the students in this class received the Standardized Test for the Assessment of Reading (STAR) and were compared with a control group, n = 12. Results. Overall inattention, impulsivity and variability as rated by the TOVA improved significantly. The eight students from the SPALD-ING reading program who received AVE improved their reading scores more than their classmates who served as controls. The results included normalization as recorded on the TOVA, substantial improvements in reading as recorded on the STAR, and improvements in general behavior as noted by teachers and parents. Discussion. The data suggests AVE was a useful experience for the participants. Parents and teachers reported the children were calmer and could focus better. The results met or exceeded our expectations.

Julsgaard, S. B., Jensen, C. M., & Lauritsen, M. B. (n.d.). *Impact of intelligence on performance on the Test of Variables of Attention in children with Attention-Deficit/Hyperactivity Disorder or Attention Deficit Disorder.*
Introduction: Test of Variables of Attention (TOVA) is used as a diagnostic tool in the assessment of Attention-Deficit/Hyperactivity Disorder (ADHD) and Attention Deficit Disorder (ADD). Existing literature suggests that intelligence may influence performance on TOVA, however research on this topic is limited. The purpose of this study was to identify whether there exists a correlation between Full Scale Intelligence Quotient (FSIQ) and TOVA scores among children with ADHD or ADD. A second aim was to investigate if IQ index scores correlated with TOVA scores in the same group of children. Methods: Hospital records of children aged six to 17 years with ADHD or ADD who attended the Department of Child and Adolescent psychiatry, Aalborg University Hospital from 1st June 2014 to 31st May 2015 were collected. To be included, the child had to have completed both an intelligence test and a TOVA test. Data were analyzed using descriptive statistics, Pearson’s correlation test and Kruskal Wallis test. Results: The sample comprised 75 children. There were significant correlations between FSIQ and all TOVA variables except from response time (RT). Additionally, IQ index scores correlated with some of the TOVA variables as well. Correlations were positively associated and weak to moderate in strength. Significant differences in some TOVA variables were demonstrated when children were grouped according to IQ. Discussion and conclusion: Intellectual functioning significantly influenced TOVA performance. Children with low IQ performed significantly poorer than children with high IQ of whom some despite ADHD/ADD passed the TOVA test. This questions sensitivity and specificity of the test. A small sample size, no appropriate control group and lack of a limited time span between conduction of the intelligence- and TOVA test impaired results, thus results must be interpreted with caution.


Background: Neurofeedback studies have been criticized for including small numbers of subjects. The effect of SMR-beta neurofeedback training on the Test of Variables of Attention was evaluated in more than 1,000 subjects from thirty-two clinics. *Methods:* 1089 subjects (726 children, 324 females, 186 with ADHD or ADD diagnoses) underwent twenty or more sessions of SMR-beta neurofeedback training for attentional and behavioral complaints at thirty-two clinical settings affiliated with EEG Spectrum, Inc. Subjects were evaluated prior to training and at training completion. One hundred and fifty-seven subjects who elected extensive training (forty sessions or more) were tested after both twenty and forty training sessions. *Results:* Neurofeedback training produced significant improvement in attentiveness, impulse control, and response variability. Significant clinical improvement in one or more measures was seen in eighty-five percent of those subjects with moderate pre-training deficits. *Conclusions:* Neurofeedback training is effective in remediating attentional dysfunction. Nevertheless, large-scale studies with greater control (e.g., wait-list designs) are sorely needed.


Evaluation of the efficacy of a patented, compound herbal preparation (CHP) in improving attention, cognition, and impulse control in children with ADHD. A randomized, double-blind, placebo-controlled trial. University-affiliated tertiary medical center. 120 children newly diagnosed with ADHD, meeting DSM-IV criteria. Random assignment to the herbal treatment group (n = 80) or control group (placebo; n = 40); 73 patients in the treatment group (91%) and 19 in the control group (48%) completed the 4-month trial. Test of Variables of Attention (TOVA) administered before and after the treatment period; overall score and 4 subscales. The treatment group showed substantial, statistically significant improvement in the 4 subscales and overall TOVA scores, compared with no improvement in the control group, which persisted in an intention-to-treat analysis. The well-tolerated CHP demonstrated improved attention, cognition, and impulse control in the intervention group, indicating promise for ADHD treatment in children.
Attention deficits are prevalent among individuals with substance use disorders and may interfere with recovery. The present study evaluated the effectiveness of an automated electroencephalogram (EEG) biofeedback system in recovering illicit substance users who had attention deficits upon admission to a comprehensive residential treatment facility. All participants (n = 95) received group, family, and individual counseling. Participants were randomly assigned to 1 of 3 groups that either received 15 sessions of automated EEG biofeedback (AEB), 15 sessions of clinician guided EEG biofeedback (CEB), or 15 additional therapy sessions (AT). For the AEB and CEB groups, operant contingencies reinforced EEG frequencies in the 15-18 Hz (beta) and 12-15 Hz (sensorimotor rhythm, "SMR") ranges and reduce low frequencies in the 1-12 Hz (Delta, theta, and alpha) and 22-30 Hz (high beta) ranges. The Test of Variables of Attention (TOVA), a "Go-NoGo" task, was the outcome measure. Attention scores did not change on any TOVA measure in the AT group. Reaction time variability, omission errors, commission errors, and d' improved significantly (all p values < .01) in the AEB and CEB groups. AEB and CEB did not differ significantly from each other on any measure. The results demonstrate that automated neurofeedback can effectively improve attention in recovering illicit substance users in the context of a comprehensive residential substance abuse treatment facility.

INTRODUCTION: The purpose of this pilot study was to explore the potential for the use of binaural auditory beat stimulation to reduce the symptom of inattention in children and adolescents with attention-deficit/hyperactivity disorder. METHODS: This pilot study had a randomized, double-blind, placebo-controlled design. Twenty participants were randomly assigned to listen to either an audio program on compact disk that contained binaural auditory beats or a sham audio program that did not have binaural beats for 20 minutes, three times a week for 3 weeks. The Children's Color Trails Test, the Color Trails Test, the Test of Variables of Attention (TOVA), and the Homework Problem Checklist were used to measure changes in inattention pre- and postintervention. RESULTS: Repeated measures analysis of variance was used to analyze pre- and postintervention scores on the Color Trails Tests, Homework Problem Checklist, and the TOVA. The effect of time was significant on the Color Trails Test. However, there were no significant group differences on the Color Trails Test or the TOVA scores postintervention. Parents reported that the study participants had fewer homework problems postintervention. DISCUSSION: The results from this study indicate that binaural auditory beat stimulation did not significantly reduce the symptom of inattention in the experimental group. However, parents and adolescents stated that homework problems due to inattention improved during the 3-week study. Parents and participants stated that the modality was easy to use and helpful. Therefore, this modality should be studied over a longer time frame in a larger sample to further its effectiveness to reduce the symptom of inattention in those diagnosed with attention-deficit/hyperactivity disorder.

Purpose. The purpose of this investigation was to determine the effectiveness of binaural auditory beat stimulation in reducing the symptom of inattention in children and adolescents with Attention-Deficit Hyperactivity Disorder (ADHD). Methods. This study was a randomized, double-blind, placebo-controlled clinical investigation to determine the effectiveness of binaural auditory beats on the symptom of
inattention in children with ADHD. Participants were randomly assigned to listen to a CD that contained binaural auditory beats or a sham CD, three times a week for three weeks while completing homework assignments. The sample was comprised of 20 children and adolescents, eight to twenty-one years of age. Participants were recruited from Charlottesville, Virginia and the surrounding counties via newspaper advertisements, brochures and flyers that were posted in the Primary Care Clinic at the University of Virginia's Health Center and local pediatrician's offices. Measures. The Children's Color Trails Test, The Color Trails Test and the Test of Variables of Attention (TOVA) were used to measure changes in inattention pre and post intervention. The Homework Problem Checklist was used to measure changes in homework behaviors during the three week study. Results. Repeated measures ANOVA were used to analyze pre and post intervention scores on the Color Trails Tests. Analysis of Covariance (ANCOVA) was used to analyze pre and post intervention scores on the TOVA. The effect of time was significant on the Color Trails Test. However, there were no significant group differences on this measure. In addition, there were no significant group differences on the TOVA when pre and post-intervention scores were compared. Repeated measures ANOVA were used to evaluate changes on the Homework Problem Checklist over three week intervention. Homework problems significantly decreased in both groups; however, group differences were not significant. Conclusion. The results from the present study suggest that BABS did not significantly reduce the symptom of inattention in children and adolescents affected with Attention Deficit Hyperactivity Disorder. This may be attributable to the small sample size. Therefore, this modality should be studied using a sufficient sample to determine its effectiveness to reduce the symptom of inattention in those diagnosed with ADHD.


ABSTRACT: The primary objective of this study was to improve the educational success of children with sickle-cell disease (SCD) and cerebral infarcts. A prospective intervention trial was conducted; a multidisciplinary team was created to maximize educational resources for children with SCD and cerebral infarcts. Students were evaluated systematically before and after the intervention. A baseline evaluation was completed assessing the presence of an Individualized Education Plan (IEP), grade retention in school, and days absent from school in the year preceding the intervention. A postintervention assessment occurred 2 years later for these same measurements. At baseline, 74% (17 of 23) of the students were receiving IEPs. Two years later, 87% (20 of 23) students received IEPs (p 1/4 .34). Despite the intervention, the rate of children retained in their school grade increased from 0.6 per 100 years in school at baseline to 1.7 per 100 years, 95% CI (y3.86, 1.49). The school absenteeism rate did not significantly change after the intervention; the average days absent per student rose from 15.5 to 22.5, (p 1/4 .05). The multidisciplinary team effort alone was insufficient to decrease grade retention and absenteeism rate. Further support, from either the parents or school administration, is needed to increase education attainment of students with cerebral infarcts.

This study was designed to assess the clinical efficacy of EEG-Driven Stimulation (EDS) on attention and memory of adults with Attention Deficit Hyperactivity Disorder. Two groups were used in the study, a photic stimulation EDS group (N = 12; mean age = 37.7) and a stimulant medication (MED) group (N = 13; mean age = 45.8). Both groups were similar with respect to age, IQ, an approximate measure of hypnotic ability, gender, and primary and secondary diagnoses. Participants in the MED group were adults already taking stimulant medication. They were off their medication 24 hours prior to and during pretesting. For the remainder of the study and during posttesting, they remained on their medication. Due to the individualized nature of the EDS training protocol, participants in the EDS group were in treatment from 4 to 5 months with a mean number of treatment sessions being 28. The generalized goal of training was to reduce amplitude in delta and alpha bands from 21 scalp locations down to 2-3 microvolts. It was hypothesized that EDS training would be associated with a significant decrease in theta/high beta power ratios along with significant improvements in attention and memory. It was also hypothesized that the EDS group and MED group would demonstrate comparable improvements in attention and memory. The Test of Variables of Attention (TOVA), the Rey Auditory-Verbal Learning Test (RAVLT), and theta/high beta power ratios from 21 scalp locations were used to assess both groups' pre- to posttreatment changes in attention, memory, and EEG activity. Statistically significant results in attention were observed in both treatment groups. For the memory variables, only the IVIED group yielded statistically significant results. Regarding difference in degree of improvement in attention and memory variables, no statistical significance was found between treatment groups. Though not significant, an overall reduction in theta/high beta power ratios along 21 scalp locations for the EDS group was observed. No difference in power ratios, from nonmedicated to medicated conditions was demonstrated in the MED group. Despite the apparent ability of both EEG-driven stimulation and stimulant medication to improve adult attention, the hypothesized mechanism for change, that is, reductions in theta/high beta power ratios, was not found to be a correlate of change, nor was hypnotic ability or suggestibility found to be a factor. These clinical findings suggest that physiological and psychological mechanisms may have had only a limited impact on change. Further research is needed to assess the influence of proposed mechanisms of change as well as nonspecific effects.


The effects of amitriptyline (Elavil) and methylphenidate (Ritalin) on the vigilance of 20 hyperactive/aggressive children was investigated using an auditory version of the Continuous Performance Test (CPT). Over the course of this letter-detection task, correct detections tended to return to pretreatment levels under placebo, but were maintained at significantly improved levels under amitriptyline and methylphenidate. The relatively steep performance decrement which occurred in the placebo condition was found to be associated with a progressive increase in responses to the letter which immediately followed a target letter. Treating these 'late' responses as slow but 'correct' detections failed to eliminate the treatment effects obtained with amitriptyline and methylphenidate. It was concluded that in addition to keeping detection response latencies from increasing, the medications produced a heightened level of vigilance which resulted in an absolute increase in the number of correct detections. The facilitation of vigilance performance by amitriptyline was in apparent contradiction to reports by parents and teachers that children appeared 'drowsy' while receiving this medication. Findings of the study suggested that children's ability to process information was unaffected by the reported side effect.


The Test of Variables of Attention (TOVA) is a continuous performance test commonly used to evaluate symptomatology associated with Attention Deficit Hyperactivity Disorder (ADHD). The current study
investigated the TOVA's sensitivity for detecting feigned symptoms of ADHD in a coached simulator research design, relative to the accuracy of the Word Memory Test (WMT) for classifying participants as having provided poor or good effort during the examination. Data regarding TOVA and WMT performance were collected from undergraduate student participants, which included 24 persons coached to simulate ADHD symptoms and 27 individuals instructed to give their best effort throughout the testing. The TOVA results yielded an overall accuracy of 86% (79% sensitivity; 93% specificity) for classifying individuals into their correct groups. Commonly used cut scores from WMT yielded 96% correct classification (92% sensitivity; 100% specificity) of the participants. While the WMT's classification rates were slightly higher than the rates for the TOVA, a z-test for two proportions indicated the rates for the two tests did not differ significantly (p = .078). Overall, the study findings provide support for the utility of TOVA embedded effort indicators to detect feigned impairment when evaluating for ADHD.


Six new scales for the TOVA were developed: Omission Variability, Commission Variability, Omission Learning Slope, Omission Performance Slope, Commission Learning Slope and Commission Performance Slope. The variability scales examine within subject variance for the Omission and Commission Scales already in existence. The two learning slopes offer an objective measure of the subject's ability to respond to the novel task demands of the task. The performance scales provide an objective measure of the sustain inhibition and attention over both time and demands of the test. The normal control group consisted of 913 subjects (453 males, 460 females) from the Greenberg and Waldman (1993) normative data base. Group one ADHD sample consisted of 104 subjects (85 males, 19 females) from the same 1993 data base. Group two ADHD subjects came from the author's clinic. This sample consisted of 196 subjects 142 males, 54 females) seen for ADHD evaluation. ADHD was determined by DSM-III-R standards for Group 1 and DSM-IV for Group 2. Diagnosis in both groupings was made independent of test results by licensed providers. Results of t-tests for mean score differences between the Normal controls and ADHD Group 1 were significant for five (5) of the new scales, excepting Commission Learning Slope. Results of t-tests for mean score differences between Normal controls and ADHD Group 2 were significant for all six (6) scales. Comparison between normal controls and a collapsed sample from both groups found significance for all six (6) new scales. Discussion of differences between the two ADHD samples is given. However, caution is still advised as ADHD group differences were found between the two ADHD sample groups. This difference affected scale score results. The Test of Variables of Attention (TOVA) is a non language based continuous performance test. The test consists of four (4) basic scales: Omission (inattention), Commission (impulsivity), Response Time and Response Time Variability. Additional scales compliment these: Anticipatory Responses, Multiple Responses and Post Commission Response Time. Greenberg and Waldman (1993) reported that the TOVA was able to discriminate between normal controls and an ADHD group. They also reported gender differences for the scales. Greenberg and Waldman (1993) reported normative data for the test by age and gender. The test has been used with a variety of samples including NFI (Pulst, 1996); metachromatic leukodystrophy (Shapiro, 1994); adolescent schizophrenics (Erickson et al., 1984); as well as in ADHD (Greenberg, 1987; Greenberg & Waldman, 1993; Reader et al., 1994; Raymond et al., 1993; Teicher et al., 1996; Yellin, 1980). In addition, it has been found to be useful as a neuropsychological screening measure in non-English-speaking subjects (Boivin, 1996). There is disagreement amongst researchers as to the etiology of ADHD. Barkley (1996) maintains impaired inhibition of response or capacity to delay responding is the basis. This impaired inhibition of response is displayed behaviorally as impulsivity and hyperactivity. Mirsky (1991) suggests impaired ability to sustain attention is the basic causation. The TOVA currently has four basic scales that permit each of these models to be explored: Omission (inattention), Commission (impulsivity), Response Time and Response Time Variability. Interpretation of the scales looks at total score differences as the primary model. The TOVA uses a two condition test-retest design. The first quarter, the target stimulus appears 36 times, the nontarget stimulus 126 times. This is repeated as a retest in Quarter 2. Quarter 3 has 126 targets and 36 nontargets, with a retest in Quarter 4. While studies indicate that this is appropriate (Greenberg & Waldman, 1993), this
model does not allow for comparison of within subject variability. Within subject variability (scatter) is a hallmark for ADHD subjects. Also, there is not model to evaluate whether or not there are differences between the test-retest. In other words, is the subject able to "learn" the test and can the subject sustain performance over both demands of time and increased stimulus. In order to examine these problems, new scales were developed. Two of these, Omission Variability and Commission Variability measure the subject's variability between quarters for the Omission and Commission scales. Omission Learning and Commission Learning measure the subject's ability to learn the tasks as defined by: \[\frac{\text{Quarter 1} + \text{Quarter 3}}{2} - \frac{\text{Quarter 2} + \text{Quarter 4}}{2}\]. This represents the stimulus presentation for both conditions and the subject's ability to "learn" the conditional demand. The final two scales, Omission Performance and Commission Performance assess the subject's ability to sustain his performance over the duration of the test itself. The formula used to obtain this scores is: \[\frac{\text{Quarter 1} + \text{Quarter 2}}{2} - \frac{\text{Quarter 3} + \text{Quarter 4}}{2}\]. Essentially, this represents differences in the subject's performance over the two test conditions.


This study was designed to be a cross-validation of the T.O.V.A. test's ability to distinguish between the performance of normal children and those with ADHD. This study involved 44 ADHD subjects (mean age = 8.77 years, SD = 0.42), who were strictly diagnosed according to DSM-IV criteria using structured interviews. The subjects were diagnosed independent of the test performance and the raters were blind to the study. These subjects were compared to 44 subjects (mean age = 8.64 years, SD = 0.49) randomly selected from the test's normative data sample. Mann-Whitney U tests were used to compare mean group ranks for the raw Omission and Commission Scale scores of the T.O.V.A. test. Significant differences (p<0.001) were found between the mean group rankings, with the ADHD group having higher mean rank scores (i.e., poorer performance) when compared to the aged matched normal controls. Student t-tests were conducted on the raw Response Time and raw Response Time Variability Scales. Statistically significant mean score differences were found between the clinical and normative groups (p<0.05). The ADHD group showed slower speed with greater variability than did the normals. To assess the ability of the test to classify subjects into correct diagnostic groupings, a discriminate function analysis was performed using the raw test scores for the 4 scales (Omission, Commission, Response Time and Response Time Variability) and the diagnostic groupings. This yielded an overall 84.1% original group classification rate. The breakdown was: 41/44 (93.2%) normals correctly classified, 3/44 incorrectly classified (6.8%); and 33/44 ADHD (75%) correctly classified, 11/44 incorrectly classified (25%). The test manual indicates that the initial hit rate of the test at 80/20 for both diagnostic groups using DSM-III criteria present for that time. Forbes (1998) reported an overall classification of 80% for ADHD using DSM-IIIIR criteria. The data show similar overall hit rate using current DSM-IV criteria and improved classification of normal controls. The study provides further discussion and analysis of differences between classification strategies, and provides discussion of relevance to clinical practice.


This study investigated the effects of malingering on the Test of Variables of Attention. Thirty-seven college-aged subjects participated in the study. The sample consisted of 17 males (mean age = 22.15 years, SD = 2.78) and 20 females (mean age = 22.45 years, SD = 2.11). In order to determine if test order may have an effect on the subjects' malingering performance, subjects were randomly placed into two groups. Group 1 took the TOVA under normal conditions first. They were then requested to try their best to make themselves look like they had ADHD when indeed they did not, but they were to try to make their faking look subtle so as not to make it obvious that they were faking (i.e., Malingering). Group 2 took
the TOVA under the same Malingering instructions first, then took the test under Normal conditions the second time. A t test for the analysis of the effects of test order yielded nonsignificant differences for basic TOVA variables (Omission, Commission, Response Time, and Response Time Variability) across all four quarters, both halves and the Total score. Thus, test order did not contribute to the subject’s performance on the test. A t-test analysis for group mean differences between the normal instruction and malingering instruction yielded significant differences across the basic TOVA variables across the four quarters, two halves, and Total score. The effects of the instruction to malinger did produce significant performance effects on the test. Group means are presented for the normal and malingering groups. The malingering group performed excessively poorer in all scales. They had excessive amounts of omission and commission errors, their response time was greater (i.e., slower to perform) and had greater variance around their response time mean. Clinical interpretation recommendations are provided.


This study investigated the effects of faking bad (FB) on the Test Of Variables of Attention (TOVA) using subjects randomly placed into two groups. Subjects in Group 1 took the TOVA under normal conditions (NC) first; they were then requested to subtly fake bad. Group 2 subjects took the TOVA under the same fake bad instructions first, then took the test under normal conditions the second time. An analysis of the effects of test order yielded non-significant differences for basic TOVA variables across all four quarters, both halves and the total score. An analysis for group mean differences between the NC and the FB instructions yielded significant differences across the basic TOVA variables across the four quarters, two halves and total score. The FB group had excessive amounts of omission and commission errors, a greater response time mean (i.e., slower to respond) and had greater variance around their mean response time. The study affirms that the professional using the TOVA needs to carefully eliminate a fake bad test-taking bias when subjects produce excessive test results.


Test-retest reliability of the T.O.V.A. was investigated using two different time intervals. The first study used a seven day (+/- 2 days) interval and the second study used a 90 minute interval. The second-day epoch was selected as a reasonable period of time between which patients may be retested. The second epoch was selected with concern for the use of the test in stimulant medication trials. In this scenario, a practitioner assesses the patient, makes a determination for medication, administers the medication and then retests at ideal peak absorption of the medicine. For the first study, 33 school aged children (mean age = 10.01 years, sd = 2.59) were administered the T.O.V.A., then readministered the test one week later, as close as possible to the original time of day for the first testing. Positive reliability coefficients were obtained for Omission (.86), Commission (.76), Response Time (.79), and Response Time Variability (.87). To investigate the 90-minute reliability coefficients 24 school aged children (mean age = 8.58 years, sd = 1.82) were administered the T.O.V.A. then readministered the test 90 minutes afterward. Positive reliability coefficients were obtained for Omission (.80), Commission (.78), Response Time (.93), and Response Time Variability (.77). Standard error of measurement (S(\text{em})) across each T.O.V.A. scale are presented or both the one-week and the 90-minute intervals. Discussion of the data towards test interpretation strategies is provided.

The Test of Variables of Attention -- Auditory version (T.O.V.A. -A) has been released as an experimental version. This is due to the fact that no validity studies had been done. This study represents the initial validation study. To assess this, 52 children who were diagnosed as having met the criteria for ADHD (DSM-IV) were compared to 52 age matched subjects selected randomly from the T.O.V.A. -A base. The ADHD subjects had been evaluated at an outpatient clinic and the raters were blind to this study. An independent t-test yielded non-significant differences for age between the two groups. A discriminant function analysis was conducted utilizing raw scores and z scores. The results of the raw score analysis recorded 38 out of 52 normal subjects classified as normal (73% hit rate). For the ADHD subjects, 37 out of 5 (71% hit rate) were classified as ADHD. The overall hit rate was 72% correctly classified. An analysis using z-score transformations were conducted as these scores reflect a more stable understanding of the performance. The discriminant function analysis here found all 52 normal subjects classified as normal and all 52 of the ADHD subjects classified as abnormal. This yielded an overall hit rate at 100%. The discussion provides an explanation of the differences between the hit rates and suggestions for further studies. Overall the study indicates construct validity for the T.O.V.A.-A.


Test-retest reliability of the Test of Variables of Attention (T.O.V.A.) was investigated in two studies using two different time intervals: 90 min and 1 week (2 days). To investigate the 90-min reliability, 31 school-age children (M = 10 years, SD = 2.66) were administered the T.O.V.A. then readministered the test 90 min afterward. Significant reliability coefficients were obtained across omission (.70), commission (.78), response time (.84), and response time variability (.87). For the second study, a different sample of 33 school-age children (M = 10.01 years, SD = 2.59) were administered the test then readministered the test 1 week later. Significant reliability coefficients were obtained for omission (.86), commission (.74), response time (.79), and response time variability (.87). Standard error of measurement statistics were calculated using the obtained coefficients. Commission scores were significantly higher on second trials for each retest interval.


Deficits in attention are a hallmark of the effects of heavy prenatal alcohol exposure but although such deficits have been described in the literature, no attempt to use measures of attention to classify children with such exposure has been described. Thus, the current study attempted to classify children with heavy prenatal alcohol exposure (ALC) and non-exposed controls (CON), using four measures of attentional functioning: the Freedom from Distractibility index from the Wechsler Intelligence Scale for Children–Third Edition (WISC–III), the Attention Problems scale from the Child Behavior Checklist (CBCL), and omission and commission error scores from the Test of Variables of Attention (TOVA). Data from two groups of children were analyzed: children with heavy prenatal alcohol exposure and non-exposed controls. Children in the alcohol-exposed group included both children with or without fetal alcohol syndrome. Groups were matched on age, sex, ethnicity, and social class. Data were analyzed using backward logistic regression. The final model included the Freedom from Distractibility index from the WISC–III and the Attention Problems scale from the CBCL. The TOVA variables were not retained in the final model. Classification accuracy was 91.7% overall. Specifically, 93.3% of the alcohol-exposed children and 90% of the control children were accurately classified. These data indicate that children with heavy prenatal alcohol exposure can be distinguished from non-exposed controls with a high degree of accuracy using 2 commonly used measures of attention.
Introduction: OSA has been shown to impact children’s neurobehavioral functioning. The specific mechanisms of the effects of OSA are not yet fully understood. In this study we used a neurobehavioral battery to understand the impact of chronic and acute sleep restriction on children aged 6 to 10. Methods: To date 27 children, 16 in the OSA group (9 boys and 7 girls, mean age = 8.5 (sd = 1.7) and 10 in the comparison group (7 boys and 3 girls, mean age 8.5 (sd = 1.5) completed the protocol. All subjects completed a standard baseline PSG. Asid from OSA all subjects were healthy and free of psychiatric disorders. Subjects completed a baseline neurobehavioral battery on a weekend morning between 8:30 and 2:00 p.m. and then returned in exactly two weeks for the sleep restriction (SR) phase. Following a full day of wakefulness subjects were kept awake until 4:00 a.m. and then slept until 8:00 a.m. Subjects then completed a battery nearly identical to that conducted at baseline. The measures reported on here included, IQ (WASI-baseline and WISC-III Vocabulary at SR, a memory and response inhibition task (n-back paradigm) that paired targets with photos with positive, neutral and negative emotional valences, the emotional-face-go-no-go task, and the TOVA, a standard continuous performance task. Results: Differences were present in SES (parent education OSA<4 and comparison group>4 years of post secondary education and income, OSA=20-50,000 and comparison group=50-100,000, and the racial composition of groups (OSA- African American=14, Caucasian=1, Hispanic=1, and comparison group- African American=4, Caucasian=4, Other=2). Significant differences (24)=5.28 (p<.001) were found at baseline on all IQ scales (full scale, OSA mean=92.4 (sd=10.3) and comparison mean=111.9 (sd=6.8). Significant time and group effects were found on the vocabulary subtests from the WASI at baseline (OSA=8.3, sd= 3.3, Comparison=12.8, sd= 1.7) and WISC at SR (OSA=7.4 sd=3.1, Comparison=11.4, sd=1.7). On the affectively modified n-back task interesting trends suggested that on the easier 0-back portion, the comparison group tended to be more sensitive to stronger emotional stimuli and on the 2-back portion, the comparison group tended to be more sensitive to stronger emotional stimuli and on the 2-back portion, the OSA groups’ reaction times slowed and accuracy decreased only minimally from baseline. On the emotional-Face Go-No-Go both groups had increased omissions and decreased accuracy at SR compared to baseline while the comparison group’s response time increased. On the TOVA, significant time (F(1,21)=12.43, p<.003) and group (F(1,21)=5.12, p<.001) effects were found for omissions, and there was a group effect (F(1,21)=4.18) for reaction time. OSA subjects had greater performance decrements on the TOVA. Discussion: The OSAS subjects tended to have significant decrements in performance at baseline and to be significantly affected by SR. Verbal functioning and attention appeared to be most sensitive to the effects of chronic sleep disruption and acute sleep restriction. Comparison group subjects’ increased errors may have been due to shorter reaction times suggesting greater impulsivity while the OSA group tended to be slower. It is interesting to note that both groups’ performance decreased on a standard IQ subtest (Vocabulary) that is assumed to remain stable over time. Differences in the racial and SES makeup of groups may account for some differences. It will also be important to explore the association between OSAS severity and performance.


OBJECTIVES/HYPOTHESIS: Children with sleep-disordered breathing may experience behavioral and learning problems such as inattentiveness and hyperactivity. The aim of this study was to measure the impact of adenotonsillectomy on sleep-related adverse events and behavioral problems in children with sleep-disordered breathing. METHOD: This prospective and interventional study enrolled 40 sleep-disordered breathing children (mean age, 8.4+/-1.6 years) with hypertrophic tonsils and adenoids. All patients completed two polysomnographies, tests of variables of attention (TOVAs), and Child Behavior Checklists, one at baseline and the other 6 months after adenotonsillectomy. RESULTS: The apnea-hypopnea index (P<.001), TOVA scores (P<.001), and 8 of 9 individual domains of the Child Behavior Checklist scores (P<.05) significantly improved after surgery. However, the change in the apnea-hypopnea index was not negatively correlated with TOVA score (r=-0.17, P=.38). CONCLUSION:
Adenotonsillectomy could significantly improve behavior (TOVA) scores, but the improvement may not simply be attributable to changes in sleep apnea events.


Objective: To explore the effect of electroencephalographic biofeedback (EEGBF) technique on brain function of children with spastic cerebral palsy. Method: Sixty children with spastic cerebral palsy were enrolled. According to their gender, age, degree of illness and order of admission, the children were randomly divided into 2 groups. Everyday, 30 children in observation group received routine rehabilitation, and EEGBF therapy; 30 children in control group only received routine rehabilitation without EEGBF. The course of treatment lasted for 3 months. Electroencephalogram was used to detect the changes of θ waves, β waves, α waves, SMR waves, α/SMR power ratio, θ/β power ratio. Before and after intervention, Chinese-Binet intelligence scale (CBIS) and the test of variables of attention (TOVA) were tested. Result: Observation group: After 3 month-EEGBF treatment, the children’s θ waves reduced markedly (P<0.05), β waves increased significantly (P<0.05), θ/β power ratio decreased obviously (P<0.05); α waves decreased obviously (P<0.05), SMR wave increased significantly (P<0.05), α/SMR power ratio decreased obviously (P<0.05). Control group: comparing with those waves before treatment, θ waves decreased obviously (P<0.05), β waves, θ/β power ratio, α waves, SMR waves and α/SMR power ratio showed no significant difference (P>0.05). After treatment, in observation group the intelligent elevated significantly (P<0.001), and scores of all indexes of TOVA showed significant differences than those before treatment, Namely the curative effect of observation group after treatment was better than control group. Conclusion: EEGBF technique can effectively improve the brain function of children with cerebral palsy.


Studied the application of the TOVA in children with attention deficit hyperactivity disorder (ADHD) in China. 56 children with ADHD (aged 8-13 yrs) (matching the criteria of the Diagnostic and Statistical Manual of Mental Disorders-III-Revised (DSM-III-R) and Ss’ IQ <= 75) and 16 normal children (aged 8-13 yrs) in Beijing were tested with the visual software of the TOVA. Ss’ reaction time (RT), mistakes, and missing errors were compared between ADHD Ss and the normals. ADHD Ss received medication and were tested and retested before and after; the test results were compared with the results of the Conner’s Parent Rating Scale. It is reported that significant difference in each variable of the TOVA was found between the ADHD Ss and the normals; and that the sensitivity and speciality of diagnosis of the TOVA were 85.7% and 87.5% respectively compared to the clinical standards. The ADHD Ss also improved significantly after medication. The results of the TOVA reflect the pathological characteristics of ADHD and demonstrate sensitivity to treatment efficacy.


**OBJECTIVE:** This study explored auditory and visual attention in children with ADHD. **METHOD:** In a randomized, two-period crossover design, 50 children with ADHD and 50 age- and sex-matched typically developing peers were measured with the Test of Various Attention (TOVA). **RESULTS:** The deficiency of visual attention is more serious than that of auditory attention in children with ADHD. On the auditory modality, only the deficit of attentional inconsistency is sufficient to explain most cases of ADHD; however, most of the children with ADHD suffered from deficits of sustained attention, response inhibition, and attentional inconsistency on the visual modality. Our results also showed that the deficit of
Attentional inconsistency is the most important indicator in diagnosing and intervening in ADHD when both auditory and visual modalities are considered. CONCLUSION: The findings provide strong evidence that the deficits of auditory attention are different from those of visual attention in children with ADHD.


Psychometric properties of the Test of Variables of Attention (TOVA) were examined in a cohort of children (n=63) strictly diagnosed with attention-deficit/hyperactivity disorder (AD/HD). Internal consistency was assessed via correlational analyses to determine the degree of agreement among various test portions. The temporal stability of errors of omission, errors of commission, response time, and response time variability was evaluated using test-retest reliability. Reproducibility of individual scores for the same indices was assessed using the Bland-Altman procedure. Select TOVA index scores exhibited high internal consistency in this cohort. Although the temporal stability of group scores (test-retest reliability) was satisfactory, individual test scores were less reproducible. Temporal stability and individual test-retest score agreement were greater for response time and response time variability than for errors of omission and errors of commission.


The internal consistency of the Test of Variables of Attention (TOVA) was examined in a cohort of 6- to 12-year-old children (N = 63) strictly diagnosed with ADHD. The internal consistency of errors of omission (OMM), errors of commission (COM), response time (RT), and response time variability (RTV) under different test conditions (stimulus infrequent condition [Q(1) vs. Q(2)] and stimulus frequent condition [Q(3) vs. Q(4)]) was assessed via correlation analyses. All TOVA index scores under investigation exhibited statistically significant correlations. All correlations fell in the moderate-high range.


The degree of association between performance on a sustained attention task requiring visual discrimination and urinary excretion of catecholamine metabolites was examined in a cohort of 6- to 12-year-old children (n = 31) strictly selected and diagnosed with attention-deficit/hyperactivity disorder (AD/HD) according to DSM-IV and other strict criteria. Sustained visual attention and discrimination were measured using the Test of Variables of Attention (T.O.V.A.). Urinary excretion of dopamine (DA) and norepinephrine (NE) metabolites was measured by reversed high-pressure liquid chromatography (HPLC). Pearson product-moment correlations were used to investigate the relationship between T.O.V.A. errors of omission (OMM), errors of commission (COM), response time (RT), and response time variability (RTV) and catecholamine metabolites of DA and NE. All T.O.V.A. indexes under investigation were significantly correlated with urinary excretion of NE metabolites, but correlations were low-to-moderate in magnitude (.37-.50). In contrast, there were no statistically significant correlations between T.O.V.A. indices and DA metabolites. These findings and their concordance with past research
in human adults and animals, as well as theoretical issues associated with the present results, are discussed.


Children and adolescents with the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) diagnosis of attention-deficit hyperactivity disorder (ADHD) can have comorbid conditions such as conduct disorder, oppositional defiant disorder, and obsessive-compulsive disorder (comorbid type). The purpose of our study was to compare the pattern of regional cerebral perfusion in these two groups of children with ADHD during a computerized performance test. Nineteen children and adolescents were enrolled in the study. Seven boys and one girl with pure ADHD (group 1: mean age 12 years, range 9-16 years) and nine boys and two girls with comorbid ADHD (group 2: mean age 11 years, range 8-16 years) were studied by single-photon emission computed tomography (SPECT). The patients were not receiving any medication for at least 48 hours prior to the study. All patients were injected with 99mTc-ethylcysteinate dimer while doing a computerized performance test. Nine age-matched control children (five boys and four girls, mean age 12 years, range 9-17 years) with a normal brain SPECT served as controls. All patients in group 2 showed significantly decreased perfusion in the temporal lobes (P < .005). Five patients had decreased frontal lobe perfusion. Additionally, two patients in group 2 had decreased perfusion in the basal ganglia (not significant). Four of eight patients in group 1 had decreased frontal lobe perfusion (not significant). In addition, two patients had bilateral temporal lobe abnormalities, whereas two patients had a normal SPECT. Three patients in group 1 also had decreased basal ganglia perfusion. In contrast to previous studies of brain perfusion in ADHD that focused mainly on frontal and prefrontal cortical abnormalities, our study demonstrates that temporal lobe perfusion abnormalities are more common in patients with the comorbid type of ADHD. We postulate that these findings can have therapeutic implications and explain the decreased response to stimulants in this group of patients.


Attention-deficit-hyperactivity disorder (ADHD), while largely thought to be a genetic disorder, has environmental factors that appear to contribute significantly to the aetiopathogenesis of the disorder. One such factor is preterm birth with vulnerable cerebrovascular homeostasis. We hypothesised that cerebral ischaemia at birth could contribute to persistent deficient dopaminergic neurotransmission, which is thought to be the pathophysiological basis of the disorder. We examined dopamine D(2/3) receptor binding with positron emission tomography (PET) using [11C] raclopride as a tracer, and continuous reaction times (RT) with a computerized test of variables (TOVA) in six adolescents (12-14 years of age, one female) who had been examined with cerebral blood flow (CBF) measurements at preterm birth and had a subsequent history of attention deficit. We found that high dopamine receptor availability ('empty receptors') was linked with increased RT and RT variability, supporting the concept of a dopaminergic role in symptomatology. High dopamine receptor availability was predicted by low neonatal CBF, supporting the hypothesis of cerebral ischaemia as a contributing factor in infants susceptible to ADHD.

A study with three component parts was performed to assess the effectiveness of neurofeedback treatment for Attention Deficit/Hyperactivity Disorder (ADHD). The subject pool consisted of 23 children and adolescents ranging in age from 8 to 19 years with a mean of 11.4 years who participated in a 2- to 3-month summer program of intensive neurofeedback training. Feedback was contingent on the production of 16-20 hertz (beta) activity in the absence of 4-8 hertz (theta) activity. Posttraining changes in EEG activity, T.O.V.A. performance, (ADDES) behavior ratings, and WISC-R performance were assessed. Part I indicated that subjects who successfully decreased theta activity showed significant improvement in T.O.V.A. performance; Part II revealed significant improvement in parent ratings following neurofeedback training; and Part III indicated significant increases in WISC-R scores following neurofeedback training. This study is significant in that it examines the effects of neurofeedback training on both objective and subjective measures under relatively controlled conditions. Our findings corroborate and extend previous research, indicating that neurofeedback training can be an appropriate and efficacious treatment for children with ADHD.


The present research describes the development of a new measure of attention, the Mathematics Continuous Performance Test (MATH-CPT), which uses a sequence of simple mathematical questions projected onto a computer screen as visual stimuli. A new approach to testing was developed: it has more complicated stimuli and has an open reaction time allowing participants to react according to individual pace. The development of reliability and validity of the MATH-CPT is described. Discriminant function analysis of 240 normal control participants compared with 63 individuals with ADHD showed correct classification of 91.6% of participants in both groups. The MATH-CPT diagnosed a sample of participants with ADHD better than another CPT-type test, the Test of Variables of Attention. This is an initial step in developing a new measure of attention and to assist with the diagnosis of adolescents and young adults with ADHD.


OBJECTIVE: To examine the incidence and neuropsychological, behavioral, and neuroimaging correlates of postconcussive symptoms (PCS) in children with mild closed head injuries (CHI). DESIGN: 26 Children with mild CHI and 8 of their uninjured siblings, from 8 to 15 years old, were recruited prospectively and assessed at baseline (ie, within 7 days of injury) and at 3 months postinjury. Parents rated PCS, motivation and affective lability, and behavioral adjustment. Baseline ratings assessed premorbid functioning retrospectively, and follow-up ratings assessed postinjury status. On both occasions, children completed neuropsychological testing, and those with mild CHI also underwent magnetic resonance imaging (MRI). RESULTS: Children with mild CHI did not differ from siblings in baseline ratings of premorbid PCS but displayed higher ratings on several PCS at 3 months postinjury. Thirty-five percent of children with mild CHI showed increases in PCS, compared with baseline premorbid ratings, but none of the siblings did so. Children with mild CHI whose PCS increased from premorbid levels showed poorer neuropsychological functioning at baseline than did children whose PCS did not increase, although the differences had partially resolved by 3 months. They also displayed decreased motivation over time. Their behavioral adjustment was poorer and they had smaller white matter volumes on MRI, but the latter differences were present at baseline and did not change over time, suggesting that they existed prior to the injury. CONCLUSION: Postinjury increases in PCS occur in a sizable minority of children with mild CHI and more often than among uninjured siblings. Increases in PCS following mild CHI are associated with premorbid neurological and psychosocial vulnerability, but also with postinjury decrements in neuropsychological and neurobehavioral functioning.
Human alertness varies in tasks requiring sustained attention. This can lead to severe consequences in occupations like car traffic operation, air traffic control and nuclear power plant monitoring and so on. EEG that is the electrical activity of brain can reflect the state of alertness. In this paper, the present work aims at real-time estimation of alertness from EEG signals. We made subjects perform a test of variables of attention (TOVA) and recorded their response time that was selected as a metric to quantify the subject's performance. Synchronously, we acquired the EEG signals of the subjects during the whole test. We studied the correlation between EEG power spectrum and response time, and used the power spectrum to construct the models of estimation alertness for single subjects by means of support vector machines method. The experimental results show the possibility of using EEG signals to real-time estimation alertness. We conclude that the method is helpful for the construct of the practical real-time detection system to alertness.


Objectives: Few reports in the literature note how optometric vision therapy (OVT) can improve the quality of life for those with traumatic brain injury (TBI). This presentation discusses the significant improvements of signs and elimination of symptoms noted after a regimen of OVT that resulted in improved oculomotor skills, attention, reading and driving ability in a patient with TBI. Case Report: PA, a university professor, is a 53 y/o WF with a history of traumatic brain injury due to a car accident. Her symptoms included falling asleep while reading, avoidance of reading, decreased attention, and major problems parking her car. The TOVA (Test of Variables Attention) showed an ADHD Score of -4.00 while the Visagraph revealed significant problems in span of recognition, fixation, reading rate/comprehension, efficiency and fluency. She was diagnosed with convergence insufficiency, oculomotor dysfunction (pursuits/saccades), and attention deficit. Optometric vision therapy sessions followed a standard format that included monocular, biocular, binocular and an integration/stabilization therapy phase. Computer aided OVT included the use of Vision Builder, CAVTs VIPS, and Home Therapy Solutions HTS and the EyePort. After 27, 45 min OVT sessions both the TOVA and Visagraph showed normal attention and oculomotor skills, convergence insufficiency resolved, reading ability improved and parking problems eliminated. All other symptoms were either improved or eliminated. PA currently successfully teaches at a major USA university. Conclusions: Individuals with TBI often exhibit marked problems in oculomotor skills, binocular vision dysfunction, attention, and other visual abilities that affect their quality of life. Primary eye care providers, in general, do not diagnosis or manage the many vision function, functional vision and vision information processing disorders associated with TBI. Primary eye care providers can utilize this case as a starting point to help them do so in the future or to motivate them to refer to those who have experience and expertise in this area. This case demonstrates that with OVT both symptoms and signs that adversely affect an individual’s quality of life after traumatic brain injury can be improved.


Attention Deficit Hyperactivity Disorder (ADHD) is a heterogeneous disorder of unknown etiology. ADHD is estimated to affect 5 to 30 percent of the school age population (Barkley, 1990; Shaywitz & Shaywitz, 1991; Taylor, Sandberg, Thorley & Giles, 1990). Despite the fact that it is one of the most extensively studied childhood psychiatric disorders, few researchers have conducted the kinds of thorough evaluations necessary to gain broad and varied amounts of information about a child suspected of having ADHD. In addition, it is common for clinicians to diagnose a child based on a brief clinic visit and
information from one persons’ perspective of the child’s behavior. A total of 56 children participated in this study to further the understanding of assessing children for ADHD. The children were referred for behavioral and/or attentional problems. There were 30 children in the ADHD group and 26 children in the Non-ADHD group. The researcher examined whether multiple raters, settings, and measures are necessary to accurately distinguish ADHD children from a group of referred children who did not have ADHD. Specifically, this study’s purpose was to investigate whether children who met DSM-IV criteria for ADHD could be accurately and independently diagnosed as having attentional impairment through parent and teacher behavioral questionnaires. In addition, this study examined the efficacy of including direct observations of behavior and theoretically relevant measures of cognitive and motor disinhibition in parent and teacher observations of ADHD. Dr. Russel Barkley’s (1994) theoretical model of ADHD as a deficit in behavioral inhibition was employed as the theoretical rationale for employing the additional measures that included actual behavioral observations along with laboratory tests of attention and clinical tests of complex memory. It was of interest to determine if direct measurement of the child added significantly to the discrimination that is obtained solely from the observations of informants. Results from this study suggest that both multiple raters and settings are important in the diagnosis of ADHD. The child's parent, teacher, and clinician are valuable informants’ of the child's behavior. Likewise, observing the child in various settings such as his or her home and school add information to aid in the diagnosis of ADHD. In regards to measures, the results suggest that the observations or perceptions from others such as the DISC-P structured interview, CBCL-parent and teacher rating scales, and the BASC-SOS, help add to the prediction of ADHD. However, direct measures of performance such as the TOVA continuous performance test and complex memory tasks (K-ABC-Word Order & Hand Movements subtests and the McCarthy Tapping Sequence subtest) do not aid in the prediction of ADHD.


OBJECTIVE: To evaluate the efficacy, safety, and tolerability of an oral extended-release (ER) formulation of the nonstimulant metadoxine in the treatment of adult attention-deficit/hyperactivity disorder (ADHD). METHOD: This was a 1:1 randomized, double-blind, placebo-controlled, parallel-design, phase 2 study of metadoxine ER 1,400 mg/d treatment for 6 weeks, following a 2-week baseline/screening period, involving 120 adults with DSM-IV-defined ADHD. A follow-up assessment occurred 2 weeks after the trial was completed. Efficacy measures included changes in Conners’ Adult ADHD Rating Scale-Investigator Rated (CAARS-INV) total ADHD symptoms score with adult ADHD prompts (primary measure), response rates (>/= 25% or 40% improvement in CAARS-INV total ADHD symptom score), Test of Variables of Attention (TOVA) performance, and Adult ADHD Quality of Life (AAQoL) total score. The study was conducted from March 15, 2011, to August 21, 2011. RESULTS: Intent-to-treat analysis revealed that subjects receiving metadoxine ER showed statistically significant improvement in CAARS-INV total ADHD symptoms score (P = .02), higher rate of response (> /= 25% [P = .03] or >/= 40% [P = .04] improvement) on the CAARS-INV total ADHD symptoms score, and improvement in TOVA score (P = .02) and AAQoL score (P = .01) compared with the placebo group. Improvements in ADHD symptoms (scored by CAARS-INV) were significantly different in subjects treated with metadoxine ER versus placebo as early as 2 weeks following treatment initiation. Metadoxine ER was generally well tolerated, with nausea (17% [10/58] vs 0% [0/59]), fatigue (31% [18/58] vs 27% [16/59]), and headaches (29% [17/58] vs 39% [23/59]) being the most frequently reported adverse effects for the metadoxine ER and placebo groups, respectively. CONCLUSIONS: Findings suggest that metadoxine ER is a well-tolerated and effective treatment for adults with ADHD.

Attention deficit hyperactivity disorder (ADHD) is a chronic disabling disorder that often persists to adulthood (70%). Methylphenidate (MPH) is reported efficient in adults suffering from ADHD. MPH dosage of ~0.5mg/Kg is common in children and adolescents. MPH dosage in adults is not determined and upper limit of 1mg/kg[1] was recommended. Objective: To evaluate the efficacious dosage of MPH in adults. Method: Adult ADHD/ADD patients who responded to MPH, according to the Test of Variables of Attention (T.O.V.A), were included. Response was estimated by repeating T.O.V.A.[2]. The dose, 15mg/20mg, was weight dependent (<80Kg). Results: 42/47 diagnosed adults had good response to MPH. Mean age 31.8±9.0, M:F ratio 21:21, ADHD/ADD 20:22. Highest dose 0.35 mg/Kg. Mean dosage was 0.2±0.05mg/Kg with a significant improvement in all T.O.V.A. scores: ADHD scores (p<0.0001); Standard Scores (p 0.02-0.001). The most effective dosage was 0.2-0.25mg/Kg (p≤0.001). Commission score, which correlates to impulsivity, showed the least improvement under MPH treatment, and was aggravated at higher doses (T= -0.16, p=0.88). Conclusions: Low doses of MPH seem to be efficient in adults according to the improvement in T.O.V.A., while higher dosages may correlate with side effects.


OBJECTIVE: Both adolescent suicide and attention deficit hyperactivity disorder (ADHD) are troubling phenomena with high comorbidity, including impulsivity, depression and personality disorders (PD). Studies on the association between these two phenomena are relatively rare. This pilot study’s aim was to estimate the rate of ADHD in adolescents attempting suicide. METHOD: Subjects constituted consecutive admissions to the psychiatric emergency room (ER) who were admitted as a result of attempting suicide. Assessment included the use of the Kiddie-SADS, Strengths and Difficulties Questionnaire (SDQ) and the Conners’ Rating Scale (CRS). Those diagnosed as suffering from ADHD were assessed by a standardized Continuous Performance Test (Test of Variables of Attention [TOVA]) that included methylphenidate (MPH) challenge. Twenty-three (23) adolescents completed the study. M:F ratio was 5:18, respectively. RESULTS: Of the 23 participants who completed the study, 65% were diagnosed with ADHD, 43.5% with depression and 39% with cluster B PD. ADD/ADHD ratio was 66%:34%. Only five of the patients were formerly diagnosed as ADHD, only three had been medicated and 14 out of 15 adolescents responded well to MPH challenge. CONCLUSION: These preliminary results suggest a significant association between ADHD and suicidal behavior in adolescents. Further study is needed to establish this association and assess the causality.


The main objective of this study was to examine neuropsychological mechanisms mediating the association between tryptophan hydroxylase 2 (TPH2) and attention deficit hyperactivity disorder (ADHD). A continuous performance test (T.O.V.A.) was administered to 344 participants diagnosed with DSM IV ADHD who were also genotyped for eight TPH2 intronic SNPs. Association between TPH2 (single SNPs and haplotypes), ADHD, and performance on the T.O.V.A. were tested using robust family-based association tests as implemented in two statistical genetic programs: UNPHASED and PBAT. Association was only observed between an eight locus haplotype and ADHD DSM IV combined type III (global P = 0.036). Robust association was observed between TPH2 single SNPs (and haplotypes) and performance on the T.O.V.A., especially Errors of Omission (eight locus haplotypes, global P = 0.038). Significant associations were also observed between TPH2 and improvement (before-after scores) in T.O.V.A. Total Response Variability scores following acute methylphenidate
challenge (eight locus haplotypes, global P = 0.009). Using the MFBAT program, significant multivariate association was observed between single SNPs and haplotypes [eight locus haplotypes and all four T.O.V.A. variables (PBAT-GEE P = 0.013)]. The two most common TPH2 eight locus haplotypes were in a Yin Yang configuration and the Yang haplotype was the risk haplotype for both DSM IV ADHD and deficits in neuropsychological performance. The current investigation shows that risk for ADHD conferred by TPH2 variants is partially mediated by serotonergic mechanisms impacting some facets of executive function. Importantly, improvement in T.O.V.A. performance, especially on Response Time Variability, following methylphenidate was also associated with TPH2.


Subjective improvement-assessment in attention deficit/hyperactivity disorder (ADHD), following a single dose of methylphenidate (MPH) was compared to performance on the Test-of-Variables-of-Attention (TOVA). Self-perception was assessed with the clinical-global-impression-of-change (CGI-C). Participants included 165 ADHD subjects (M:F ratio 67%;33%) aged 5-18 (11.09 +/- 3.43) years. TOVA was administered before and after MPH challenge (0.3 mg/kg). Self-perception CGI-C scores were compared to the TOVA scores. An inverse correlation was found only between CGI-C and the TOVA-Commission-scores (r = -0.326, p < 0.001). We thus conclude that subjective reports are too unreliable to be used in order to assess MPH benefit in ADHD pediatric populations.


Attention-deficit/hyperactivity disorder (ADHD) encompasses a broad constellation of behavioral and learning problems. These patients are also characterized by low blood long-chain polyunsaturated fatty acid concentrations


Background: Attention-deficit/hyperactivity disorder (ADHD) is estimated to affect 4% to 6% of the adult population. In recent years, more and more middle-aged and older adults (955 years) turn to the ADHD unit at Geha Mental Health Center suspecting ADHD. Yet, a literature search resulted in very few relevant studies. Methods and Results: This study, approved by the Geha Mental Health Center ethics committee, presents 11 patients, 55 years or older, diagnosed and treated by the unit. The patients underwent complete clinical evaluation for ADHD according to Diagnostic and Statistical Manual of Mental Disorder, Fourth Edition. The data-collection phase included demographic and clinical data; Test of Variables of Attention scores used as indicators of methylphenidate (MPH) response; Clinical Global Impression scores of both severity and improvement were used. Because the sample is very small, allowing only limited statistical analyses, nonparametric statistics were used. Eleven patients, aged 61.64 T 3.87 years (male-female ratio, 9:2), were assessed. The follow-up was conducted for more than 2 months. Fifty-five percent had ADHD, predominantly inattentive, and 45% had ADHD combined type. All patients indicated suffering (Clinical Global-Impression Severity score range: mild = 27.3%, moderate = 45.4%, severe = 27.3%). Fifty-four per-cent showed at least 1 psychiatric comorbidity. Test of Variables of Attention scores showed significant improvement in 90% (8/9 patients) with MPH dosages similar to those used in younger adults. All patients attended the follow-up visits. Ninety-one percent (10/11) continued with the medication. Clinical Global Impression-Improvement scores showed significant improvement in 73%. No adverse effects were reported. Conclusions: This pilot study described 11
OBJECTIVE: To assess the first-dose effectiveness and tolerability of metadoxine extended release (MDX) in adults with predominantly inattentive attention-deficit/hyperactivity disorder (ADHD-PI). METHODS: In this double-blind, placebo-controlled, crossover study, adults with ADHD-PI were randomized 1:1:1 to receive a single dose of MDX 1400 mg, MDX 700 mg, and placebo (ClinicalTrials.gov identifier: NCT01685281). The primary efficacy end point was the mean change in the Test of Variables of Attention (TOVA) ADHD score from baseline to 3 to 5 hours after drug administration. Secondary assessments included TOVA subscores, TOVA response rates (defined as an increase of 0.8 points in the TOVA ADHD score), and the Cambridge Neuropsychological Automated Test Battery. Safety assessments included adverse events and vital signs. RESULTS: The intention-to-treat population included 36 patients (52.8% men; mean age, 32 years). The efficacy of MDX 1400 mg was demonstrated by a statistically significant difference in the mean (± SD) change in the TOVA ADHD score at baseline to 3 to 5 hours after drug administration compared with placebo (2.0 [± 4.2]; P = 0.009). The TOVA response time variability subscore was significantly different between MDX 1400 mg and placebo (mean difference, 7.9 [± 19.2] points; P = 0.022). Significantly more adults responded to single-dose MDX 1400 mg versus placebo (97.1% vs 71.4%, P = 0.006). There were no statistically significant differences between MDX 700 mg and placebo on any measures. Exploratory analyses of the Cambridge Neuropsychological Automated Test Battery did not yield significant findings. Fatigue and headache were the 2 most frequently reported adverse events. There were no clinically significant abnormalities in laboratory values, vital signs measurements, Columbia-Suicide Severity Rating Scale scores, or electrocardiographic parameters. CONCLUSIONS: Single-dose MDX 1400 mg significantly improved sustained and selective attention in adults with ADHD-PI as measured by the TOVA ADHD score 3 to 5 hours after drug administration. Single doses of MDX 700 and 1400 mg were well tolerated.
Monoamine oxidase A (MAO A) is located on the X chromosome and metabolizes biogenic amines including dopamine, norepinephrine and serotonin. A functional promoter-region polymorphism of this gene has been described that has been studied in a number of mental illnesses but not in attention deficit hyperactivity disorder (ADHD). In the current study, we examined the MAO A promoter-region polymorphism initially in 133 triads and observed preferential transmission of the long alleles from 74 heterozygote mothers to ADHD probands (\( \chi^2 = 4.37, P = 0.036, df = 1 \)). We also examined the role of this polymorphism in a computerized continuous performance test, the TOVA. Significant differences were observed on errors of commission (\( \chi^2 = 7.021, P = 0.008 \)) and patients carrying the long MAO A allele made significantly more such errors. Errors of commission are a measure of impulsivity. However, following Ritalin (methylphenidate) administration the association between this polymorphism and errors of commission was markedly attenuated and no longer significant at the \( P < 0.05 \) level. We also analyzed the provisional association by the case-control design. A significant difference in allele frequency was observed between 110 male probands vs 202 male controls (Pearson \( \chi^2 = 7.94, P = 0.047 \)). Similarly results were obtained when 19 female probands were compared to female controls (genotype \( \chi^2 = 21.28; P = 0.0032, 3 \) df and allele \( \chi^2 = 30.88, P = 0.0007, 2 \) df). All three complementary approaches employed (family-based, case-control and quantitative trait design) suggest a role for the MAO A promoter-region polymorphism in conferring risk for ADHD in our patient population.

Objectives: To compare the effects of metadoxine extended release (ER) with those of placebo on inattentive (IA) versus hyperactive-impulsive (H-I) symptoms and predominantly inattentive (PI) versus combined type (CT) subtype in adults with attention-deficit/hyperactivity disorder (ADHD). Methods: This was a 1:1 randomized, double-blind, parallel-design study of metadoxine ER 1400 mg/day for 6 weeks in 120 adults with ADHD. Efficacy measures were baseline to end-of-treatment changes in Conners’ Adult ADHD Rating Scale–Investigator Rated (CAARS-INV) Total ADHD Symptoms scores with adult ADHD prompts, the Test of Variables of Attention ADHD scores, and response rates (≥ 25% or ≥ 40% improvement in CAARS-INV Total ADHD Symptoms score). Results: There was a significant decrease in CAARS-INV Total ADHD Symptoms scores in patients with ADHD-PI taking metadoxine ER (40%) compared with those taking placebo (21%) (P < 0.05), while the decrease for patients with ADHD-CT was not significant (27% vs 26%). Similarly, there was a significant decrease in IA scores in patients with ADHD-PI (metadoxine ER, 50% vs placebo, 23%; P < 0.005), while the change in patients with ADHD-CT was not significant. There was no significant difference in percent decreases seen in H-I scores for patients with PI or ADHD-CT. Significantly higher response rates at both cutoffs (ie, 25% and 45% improvement) were seen in the metadoxine ER group compared with the placebo group in CAARS-INV Total ADHD Symptoms scores in patients with ADHD-PI, but not those with ADHD-CT. Test of Variables of Attention ADHD scores were significantly decreased in the metadoxine ER group compared with the placebo group for patients with ADHD-PI, but not those with ADHD-CT. Conclusion: These data suggest that metadoxine ER is selectively efficacious for treating IA symptoms in adults with ADHD-PI.


OBJECTIVE: To determine the effects of diphenhydramine 50 mg and fexofenadine 180 mg on cognitive performance using the Test of Variables of Attention (TOVA), and to ascertain whether the TOVA was sufficiently sensitive to differentiate between the effects of these first- and second-generation H1-receptor antagonists on performance. STUDY DESIGN: The study used a double-blind, placebo-controlled, randomized, crossover design. Forty-two subjects completed four separate TOVA tests: at baseline and after administration of placebo, diphenhydramine 50 mg, and fexofenadine 180 mg. On each occasion, subjects rated subjective feelings of drowsiness on a visual analog scale (VAS) before taking the TOVA. RESULTS: Compared with placebo, diphenhydramine caused an increased response time (P = 0.0230) and more omission errors (P = 0.0398). Diphenhydramine was also associated with increased drowsiness VAS ratings (P = 0.0065) compared with placebo. Diphenhydramine caused significantly more commission errors than fexofenadine (P = 0.0354). Neither placebo nor fexofenadine 180 mg caused significant changes in any TOVA or VAS measurements compared with baseline. Fexofenadine was not statistically different from placebo for any evaluation. CONCLUSIONS: The TOVA was sufficiently sensitive to differentiate between the central nervous system effects of fexofenadine and diphenhydramine. Fexofenadine 180 mg had no significant effect on the TOVA measures of performance or on self-reported drowsiness compared with placebo. In contrast, diphenhydramine 50 mg caused significant increases in omission errors and response time on the TOVA and increases in self-reported drowsiness compared with placebo [corrected].

This study examines the effectiveness of symptom validity measures to detect suspect effort in cognitive testing and invalid completion of ADHD behavior rating scales in 268 adults referred for ADHD assessment. Patients were diagnosed with ADHD based on cognitive testing, behavior rating scales, and clinical interview. Suspect effort was diagnosed by at least two of the following: failure on embedded and free-standing SVT measures, a score > 2 SD below the ADD population average on tests, failure on an ADHD behavior rating scale validity scale, or a major discrepancy between reported and observed ADHD behaviors. A total of 22% of patients engaged in symptom exaggeration. The Word Memory test immediate recall and consistency score (both 64%), TOVA omission errors (63%) and reaction time variability (54%), CAT-A infrequency scale (58%), and b Test (47%) had good sensitivity as well as at least 90% specificity. Clearly, such measures should be used to help avoid making false positive diagnoses of ADHD.


Forty-six of 93 children with neurofibromatosis type 1 (NF1) were found to satisfy the diagnostic criteria for attention-deficit-hyperactivity disorder (ADHD). Detailed comparisons were made among 20 children with NF1 and ADHD (12 males, 8 females; mean age 10.7 years, SD 2.2), 26 control children with NF1 (15 males, 11 females; mean age 11.3 years, SD 2.3), 14 control children with ADHD (7 males; mean age 9.9 years, SD 1.9), and 14 normally developing control children (7 males; mean age 11.2 years, SD 2.8). Children with NF1 and ADHD had the lowest IQ scores among the four groups. Test of Variables of Attention (TOVA) scores were poorer in the NF1-ADHD and ADHD control groups than in the two non-ADHD groups. Those with NF1 and ADHD were rated significantly poorer on the Child Behavior Checklist (CBCL) than were the NF1 control group. By administering low doses (5 to 15 mg) of methylphenidate to the NF1-ADHD group, significantly improved TOVA scores were obtained. One-year follow-up yielded significantly improved CBCL scores. Our results show a high incidence of ADHD in NF1 and support an association between ADHD and learning and social problems in children with NF1. It was demonstrated that stimulant medication can lead to improvement in cognitive, academic, and social problems of children with NF1 and ADHD.


Research has consistently demonstrated that attentional disturbances frequently occur, not only among children diagnosed with Attention Deficit Hyperactivity Disorder, but also among depressed children and among anxious children. Given the symptom overlap and high comorbidity of ADHD with other disorders, the frequency of attention-related referrals to clinical practices, and often similar clinical presentations, this study sought to address whether performance on a measure of sustained attention could provide
data for differential diagnostic assessment as well as predict group membership. The Test of Variables of Attention (T.O.V.A.) was employed with children ages six through sixteen diagnosed with ADHD, a mood disorder, or an anxiety disorder. Numerous variables were analyzed, including first half omission scores, total test omission scores, second half commission scores, total test commission scores, total test response time, and total test variability scores. Also discussed is the concept of a performance decrement, which is typically observed among ADHD children on CPT measures. Results from this study indicated that children diagnosed with ADHD obtained significantly poorer first half omission scores than depressed and anxiety disordered subjects, suggesting poorer vigilance among the ADHD population. This finding is consistent with previous research demonstrating poor and even impaired vigilance on CPT measures among ADHD populations. However, no other significant differences emerged among the remaining variables analyzed. With regard to a performance decrement, results were inconsistent, with the ADHD group demonstrating decreased performance during the second quarter but improved performance during other quarters. Results from predictive discriminant analysis suggest that a model based on first half omission errors may be clinically useful, although not overwhelmingly predictive of group membership: the T.O.V.A. was able to accurately identify approximately


Disorders of attention and concentration are measured in neuropsychology both by self-report measures and by more objective tests of sustained attention and concentration. These methods are often used interchangeably with no regard to whether similar constructs are being measured. The present study, in an attempt to improve the situation, examined the relationship between the Personality Inventory for Children (PIC) (a self-report inventory filled out by the parent and which contains a hyperactivity scale) and the Test of Variables of Attention (TOVA). Forty-four children were referred for neuropsychological evaluation which included the PIC and TOVA as part of a comprehensive battery. The sample was predominantly male (78.4%) and right-handed (97.3%). The participants average age and education was 10.3 years (SD =2.44) and 4.8 years (SD=2.16) respectively. Fifty-four percent of the sample was Caucasian and 32.4% was African-American and/or Caribbean Black. Diagnostic groups included psychiatric disorders (27.3%), neurological disorders (36.4%), no diagnosis (3%), and a mixed group of psychiatric and neurological disorders (33.3%). Pearson correlations yielded relatively few significant correlations between the TOVA Visual and Auditory scores and PIC subscale scores. Specifically, of 11 comparisons between TOVA measures and the Hyperactivity scale, only the relationship with the Multiple Response scale (auditory) was significant at - 0.44 (p < 0.01). The remaining PIC scales showed 11 significant correlations 0, < 0.05) out of 306 comparisons, less than would be expected by chance (15.3). These results suggest that self- report that self-report of hyperactivity does not correlate with measures of sustained attention such as the TOVA. These results require both further replication as well as a considered reevaluation of the meaning of these test scores.


The development of a quantitative electroencephalographic (QEEG)-based procedure for use in the assessment of attention deficit-hyperactivity disorder (ADHD) was examined through a series of studies investigating test reliability and validation issues. This process, involving a spectral analysis of the electrophysiological power output from a single, midline, central location (the vertex), was conducted in 469 participants, 6 to 20 years of age, classified as ADHD, inattentive type; ADHD, combined type; or control. The results indicated that the QEEG scanning procedure was reliable (r = .96), was consistent with the Attention Deficit Disorders Evaluation Scale (S. B. McCarney, 1995) and the Test of Variables of Attention (L. M. Greenberg, 1994; chi-square, p < .01), and differentiated participants with ADHD from a nonclinical control group (p < .001). The sensitivity of the QEEG-derived attentional index was 90%; the specificity was 94%.


100 children (83 males and 17 females, aged 6-19 yrs) who were diagnosed with attention-deficit/hyperactivity disorder (ADHD) participated in a study examining the effects of Ritalin, EEG biofeedback, and parenting style on the primary symptoms of ADHD. All of the patients participated in a 1-year, multimodal, outpatient program that included Ritalin, parent counseling, and academic support at school (either a 504 Plan or an IEP). Fifty-one of the participants also received EEG biofeedback therapy. Posttreatment assessments were conducted both with and without stimulant therapy. Significant improvement was noted on the Test of Variables of Attention (TOVA; L. M. Greenberg, 1996) and the Attention Deficit Disorders Evaluation Scale (ADDES; S. B. McCarney, 1995) when participants were tested while using Ritalin. However, only those who had received EEG biofeedback sustained these gains when tested without Ritalin. The results of a Quantitative Electroencephalographic Scanning Process (QEEG-Scan; V. J. Monastra et al., 1999) revealed significant reduction in cortical slowing only in patients who had received EEG biofeedback. Behavioral measures indicated that parenting style exerted a significant moderating effect on the expression of behavioral symptoms at home but not at school.


Spectral analysis of the electrophysiological output at a single, midline prefrontal location (the vertex) was conducted in 482 individuals, ages 6-30 years old, to test the hypothesis that cortical slowing in the prefrontal region can serve as a basis for differentiating patients with attention deficit hyperactivity disorder (ADHD) from nonclinical control groups. Participants were classified into 3 groups (ADHD, inattentive; ADHD, combined; and control) on the basis of the results of a standardized clinical interview, behavioral rating scales, and a continuous performance test. Quantitative electroencephalographic (QEEG) findings indicated significant maturational effects in cortical arousal in the prefrontal cortex as well as evidence of cortical slowing in both ADHD groups, regardless of age or sex. Sensitivity of the QEEG-derived attentional index was 86%; specificity was 98%. These findings constituted a positive initial test of a QEEG-based neurometric test for use in the assessment of ADHD.


Scope and method of study. The purpose of the this study was to examine the relationship and consistency between the Test of Variables of Attention (TOVA) and the Test of Variables of Attention - Auditory (TOVA-A) and the Conners' Parent Rating Scale - Revised: Long Form (CPRS-R: L) and the
Conners' Teacher Rating Scale - Revised: Long Form (CTRS-R: L). Participants in the study were a group of nonreferred children between the ages of 6 and 12. Children completed the TOVA and TOVA-A CPTs. The CPRS-R: L and CTRS-R: L scales were completed by the participant's parent and teacher. Pearson Product correlations, multiple regression and chi-square analyses were utilized to determine the relationship and consistency between the TOVA and TOVA-A measures and the scales of the CPRS-R: L and CTRS-R: L. Findings and conclusions. The TOVA and TOVA-A D-Prime was consistently correlated with the Cognitive Problems/Inattention scale, the Conners' ADHD Index, and the DSM-IV: Inattentive scale and the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L; and the Social Problems scale of the CTRS-R: L. The RTV also showed a statistical relationship among these scales, although not as consistent a pattern. The ADHD score of the TOVA was consistently correlated with the CPRS-R: L and CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. Multiple regression analyses found that the TOVA and TOVA-A D-Prime, Omission Errors, and RTV scores would more likely to predict parent and teacher rating scales measuring inattention, while the TOVA and TOVA-A D-Prime or the TOVA ADHD score would be more likely to predict parent and teacher scales measuring hyperactivity and/or impulsivity. Chi-square analyses suggested that there are no differences in the proportion of children identified as normal or abnormal by the variables of the TOVA/TOVA-A and the scales of the CPRS-R: L and CTRS-R: L. These findings indicate that the TOVA and TOVA-A are measuring similar aspects of inattention, hyperactivity, and impulsivity as the CPRS-R: L and the CTRS-R: L.


There is an extensive body of literature which examines violence and its relationship to abnormalities in brain functioning. While there seems to be little dispute regarding existence of the relationship, methodological limitations make research in this area complicated. Early neuropsychological studies of brain functioning have indicated significant organic abnormalities in violent adults and adolescents. Current research has replicated earlier studies although data analysis is often controversial. While contemporary studies continue to focus on risk assessment and the interplay of genetic, biological, and environmental conditions, this study explored possible connections between neuropsychological functioning and violent behavior, with a specific concentration on attention. The study focused on neuropsychological functioning of incarcerated males in the state prison complex in Ionia, Michigan. Sixty-one subjects were assigned to one of two groups based on their classification (high risk versus low risk) as determined by the Michigan Department of Corrections' Assaultive Risk Screening sheet. The subjects ranged in ages from 18 to 30. Individuals with diagnosed mental retardation, mental illness, a history of head injury or a reading level below fifth grade were excluded from the study. Tests used for the battery were the Stroop Color and Word Test, Trail Making Test (A and B), Digit Span (WAIS-R), Arithmetic (WAIS-R), The Wisconsin Card Sort, Peabody Picture Vocabulary Test-Revised, Tests of Variables of Attention (T.O.V.A.) and Symbol Digit Modalities Test. Four elements of attention--focus-execute, shift, sustain, and encode, were examined. The purpose of this study was to investigate brain-behavioral patterns and statistically significant differences and similarities in neuropsychological functioning (particularly in the areas of attention) of individuals who are at high and low risk for future violent behavior. The hypotheses of the study stated that there would be significant abnormalities in neurological functioning (specifically attention) of adult offenders who were classified as high risk. The test results did not discriminate differences between high and low risk, but identified twenty-two out of sixty individuals (38%) as having attentional deficits in the sustain element of attention. The findings of this study were consistent with the literature on the incidence of attentional disorders in incarcerated populations.


Evaluated the effects of alpha increase neurofeedback training (Performance Enhancement Training) on blood pressure, stress reduction, attention, and observed changes in brainwave patterns. A 49-yr-old male college student diagnosed with essential hypertension controlled by medication had undergone 26 sessions of alpha-increase biofeedback (8-13 Hz) at PZ electrode site for a period of 15 wks. Pre- and postblood pressure measurements were taken for every session. At the beginning of week number 8, the S discontinued his medication as advised by his physician. Pre- and postvisual Test of Variables of Attention CPT test was administered to assess the changes in accuracy, reaction time (RT), and RT variability. Osterkamp and Press Self-Assessment Stress Inventory was administered before and after training to assess the level of stress. QEEG evaluation was conducted prior, as well as upon completion of the study. Mean Arterial Blood Pressure yielded significant results between pre- and postsessions within S blood pressure measurements.


This case study evaluated the effects of alpha-increase biofeedback training on attention in a healthy 23-yr-old male. The S underwent 23 sessions of alpha-increase biofeedback (8-13 Hz) at PZ electrode site over 11 wks. The Test of Variables of Attention (TOVA) test was administered pre- and posttreatment to assess changes in reaction time (RT) and RT variability. QEEG evaluation was conducted prior to and on completion of the study. Results of the TOVA test indicate an improvement in the S's RT and the RT variability. Statistical analysis shows that before and after QEEG evaluations were within normal limits.

Attention appears to be inheritable, stable, and influenced by genetic factors. The use of the Continuous Performance Test (CPT), as an endophenotypic measure, is valuable for genetic studies because it may show increased sensitivity to specific dimensions in attention deficit hyperactivity disorder. However, few studies have been designed to examine the influence of the genotype on attention level measured by CPT in ADHD patients. This study examined the difference between 10/10 and 10/* genotype in the attention deficits measured by the CPT in ADHD patients. Forty-four unrelated ADHD patients were recruited from the psychiatric outpatient's clinic at Kangbuk Samsung Hospital. Two child psychiatrists made the diagnoses of ADHD using the DSM-IV diagnostic criteria. The genomic DNA was extracted from the blood, and analyzed to determine the genotype. A 40-base pair variable number of tandem repeats (VNTR) polymorphism in the 3' untranslated region was amplified. The attention deficits were measured by the test of variables of attention (T.O.V.A.). Between the 10/10 genotype and 10/* genotype, standard scores of the T.O.V.A were compared using a Mann-Whiney test. A comparison with the 10/10 genotype and 10/* genotype showed that those patients with the 10/10 genotype made less omission errors in the first quarter of the test (p < 0.05, by Mann-Whiney test). No significant differences were observed in the errors of commission, response time, variability. This study found that the 10/10 genotype made less omission errors on the T.O.V.A. This suggests that the dopamine transporter genotype influences the attention deficits measured by T.O.V.A.


The percent and characteristics of children who produced invalid profiles on two different continuous performance tests (CPTs) tasks were examined. Sixty-one children referred for attention deficit hyperactivity disorder (ADHD) assessment and 24 non-clinical control children (all children ages 5-16) were given the Test of Variables of Attention (TOVA) and the Intermediate Visual and Auditory Continuous Performance Test (IVA) as part of a larger assessment battery. Results revealed that 19 percent of all subjects produced an invalid profile on the TOVA and 24 percent of subjects yielded an invalid profile on the visual and/or auditory scales on the IVA. The majority of invalid profiles on the IVA were produced by children diagnosed with ADHD. On the TOVA, a similar number of ADHD and control children produced invalid results in the second half of the test due to excessive anticipatory errors. Children under the age of 7 and those with an estimated IQ of less than 85 were more likely to produce invalid profiles on the IVA. Results suggest that a significant number of children referred for ADHD assessment are likely to produce invalid scales on these two commonly used CPT measures, indicating that CPT manuals and research should address this problem.


OBJECTIVE: We assessed major cognitive domains in major depressive disorder (MDD) compared to a healthy control group using neurocognitive tests. We hypothesized that lower serum brain-derived neurotrophic factor (BDNF) levels would be associated with poorer neurocognitive performance in patients with major depression and that these associations would be shown in healthy controls as well. 

METHOD: Executive functions, sustaining and focusing of attention, memory functions, and verbal fluency were assessed in this study using the Trail-Making Test (TMT), Stroop Color Word Interference Test-TBAG Form (SCWT), Wisconsin Card Sorting Test (WCST), Test of Variables of Attention (TOVA), Auditory Consonant Trigram test (ACTT), Digit Span subtest of the Wechsler Memory Scale (DST), Rey Auditory Verbal Learning Test (RAVLT), and Controlled Oral Word Association Test (COWAT).

RESULTS: The MDD group showed significantly poorer performance than the control group in cognitive functions; they also had lower levels of BDNF than the control group. However, there was no correlation
CONCLUSIONS: The current understanding of the importance of neurocognitive assessment and related biological markers in depression is improving. Further studies with larger sample sizes evaluating neurocognitive functions with molecular analyses of BDNF levels may reveal a novel marker for predicting and monitoring neurocognitive deficits in depression.


Abstract: Attention-Deficit/Hyperactivity Disorder (ADHD) is often regarded as a disorder of childhood and adolescence, but it affects millions of adults each year. For adults the symptoms of ADHD can include inattention, impulsivity and a poor working memory. Computerized cognitive working memory training has previously been used with children and adolescents with ADHD to see how it affects their symptoms with some success; however, this work had not been done yet with adults with ADHD. This study used a quantitative quasi-experimental design with an experimental group and a wait list control group to look at the effects of working memory training on ADHD symptoms on a sample of adults with ADHD. All participants met with this researcher for pretest and posttest measures, which consisted of two subtests from the Wechsler Memory Scales III (Spatial Span Board and Letter Number Sequencing) that were combined as one measure, and the overall ADHD score on the Attention of Variable’s Test (TOVA) as a second measure. The experimental group used a computerized working memory training program for a period of five weeks (or 25 sessions) in their homes. A MANOVA was used to look at within and between group differences on post test scores. A statistically significant improvement in working memory scores was seen in the experimental group from pretest to posttest. An improvement on TOVA scores was also seen, but not to a statistically significant degree.


The inhibitory account of attention deficit hyperactivity disorder (ADHD) was tested by examining the performance of college-aged adults on a variety of inhibitory tasks, including the stop signal task, the negative priming task, a measure of working memory capacity, and the Test of Variables of Attention. 24 undergraduates with ADHD (mean age 19.21 yrs) and 24 undergraduates without ADHD (mean age 19.42 yrs) participated. The poorer performance of adults with ADHD compared with controls on negative priming, stopping, and continuous performance tasks, combined with similar group performances on a test of working memory capacity, indicates a specific inhibitory deficit as opposed to a general limitation in attentional capacity. Overall results provide evidence for extending the inhibitory deficit hypothesis to adult ADHD, not only for mechanisms of response (or motor) inhibition but also for mechanisms of cognitive inhibition.


Presents the case of a 33-yr-old man with attention deficit hyperactivity disorder (ADHD) who showed a positive response to reboxetine. After beginning reboxetine, the S was better able to concentrate and was able to read for pleasure. Job functioning also improved, as evidenced by a self-reported increase in
sustained attention at work from 10 min to 45 min posttreatment. He also showed a dramatic improvement on the Test of Variables of Attention.


We assessed major cognitive domains in symptom-free children of patients with schizophrenia compared to the healthy children of parents with no psychopathology using neurocognitive tests. We hypothesized that, offspring at high-risk for schizophrenia would have significant impairment in major domains: attention, memory, verbal–linguistic ability and executive functions. Thirty symptom-free children (17-males, 13-females; intelligence quotient = 99.6 ± 13.6; age = 12.69 ± 2.32 and education = 5.8 ± 2.3 years) having a parent diagnosed with schizophrenia and 37 healthy children matched for gender (19-males, 18-females), IQ (106.05 ± 14.70), age (12.48 ± 2.58) and years of education (6.0 ± 2.5) were evaluated. The study group showed significant poor performance in cognitive domains, such as working memory (assessed with Auditory consonant trigram test), focused attention (Stroop test), attention speed (Trail making test), divided attention (Auditory consonant trigram test), executive functions (Wisconsin card sorting test), verbal fluency (Controlled word association test) and declarative memory (Rey verbal learning and Short-term memory test). However, no group differences were detected either on verbal attention (Digit span forward test) or sustained attention (TOVA, a continuous performance task); the latter as consistently reported to be a predictor of schizophrenia. In order to determine the cognitive endophenotype of schizophrenia, it seems more rational to conduct comprehensive evaluation of neurocognitive domains in well-matched groups via using sufficiently challenging tests to detect slight deficits. In addition, longitudinal studies with a larger sample size evaluating neurocognitive functions combined with genetic analysis may provide clues about explaining the genetic background of the disorder within the endophenocognitype concept and serve as new targets for early interventions.


It is important to understand the neurobiological, cognitive, and behavioral factors that underlie ADHD and the ADHD subtypes. It has often been hypothesized that the ADHD-Combined Type (ADHD-CT) and ADHD-Predominantly Inattentive Type (ADHD-PI) subtypes may be the result of different underlying factors and may be associated with different types of attentional deficits. The current study compared 30 children with ADHD-CT and 35 children with ADHD-PI on several neuropsychological variables associated with various aspects of attentional processing. However, it is important to note that only 47 (22 with ADHD-CT and 25 with ADHD-PI) of the participants were assessed with some of the experimental measures. All participants were between the ages of 6 years, 0 months and 12 years, 11 months. Participants were evaluated using several neuropsychological measures associated with various aspects of attentional processing in order to test five hypotheses regarding possible subtype differences in specific types of attention. The attentional processes of interest included response activation, sustained attention, encoding/working memory, the focus/execute aspect of attention, and attentional stability. These constructs were taken from the theories of Tucker and Williamson (1984) and Mirmir and Colleagues (1999). The attentional measures used in this study were taken from the Test of Variables of Attention (TOVA), the Children's Memory Scale (CMS), and the Wechsler Intelligence Test for Children-Third Edition (WISC-III). Analysis of possible subtype differences in the occurrence rate of reading disabilities was also conducted. Finally, post hoc analyses were conducted in order to test the hypothesis that specific attentional processes might impact other specific aspects of the neuropsychological functioning of children with ADHD. The attentional processes of interest were response activation and attentional stability. The dependent variables for the post hoc analyses included measures of language ability as well as behavioral ratings of attention and hyperactivity. No statistically
significant group differences were found for any of the variables reflecting the five aspects of attentional processing. Nor were any significant subtype differences in the occurrence rate of reading disabilities or the post hoc analyses. The post hoc analyses did not yield statistically significant results either. Finally, weaknesses of the current study as well as future directions for ADHD research were discussed.


This study examined whether a subscale of the Personality Assessment Inventory (PAI) was able to function as an identifying marker for Attention Deficit/Hyperactivity Disorder (ADHD) in adults. Consisting of a group of non-ADHD subjects who had other mental disorders and a group of ADHD subjects, the study examined the Schizophrenia-Thought Disorder subscale (SCZ-T) raw scores by comparing the means from each group. The subjects ranged in age from 18 to 75 years and were from an outpatient psychiatric private practice. The total sample (N = 82) consisted of an equal number of male and female participants who were mostly Caucasian. This study utilized the Test of Variables of Attention (TOVA) to distinguish between non-ADHD subjects and ADHD subjects. This study found that the SCZ-T subscale of the PAI discriminated between non-ADHD and ADHD subjects, which suggest that this subscale is capable of serving as an identifying marker for ADHD in adults. Furthermore, this study demonstrates that the PAI is clinically beneficial in the assessment of ADHD in adults. Although the findings do not suggest that the PAI is able to diagnose a mental disorder apart from other clinical information, the findings indicate that the subscale can improve symptom identification and diagnostic accuracy.


The Test of Variables of Attention (T.O.V.A.; R. A. Leark, T. R. Dupuy, L. M. Greenberg, C. L. Corman, & C. L. Kindeschi, 1996) is a continuous performance test used widely to help diagnose attention deficit hyperactivity disorder (ADHD) in both hearing and deaf people. The T.O.V.A. previously has been normed only on the hearing population. The T.O.V.A. performance of 38 prelingually and severely-to-profoundly deaf young adults and 34 hearing young adults who did not have ADHD was examined in this study. Deaf and hearing participants did not differ on the T.O.V.A. omission variables. However, deaf participants had significantly lower d' scores than hearing participants, indicating reduced perceptual sensitivity to the distinction between target and distractor stimuli. Consistent with the existing literature on attentional reorganization in the deaf population, this result was interpreted as indicating a deafness-related reduction in attention to centrally presented stimuli. Deaf participants also showed 2 to 3 times more commission errors than hearing participants and displayed a higher incidence of anticipatory errors. These results suggest a deafness-related increase in impulsivity at the time of response initiation. Beta score analysis confirmed that deaf participants adopted an overall less conservative (more impulsive) response criterion that contributed to their total elevated commission errors. However, a portion of the commission errors was secondary to their reduced d', not to increased behavioral impulsivity. Separate factor analyses of the standard T.O.V.A. variables revealed highly similar factor structures for deaf and hearing participants, indicating similar construct validity of the T.O.V.A. for both groups. The evidence for increased inattention and impulsivity in a non-ADHD deaf sample are interpreted in the context of an adaptive attentional reorganization due to deafness. Along with the factor analytic results, these considerations suggest that separate T.O.V.A. norms must be developed for the deaf population to avoid overdiagnosis of ADHD in deaf individuals.

Continuous performance tests (CPTs) are frequently used in clinical practice to assess the attentiveness of ADHD children. Although most CPTs do not categorize T scores by intelligence, there is great diversity of opinion regarding the interrelation between intelligence and CPT performance. This study aimed to determine if ADHD children with superior IQs would perform better than ADHD children with average IQs. Additionally, we aimed to examine the need for CPTs' to categorize according to IQ.

Methods Participants were 326 outpatients, aged 5-15 years, diagnosed with ADHD. All participants completed the Wechsler Intelligence Scale for Children-Revised and a CPT. After excluding those who meet exclusion criteria, we had 266 patients for our analysis. Results The "Highly Intelligent Group" (HIG), patients with IQs 120 and above, performed superiorly to the "Normally Intelligent Group" (NIG) patients, with IQs between 70 and 120, with regard to omission and commission errors on the visual-auditory CPT, even after controlling for age and gender. The HIG had higher ratios of subjects with T scores <65 on the visual and auditory CPT variables than the NIG did. Conclusion The results of this study suggest this CPT is not sensitive for discerning ADHD in children with superior IQs.


The primary aim of this nursing clinical research dissertation was to test a photic driven electroencephalograph (EEG) neural training procedure designed to enhance the regulation of brain wave activity and thus improve cognitive functioning in ADHD children. The outcome measures used were a combination of psychometric test scores, behavior profiles, computerized performance test scores and EEG measures. A related goal was to describe the associated changes in dynamic EEG patterns in order to evolve a theoretical basis for the EEG treatment. The study subjects were 8-14 year old children of intact families referred from a number of sources and were screened by a developmental pediatrician for other concurrent DSM-3-R diagnoses and medical conditions. Some of the subjects were medicated and some were not. A quasi-experimental waiting control group design was used with repeated tests consisting of the Wechsler Intelligence Scale for Children Third Edition (WISC-3), Raven Progressive Matrices (RPM), Wechsler Individual Achievement Test (WIAT), Achenbach Child Behavior Checklist and Profiles (CBCL-P), and Test of Variables of Attention (TOVA). Electroencephalograph (EEG) measures were also used to identify changes due to treatment. No significant changes were noted in any of the waiting period control group tests. Experimental results revealed significant improvement in WISC-3 processing speed (impulsivity), freedom from distractibility (attention), and improvement in the CBCL-P parent and youth self-report form attention problem profiles. Significant changes were not found in the Raven (attention) scores. The TOVA test scores showed significant post-treatment reduction in impulsivity as measured by errors of commission; however, changes in omission errors did not reach significance at the .05 level. Follow-up WIAT testing is incomplete, however the 11 evaluated so far have shown systematic improvements. Unfortunately, there were no significant descriptive changes discerned.


Investigated a 15-session EEG driven photic stimulation neural training procedure designed to enhance the regulation of brain wave activity and thus improve cognitive functioning in 25 8-14 yr olds with attention deficit hyperactivity disorder (ADHD) (14 medicated). A quasi-experimental waiting control group design was used with repeated psychometric tests consisting of the Wechsler Intelligence Scale for Children - IIIrd Edition (WISC-III), Raven Progressive Matrices, Wechsler Individual Achievement Test (WIAT), Child Behavior Checklist and Profiles (CBCL-P), a computerized performance test of variables of attention, and 2 separate EEG measures. No significant changes were noted in any waiting period control group tests. Results reveal highly significant EEG changes, improvements in the WISC processing speed and freedom from distractibility scales, WIAT, CBCL-P, and 4th quarter commission.
error test scores. Further study is indicated to explore the effects of longer treatment courses, different training goals, and better data procurement procedures using outcome measures of EEG variability coupled with successful psychometric performance.


The clinical use of computerized Continuous Performance Tests (CPTs) with children with Attention Deficit-Hyperactivity Disorder (ADHD) presents several complex issues relating to diagnosis and construct validity. Moreover, these tests have not typically provided adequate measures of "sustained" attention—that is, subject performance over time, otherwise known as "vigilance". Those studies which sought to measure sustained attention decrements over time provided mixed results, and therefore different methodological approaches may better tap the vigilance decrement hypothesized in attention deficits. Overall, accurate measures of vigilance, such as signal detection measures, may improve current construct validity of CPTs. This program of research, composed of two studies, used the Test of Variables of Attention (TOVA) in a group of children with and without ADHD, as diagnosed by ADHD rating scales. Study 1, using 134 male subjects, utilized regression analyses to test the efficacy of a new multivariate measure, the Decrement Over Time (DOT), in its sensitivity to the Inattentive (IA) subtype of ADHD. Study 2 re-tested a sample of 67 children drawn from the study 1 sample at least one year later, to test the superiority of the DOT model when compared to traditional CPT measures of omission and commission errors, response time, and response variability, as well as the TOVA ADHD Score, when assessing inattention. Also, behavioral ratings were recorded during TOVA performance, and it was hypothesized that these would increase the construct validity of the TOVA measures. Results suggested that the DOT model was significantly related to external ratings of inattention, above and beyond the TOVA measures and ADHD Score. The hypothesis that behavioral ratings would supplement the TOVA measures was not substantiated, although the behavior ratings did improve the ability of the DOT model in assessing ADHD subtypes. Study 2 also sought to investigate the effects of maturation and motivation, but these hypotheses were not confirmed in this study. The implications and applications of the use of the DOT model in CPT assessment of sustained attention deficits are discussed.


A multidimensional model of attention deficits is proposed for assessing ADHD in adults. The model is based on cognitive and executive function deficits and incorporates selected subtests from the WAIS-R, WMS-R, TOVA, Trails A and B, Stroop Color-Word Interference Test, and WRAT. Using ANOVA procedures, results on 58 adult outpatients indicate the model is capable of distinguishing adults with ADHD from those without (p < .05). The author discusses utilizing the proposed model for increasing diagnostic accuracy and understanding of the cognitive and executive deficits underlying the psychosocial deficits associated with this disorder.

Continuous performance tests (CPTs) are widely used in the assessment and study of attention deficit hyperactivity disorder (ADHD). Although CPTs have reliably found differences between children with ADHD and normal controls, discriminating between children with ADHD and children with subclinical levels of behavioral or cognitive problems is a more clinically relevant and difficult endeavor. Additionally, most studies use convenience samples from clinical care settings that may not represent the ADHD population as a whole. The current study assessed the utility of a clinically used CPT, the Test of Variables of Attention (TOVA), in distinguishing between children with ADHD and children with subclinical levels of attention/behavior problems. Participants constituted a representative sample of elementary school students at high risk for ADHD, including 116 children with ADHD and 51 subclinical controls. Results found no significant differences between the ADHD and subclinical group on CPT variables, and CPT performance did not reliably predict group membership. Implications of the findings are discussed.


Introduction. This study examines recovery of attentional measures among a heterogeneous group of clients in a pre-and post-comparison using inter-hemispheric EEG training at homologous sites. A continuous performance test was used as an outcome measure. The client population was divided into three categories: (a) primarily attentional deficits, (b) primarily psychological complaints, and (c) both.

Method. Neurofeedback protocols included T3-T4, Fp1-Fp2, F3-F4, C3-C4 and P3-P4. A wide range of reward frequencies was used, and these were individually selected to optimize the subjective experience of the training. Participants were 44 males and females, 7 to 62 years old, who underwent treatment for a variety of clinical complaints. Dependent variables were derived from a continuous performance test, the Test of Variables of Attention (TOVA), which was administered prior to EEG training and 20 to 25 sessions thereafter. Results. After EEG training a clear trend towards improvement on the impulsivity, inattention, and variability scales of the TOVA was evident. Participants with normal pre-training scores showed no deterioration in their performance, indicating that homologous site inter-hemispheric EEG training had no deleterious effect on attention. In addition reaction time was predominantly in the normal range for this population and remained unchanged following training. Conclusion. Normalization of attentional variables was observed following training irrespective of the primary clinical complaint. These results suggest that inter-hemispheric training at homologous sites provides another "generic" EEG biofeedback protocol option for addressing attentional deficits. Inter-hemispheric training likely serves as a general challenge to the regulation of cerebral timing, phase, and coherence relationships. Such a challenge may result in more effective regulation of cerebral networks, irrespective of whether these are involved in attentional or affective regulation.


This study was designed to determine whether lasting attentional deficits result from repeated mild closed head injuries related to participation in youth boxing. Subjects consisted of 10 amateur boxers and 10 basketball players who were participating in tournaments at a youth club. Subjects were matched for age, grade point average, and socioeconomic status. Attentional disruptions were measured by four variables of the Test of Variable Attention (TOVA): Omission errors, a measure of attention; commission errors, a measure of response inhibition and impulsivity; response time, a measure of information processing and motor response speed; and variability of response time, a measure of consistency of attention. The boxers were tested 1 hour after the completion of the boxing tournament and again 8 weeks later. The basketball players were tested once while their tournament was in progress. The results of the study indicate that the cumulative effects of head blows sustained during the boxing season did not have a significant effect on TOVA measures of inattention, inhibition/impulsivity, or information processing and motor response speed. Variability was the only index for which the mean score of the boxers differed significantly from the norm. Consistency of attention was inconsistent and varied at the end of the boxing
season and appears to be the only variable affected by the purported head blows. The hypothesis that
there would be significant differences between boxers’ mean TOVA scores obtained 1 hour after the last
match of the tournament and those obtained 8 weeks later was partially supported. The mean scores of
the boxers for commission errors and consistency of attention improved significantly between the two
testing conditions although their reaction-time score decreased. The hypothesis that the mean TOVA
scores of the boxers obtained 1 hour after the last match of their tournament would differ from those of
basketball players was supported. The basketball players’ reaction time was significantly faster than that
of the boxers at the end of the season as well as 8 weeks later.


OBJECTIVE: This study examined the ecological validity, construct validity, and diagnostic utility of the
third factor of the WISC-III, heuristically labeled “Freedom From Distractibility” (FFD). METHOD: A
sample of 200 children, aged 6 to 11 years, with attention-deficit hyperactivity disorder (ADHD)
completed the WISC-III, the Wide Range Achievement Test-Revised, and the Test of Variables of
Attention. Objective parent and teacher report measures of attention and hyperactivity were completed.
RESULTS: Mean FFD scores were significantly lower than other WISC-III factor scores. The diagnostic
utility of FFD is limited, however, as the majority of these children did not show a significant relative
weakness on this index. Correlational analyses failed to support the concurrent, ecological, or construct
validity of the FFD. FFD scores were not correlated with a measure of sustained visual attention.
Findings suggest that among children with ADHD, a low FFD score may be associated with the presence
of a learning disability or poor academic performance. This finding was maintained after level of general
intelligence was statistically controlled. CONCLUSIONS: Clinicians and researchers should not view FFD
as a reliable or valid index of attention or as a diagnostic screening measure for identifying children with
ADHD.


Examined the ecological validity, construct validity, and diagnostic utility of the 3rd factor of the Wechsler
Intelligence Scale for Children-III (WISC-III), heuristically labeled Freedom From Distractibility (FFD). 200
children, aged 6-11 yrs, with attention-deficit hyperactivity disorder (ADHD), completed the WISC-III, the
Wide Range Achievement Test--Revised, and the Test of Variables of Attention. Objective parent and
teacher report measures of attention and hyperactivity were completed. Mean FFD scores were
significantly lower than other WISC-III factor scores. The diagnostic utility of FFD is limited, however, as
the majority of the Ss did not show a significant relative weakness on this index. Correlational analyses
failed to support the concurrent, ecological, or construct validity of the FFD. FFD scores were not
correlated with a measure of sustained visual attention. Among children with ADHD, a low FFD score
may be associated with the presence of a learning disability or poor academic performance. This finding
was maintained after level of general intelligence was statistically controlled. FFD may not be reliable or
valid as an index of attention or as a diagnostic screening measure for identifying children with ADHD.

Romans, S. M., Roeltgen, D. P., Kushner, H., & Ross, J. L. (1997). Executive function in girls with turner's

Investigated executive function and attention abilities in 105 girls with Turner’s syndrome ([TS] aged
7-16.9 yrs) and 153 age-, IQ-, and SES-matched controls. Executive skills included the ability to plan,
organize, monitor, and execute multistep problem-solving processes. Three age groups were evaluated
in order to assess developmental patterns in executive skills. Data showed that TS Ss performed
significantly less well than did controls on measures of attention, including the Freedom From
Distractibility factor of the Wechsler Intelligence Scale for Children--Revised (WISC--R) and the Test of Variables of Attention. In the executive function domain, TS Ss performed at levels comparable to controls on the Wisconsin Card Sort Test and on measures of semantic clustering, but they exhibited significant deficits on the Rey-Osterrieth organizational component and the Tower of Hanoi. In summary, girls with TS showed evidence of increased impulsivity, and their performance on tests of executive function with complex spatial demands showed similar impairment at all ages studied.


While there is a growing awareness of the co-occurrence of giftedness and Attention Deficit Hyperactivity Disorder (ADHD), little is known about the clinical presentation of ADHD in intellectually gifted children. Current diagnostic decisions with this subpopulation are made employing procedures and norms developed using a nonexceptional population. However, it is unknown whether this common practice is appropriate. This study explored how intellectually gifted children perform on three commonly used measures of ADHD, specifically: (a) the Test of Variables of Attention (TOVA); (b) the Conners’ Teacher Rating Scale, Revised-Long Form (CTS); and (c) the Conners’ Parent Rating Scale, Revised-Long Form (CPS). Children who met traditional criteria for giftedness (N = 90) were obtained from nearby public schools. Each was administered the TOVA and their parents and teachers completed a Conners’ rating scale. The performance of these children was compared to normative data. It was hypothesized that: (a) gifted children would perform significantly better on the TOVA than normative children, and (b) no differences would be found between the performance of gifted children and the normative sample on both the CTS and CPS. The hypotheses were partially supported by the findings. Gifted children performed better on three of the five TOVA variables, but only for the younger children in the sample. In addition, no evidence of differences in scores was found between the gifted children and the normative sample on the CTS and CPS. The findings do, however, address the underlying clinical question regarding the appropriateness of using the normative data provided for the TOVA, CTS and CPS to assess ADHD in intellectually gifted children. Ultimately, the performance differences found for gifted children on the TOVA suggest that alternate TOVA norms are likely needed for younger ages. A rationale for adjusting the TOVA norms is proposed, and a few simple “rules of thumb” for transforming the age-based are summarized in an Adjustment Matrix. The differences on the CTS and CPS were found mostly for variables unrelated to ADHD and suggest that the normative data for the Conners’ Scales can be used when assessing ADHD in gifted children.


This study replicated T. R. Rossiter and T. J. La Vaque (1995) with a larger sample, expanded age range, and improved statistical analysis. Thirty-one AD/HD patients who chose stimulant drug (MED) treatment were matched with 31 patients who chose a neurofeedback (EEG) treatment program. EEG patients received either office (n = 14) or home (n = 17) neurofeedback. Stimulants for MED patients were titrated using the Test of Variables of Attention (TOVA). EEG (effect size [ES] = 1.01-1.71) and MED (ES = 0.80-1.80) groups showed statistically and clinically significant improvement on TOVA measures of attention, impulse control, processing speed, and variability in attention. The EEG group demonstrated statistically and clinically significant improvement on behavioral measures (Behavior Assessment System for Children, ES = 1.16-1.78, and Brown Attention Deficit Disorder Scales, ES = 1.59). TOVA gain scores for the EEG and MED groups were not significantly different. More importantly, confidence interval and nonequivalence null hypothesis testing confirmed that the neurofeedback program produced patient outcomes equivalent to those obtained with stimulant drugs. An effectiveness research design places some limitations on the conclusions that can be drawn.

Presents the case study of a 13-yr-old male with attention deficit hyperactivity disorder (ADHD) treated with neurofeedback. The case is presented as a tutorial on Ratio feedback. Ratio feedback protocols provided visual and auditory feedback based on the ratio of slow wave activity to be suppressed divided by fast wave activity to be enhanced. The patient demonstrated marked improvement in processing speed and variability on the Test of Variables of Attention-Auditory, a 19-point increase in IQ on the Kaufman Brief Intelligence Test, significant behavioral improvement based on parental (Behavioral Assessment for Children) and patient (Brown ADD Scale) reports, and a 7.5 grade equivalent increase in reading scores. At the 17-mo follow-up parent questionnaires indicated that the patient’s behavioral gains had been maintained or were slightly improved.


Reports on patient-directed neurofeedback for attention deficit hyperactivity disorder (ADHD). Therapist involvement was limited to 10 treatment sessions used to train the patient or parents of younger children to use the equipment, to monitor treatment, and to make changes in the treatment protocol as necessary. The remaining 50 sessions were conducted at home using inexpensive, easy to operate, 1 or 2 channel Lexicor PODs. Results from the initial 6 patients (aged 7-45 yrs) are reported. Thirteen of 24 Test of Variables of Attention (TOVA) measures (e.g., attention, impulsivity, reaction time and variability) were below average at baseline. After 30 neurofeedback sessions, only 5 TOVA variables remained below average. It is concluded that patient-directed neurofeedback may be an effective alternative to therapist-directed treatment for many ADHD patients and can be delivered at substantially less cost.


Compared treatment programs with EEG biofeedback or stimulants as their primary components for patients (aged 8-21 yrs) with undifferentiated attention deficit disorder or attention deficit hyperactivity disorder (ADHD). An EEG group (23 Ss) was matched with a stimulant (MED) group (23 Ss) by age, IQ, gender, and diagnosis. The Test of Variables of Attention (TOVA) was administered pre- and posttreatment. EEG and MED groups improved on measures of inattention, impulsivity, information processing, and variability, but did not differ on TOVA change scores. The EEG biofeedback program is an effective alternative to stimulants and may be the treatment of choice when medication is ineffective, has side effects, or compliance is a problem.


OBJECTIVE: To examine the effect of once-daily dosing of modafinil, a stimulant that has a long duration of action, on clinical features of attention-deficit/hyperactivity disorder (ADHD) in children. METHOD: An open-label design was used to compare the Conners Parent and Teacher Rating Scale-Revised (L) (CPRS, CTRS), the ADHD Rating Scale-IV, and the Test of Variables of Attention (TOVA), without and with medication, in children with ADHD. Eleven children with ADHD, ranging in age from 5 to 15 years, took modafinil for an average of 4.6 weeks. RESULTS: Average TOVA ADHD scores improved by 2.43 SD (p = .0009), CTRS and CPRS ADHD index T scores improved by an average of 14.1 (p = .0009) and 17.7 points (p = .001), respectively. The mean ADHD Rating Scale-IV scores improved from the 88th percentile to the 75th percentile (p = .047). One subject withdrew from the study because of an adverse event that was resolved completely with medication withdrawal. Other side effects were mild and responded to dose adjustment. No subjects required more than one dose per day. CONCLUSIONS:
Modafinil may be a useful once-daily treatment for children with ADHD. Further study using a double-blind, placebo-controlled design is needed.


Previous clinical evidence suggested that modafinil may improve clinical features of children with attention-deficit hyperactivity disorder. To test this hypothesis, a randomized, double-blind, placebo-controlled study design was used. Of 24 children initially randomized into the study, 11 control subjects and 11 treatment patients completed the study, with evaluation before medication and after 5 to 6 weeks. The average Test of Variables of Attention attention-deficit hyperactivity disorder z score improved by 2.53 S.D.s for the modafinil group compared with a decline of 1.02 for control patients (P < or = 0.02). Conners Rating Scales ADHD total t scores for the modafinil group improved from 76.6 to 68.2 compared with improvement from 77.7 to 76.0 for control subjects (P = 0.04). Ten of 11 treatment patients were reported as "significantly" improved, whereas eight of 11 control subjects were reported as manifesting "no" or "slight" improvement (P < 0.001). Adverse effects were few and manageable, with no anorexia. Modafinil may be a useful treatment for children with ADHD, particularly when anorexia limits use of stimulants.


Examined the effect of once-daily dosing of modafinil, a stimulant that has a long duration of action, on clinical features of Attention-Deficit/Hyperactivity Disorder (ADHD) in children. An open-label design was used to compare the Conners Parent and Teacher Rating Scale-Revised (CPRS, CTRS), the ADHD Rating Scale-IV, and the Test of Variables of Attention (TOVA), without and with medication, in children with ADHD. 11 children with ADHD (aged 5-15 yrs) took modafinil for an average of 4.6 wks. Average TOVA ADHD scores improved by 2.43. CTRS and CPRS ADHD index T scores improved by an average of 14.1 and 17.7 points, respectively. The mean ADHD Rating Scale-IV scores improved from the 88th percentile to the 75th percentile. One S withdrew from the study because of an adverse event that was resolved completely with medication withdrawal. Other side effects were mild and responded to dose adjustment.


The focus of this study was on the clinical application of neurofeedback (electroencephalographic biofeedback) as a treatment strategy for the attention, concentration, short term memory, sleep problems, and emotional difficulties associated with mild to severe closed head injury. The subjects were 4 males and 6 females, ages 30 to 49 with varying degrees of head injury. The time since injury ranged from 13 months to 276 months. The design of the study was a multiple case study design with subjects serving as their own controls. The hypotheses were that EEG training of subjects with mild to severe closed head injury would be associated with a significant decrease in theta and high frequency beta magnitudes and changes in theta/high frequency beta ratios. EEG changes were to have been documented from multiple pretraining and posttraining EEG baseline measurements. It was also hypothesized that neurofeedback training would be associated with improvement in attention, concentration, short term memory, sleep problems, depression, anxiety, irritability, and mood swings. Subjects received pretesting and posttesting with the Micro-Cog Assessment of Cognitive Functioning and Test of Variables of Attention as well as a Symptom Checklist-90-R for assessment of emotional functioning. Each subject also participated in a pretraining and posttraining clinical interview and maintained a weekly symptom report form. Following the administration of the pretests, subjects engaged in a 30 session protocol of EEG biofeedback
training. Each session consisted of 30 minutes of individual training in the Cz, C3, and/or C4 cranial areas. The results did not support the expected changes in theta or high frequency beta activity. However, a statistically significant training effect was indicated in the alpha and sensorimotor (12-15hz.) frequencies in the primary area of training (Cz). Although subject report generally indicated improvement in memory, this was not supported by statistically significant test results. Statistically significant improvement was indicated for attention-concentration, sleep problems, and the emotional areas. In regard to memory function, it was possible that the protocol may not have been extensive enough in time or scope to achieve improvements that could be documented with test results. Further research on a larger scale with neurofeedback training and head injury may aid our understanding and ability to treat this often devastating condition.


Attention-Deficit/Hyperactivity Disorder (ADHD) is difficult to diagnose due to the subjectivity of its symptoms and lack of specific assessment measures. Computerized tests of attention have recently been used as objective measures that may assist in the diagnosis of the disorder. The present study evaluated consistency between the Conners Parent Rating Scale and the Test of Variables of Attention (TOVA), which is a computerized test of attention designed to identify symptoms associated with ADHD, in children clinically diagnosed with ADHD (n = 28) and controls (n = 20). Our results showed that both the Conners and the TOVA indicated significant problem areas suggestive of an attention deficit in approximately 85% of children who were clinically diagnosed with ADHD. However, the TOVA also found attentional problems in approximately 30% of control children, whereas none of the controls scored abnormally on the Conners. As computerized measures are administered more frequently, there may be a risk of overdiagnosis and treatment of "ADHD" in normal children. A combined approach using questionnaires, clinical evaluation, and computerized tests of attention in the assessment of possible ADHD may provide the most accurate means of diagnosis.


The goal of the present exploratory study was to establish whether a small sample of individuals with Asperger syndrome showed an increased number of attention deficit symptoms. Participants were eight males (aged 9.00-19.92 yrs) clinically diagnosed with Asperger syndrome and eight matched control subjects. The TOVA, a computerized continuous performance test, was administered in a standardized fashion to all participants. Evidence of an attention deficit was seen in a majority of the participants with Asperger syndrome. Only the Variability diagnostic variable was able to differentiate the two groups.


Neuropsychological and neuromotor functions were compared between boys and girls with Tourette syndrome (TS only), attention-deficit hyperactivity disorder (ADHD only), Tourette syndrome with ADHD (TS+ADHD), and a comparison group, in an age (mean = 10 years) and IQ (Wechsler Full-Scale mean = 111) matched sample (n = 116). There were no timed-task neuromotor differences among the groups. Analyses of variance revealed a group x gender interaction for Letter Word Fluency and the Rapid Automatized Naming test. Girls with ADHD only were faster than boys on both tasks. When data for girls only were analyzed, girls with Tourette syndrome with ADHD had the greatest variability of reaction time on the Test of Variables of Attention, and were slowest on Letter Word Fluency. Girls with TS only were slower than girls in the other three groups on Letter Word Fluency. Poor Letter Word Fluency is explained
as a linguistic executive dysfunction involving speed and efficiency of memory search in this bright group of girls with Tourette syndrome, not otherwise at risk for linguistic difficulties.


This study examined whether an EEG biofeedback protocol could improve outcome measures for a mixed substance abusing inpatient population. METHOD: One hundred twenty-one volunteers undergoing an inpatient substance abuse program were randomly assigned to the EEG biofeedback or control group. EEG biofeedback included training in Beta and SMR to address attentional variables, followed by an alpha-theta protocol. Subjects received a total of 40 to 50 biofeedback sessions. The control group received additional time in treatment equivalent to experimental procedure time. The Test of Variables of Attention (TOVA), and MMPI, were administered with both tester and subject blind as to group placement to obtain unbiased baseline data. Treatment retention and abstinence rates as well as psychometric and cognitive measures were compared. RESULTS: Experimental subjects remained in treatment significantly longer than the control group (p <0.005). Of the experimental subjects completing the protocol, 77% were abstinent at 12 months, compared to 44% for the controls. Experimental subjects demonstrated significant improvement on the TOVA (p<.005) after an average of 13 beta-SMR sessions. Following alpha-theta training, significant differences were noted on 5 of the 10 MMPI-2 scales at the p<.005 level. CONCLUSIONS: This protocol enhanced treatment retention, variables of attention, and abstinence rates one year following treatment.


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Objective. The purpose of this study was to determine the effects of a specific intervention, the Interactive Metronome, on selected aspects of motor and cognitive skills in a group of children with attention deficit hyperactivity disorder (ADHD). Method. The study included 56 boys who were 6 years to 12 years of age and diagnosed before they entered the study as having ADHD. The participants were pretested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hr of Interactive Metronome training exercises were compared with a group receiving no intervention and a group receiving training on selected computer video games. Results. A significant pattern of improvement
across 53 of 58 variables favoring the Interactive Metronome treatment was found. Additionally, several significant differences were found among the treatment groups and between pretreatment and posttreatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior. Conclusion. The Interactive Metronome training appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD.


Reports the experience of an 8.5-yr-old boy who was diagnosed mildly autistic by several specialists. One specialist claimed that the S was brain damaged and "autistic like" and that there was no hope for improvement. The S's score on a test of variables of attention was consistent with an attention deficit disorder. At the request of the S's mother, neurotherapy diagnosis and treatment was begun. After 31 sessions, the S showed positive changes in all the diagnostic dimensions defining autism in the Diagnostic and Statistical Manual of Mental Disorders-III-Revised (DSM-III-R).


This study investigated the neuropsychological consequences of hypoxia in children with transposition of the great arteries (TGA). TGA is a congenital heart defect requiring reparative open heart surgery to improve arterial oxygen saturation. Participants in this study were 56 children with TGA and 34 sibling controls from the Baltimore-Washington metropolitan area. Participants were assessed with neuropsychological measures including: Stanford Binet-IV Intelligence Test, Woodcock Johnson-Revised Test of Academic Achievement Wide Range Assessment of Memory and Learning, California Verbal Learning Test-Children's version, Rey Osterrieth Complex Figure, Test of Variables of Attention, and the Child Behavior Checklist. It was predicted that presence of TGA in children is related to substandard performance on tests of academic achievement and neuropsychological measures of memory and learning. Results indicated that compared to sibling controls, children with TGA performed more poorly on tests of (1) academic achievement, (2) attention, (3) acquisition memory, and (4) organization and planning abilities. Multiple regression analyses revealed that attention and acquisition memory accounted for a significant proportion of the variance in academic achievement of children with TGA. Children with TGA in the current sample were at greater risk for learning disability than learning disability prevalence rates within the normal population. A greater number of children with TGA received special educational assistance at school than sibling controls. It was concluded that chronic hypoxia in children with TGA results in mild generalized cerebral dysfunction. Many children with TGA will require special education services, and are at risk for academic struggles if they do not receive appropriate resources and support. Therefore, developmental, educational, and neuropsychological monitoring of children with a history of hypoxia should continue into the school age years.


Introduction. Atypical EEG and neuropsychological indicators have been observed among offenders. Dangerous offenders treated with a combined program that included neurofeedback (EEG biofeedback) and galvanic skin response (GSR) biofeedback demonstrated reduction in recidivism (Quirk, 1995). This study was designed to further evaluate the EEG findings of youth offenders and to provide an initial report on the effectiveness of a task oriented analog/ QEEG-based remedial neurofeedback training approach. Method. Five offenders with significant psychopathology were referred for treatment. The group was evaluated with attentional testing and analog/QEEG assessment prior to and following neurotherapy. Treatment consisted of 20 or 40 sessions of a task-activated, analog/QEEG- based
approach. Another group of thirteen offenders were assessed with attentional testing and provided with neurotherapy following QEEG assessment. Results. For all of the youth trained, in the analog/QEEG group, prevs. post-audio and visual attention testing demonstrated significant improvement within 20 remedial sessions. Three of the five youth showed rapid advancement in a residential grading system. Staff observational ratings suggested behavioral improvement in the QEEG group who in general were in training for a longer period of time. Conclusion. EEG abnormalities and deficits in neuropsychological testing were found among offenders. Neurotherapy as an adjunctive treatment appears to hold promise for improvement in cognitive performance as well as recidivism. It is anticipated that different neurofeedback protocols may enhance outcomes.


Studies indicate that the prevalence of attention difficulties in deaf individuals is greater than that in the general population. Computerized Performance Tests (CPTs) have become a valuable tool in diagnosing attention problems and recent research has demonstrated that deaf individuals perform poorly on CPTs when compared to their hearing peers. The current study attempted to validate the use of the Test of Variables of Attention (T.O.V.A.) for use with deaf adults. In addition, the present paper evaluated the significance of an inattentive or hyperactive performance on the T.O.V.A. In this study 63 deaf undergraduate students were screened with a prorated Performance IQ from The Wechsler Adult Intelligence Scale-Third Edition (WAIS-III). Subjects were then administered the Test of Variables of Attention (T.O.V.A.), the Risk-Taking Self-Report Scale, and ADHD Behavior Checklist for Adults.

Results from these measures were correlated to the students' current Grade Point Average. Results and implications for the use of the T.O.V.A. as a screening measure of attention difficulties with deaf adults are discussed.


OBJECTIVE: OROS methylphenidate HCL (MPH) is a recently developed long-acting stimulant medication used to treat attention-deficit/hyperactivity disorder (ADHD). This study was conducted to examine dosage effects on ADHD symptoms and stimulant side effects and to explore potential moderating effects of ADHD subtype. METHODS: Children with ADHD combined type (ADHD-CT) or predominantly inattentive type (ADHD-PI; n = 47), ages 5 to 16 years, underwent a placebo-controlled, crossover trial using forced titration with weekly switches at 3 dosage levels. Parent and teacher ratings of ADHD symptoms were used to evaluate efficacy. In addition, vital signs and standardized measures of stimulant side effects were obtained weekly. RESULTS: Parent ratings were more sensitive to treatment effects than teacher ratings. ADHD symptoms and Clinical Global Impressions Severity Index ratings at each dose condition differed significantly from placebo and baseline ratings, which did not differ from one another. For those with ADHD-CT, there was a clear linear dose-response relationship, with clinically significant reductions in ADHD Rating Scale-IV scores occurring in two thirds to three fourths of the subjects during either 36- or 54-mg dose conditions. Children with ADHD-PI, conversely, were more likely to respond optimally to lower doses and derived less benefit from higher doses, with 60% displaying significant improvement on the ADHD Rating Scale-IV at 36 mg or lower. Mild stimulant side effects were reported during placebo and at all dosage levels. With the exception of insomnia and decreased appetite, which were more common at higher doses, parent report of side effects was not related to dose. In addition, younger and smaller children were more likely to display sleep difficulties and decreased appetite at the higher dose levels although pulse rate increased slightly with increasing dose, there were no dose effects on blood pressure. CONCLUSIONS: In children with ADHD-CT, the most common subtype of ADHD, increasing doses of stimulant medication were associated with increased improvement of inattention and hyperactivity symptoms. In children with ADHD-PI, symptom improvement occurred at
lower doses and less benefit was derived from higher doses. In both ADHD subtypes, higher doses were associated with parent ratings of increased insomnia and decreased appetite.


Examined the external validity of attention deficit hyperactivity disorder (ADHD) without hyperactivity as a diagnostic category by comparing a group of 9 boys who met the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) criteria for ADHD, predominantly inattentive type, to a group of 9 boys who met the criteria for ADHD. Quantitative EEG analysis was used to examine possible differences in brain wave activity of the two subtypes of ADHD while completing the Test of Variables of Attention, a computerized task that measures a variety of constructs associated with attention and impulsivity. Although parent-reported behavioral ratings confirmed differential characteristics of both subtypes of ADHD, EEG findings did not differentiate between ADHD with and without hyperactivity. Implications to cognitive models of ADHD are discussed.


The purpose of the study was to examine the external validity for Attention Deficit/Hyperactivity Disorder (ADHD), Predominantly Inattentive Type, as a separate entity from ADHD, Combined Type. EEG and psychometric data were collected on a group of carefully selected 10 to 12 year old boys who met the criteria for one of these two diagnoses, as well as a group of normal control children. The EEG records were collected during the following three conditions: eyes open, eyes closed, and while completing the Test of Variables of Attention (TOVA). Means and standard deviations were calculated for each EEG variable and change scores were calculated to reflect the shift in EEG activity that occurred between the eyes open and TOVA conditions. An analysis of covariance design using the eyes open condition as covariate was also used to compare the EEG data for the three groups. Both of the clinical groups obtained similar scores on the TOVA and exhibited the presence of excessive slow wave activity and higher mean magnitude when compared to normal subjects. The majority of significant differences emerged between the predominantly inattentive subjects and the control subjects. The results do not provide support for conceptualizing ADHD, Predominantly Inattentive Type, as a distinct clinical entity. The findings are discussed in relation to the theory of optimal stimulation and its possible relevance to understanding the different behavioral presentation of the two clinical groups.


The effects of electroencephalogram (EEG) biofeedback were examined with 10 participants presenting with a variety of psychological and neurological diagnoses related to their level of arousal. These conditions included anxiety, depression, and attentional disorders. Prior to treatment, participants were given the Test of Variables of Attention (T.O.V.A.), a continuous performance test, a Symptom Checklist, and, if they were depressed or anxious, the Beck Depression Inventory or the State Trait Anxiety Inventory. After 20 sessions of neurofeedback participants took the T.O.V.A. again and completed a post-treatment Symptom Checklist and, when appropriate, the depression and anxiety inventories. The 20 neurofeedback sessions involved providing clients with feedback on their brainwave patterns, and through this feedback, training them to increase activity in some frequency bands and decrease activity in other frequency bands. The theory is that this type of training improves cognitive functioning and mood states by facilitating the brain's ability to regulate its own arousal levels. Nonparametric statistical analyses showed statistically significant improvements in TOVA response time variability, the leading
indicator of ADD. There were also improvements on the depression and anxiety inventories, although the number of subjects completing these instruments was too small to warrant statistical analyses. The study adds to the small but growing body of research suggesting the effectiveness of neurofeedback for a variety of neurologically based disorders related to arousal level.


Central Auditory Processing Disorder (CAPD) is defined as a modality-specific perceptual dysfunction that is not due to peripheral hearing impairment (McFarland & Candace, 1995). It may include limitations in the ongoing transmission, analysis, transformation, elaboration, storage, retrieval and use of auditory stimuli. CAPD has also been reported to be associated with difficulties in memory, reading, spelling, language, and attention. The broad conceptualization of CAPD has contributed to difficulty in the diagnosis and treatment of children who present with auditory processing impairment. A major concern related to the lack of specificity in the definition of CAPD is the inclusion of attention. The clinical overlap in CAPD and ADHD has led to research questions regarding the validity of CAPD as a distinct disorder. Participants were 30 children aged eight to 14 re-recruited from a larger study investigating social competence in ADHD. They were asked to volunteer to complete vii additional measures of attention and auditory processing. Prior to participating they had completed the Behavioral Assessment System for Children- Parent Rating Scale (BASCPRS) and the SIDAC. The BASC was used as measure of externalizing behavior and the SIDAC was used to classify participants into subtypes of ADHD. Participants completed the SCAN (Keith, 1995) as a measure of auditory processing and the Tests of Variables of Attention- Auditory (T.O.V.A.-A.) as a measure of attention. Participants were placed into groups based on their subtype of ADHD. There were two groups including ADH/P and a collapsed group including ADHD/combined and ADHD/HI. Discriminant function analysis was used to determine the accuracy of classification into subtypes using combinations of the predictor variables. Results of the analyses indicated that externalizing behavior was the most robust predictor variable, with an accuracy rate of 80 percent. Including auditory processing and auditory attention did not improve the classification rate. When used alone as a predictor variable, auditory processing was not found to not be effective in classifying participants. Results have research and clinical implications. Sensitivity and specificity issues related to the measures used are discussed. Recommendations for future research are offered.


This paper explores the changes in EEG when subjects performed a modified Test of Variables of Attention (TOVA), compared to open eye resting (baseline) state. To recognize these two different brain states, two machine learning algorithms, i.e. extreme learning machine (ELM) and support vector machine (SVM), were applied and compared, using 3 statistical features and 4 power spectral density per channel. The results showed that using all 14 channels, ELM and SVM achieved similar test accuracy of 94.6% and 95.1% respectively (McNemar's test \( p = 0.8 > 0.05 \)). Using recursive channel selection, 9 channels (ELM) and 8 channels (SVM) were selected from 14 channels. After channel selection, ELM outperformed SVM significantly (McNemar's test \( p = 0.0005 < 0.01 \)) with average test accuracy of 95.0% and 92.5% respectively. The channel rank of each subject was weighted and merged using analytic hierarchical process to obtain a cross-subject ranking, which revealed the close correlation between TOVA and the visual pathway in brain.

According to the DSM-IV, Mental Retardation is significantly sub-average general intellectual functioning accompanied by significant limitations in adaptive functioning in at least two of the following skill areas: communication, self-care, home living, social/interpersonal skills, use of community resources, self-direction, functional academic skills, work, leisure, health and safety. In pilot work, we have seen positive clinical effects of Neurofeedback (NF) applied to children with Trisomy 21 (Down Syndrome) and other forms of mental retardation. Given that many clinicians use NF in Attention Deficit Hyperactivity Disorder and Generalized Learning Disability cases, we studied the outcomes of a clinical case series using Quantitative EEG (QEEG) guided NF in the treatment of mental retardation. All 23 subjects received NF training. The QEEG data for most subjects had increased theta, alpha, and coherence abnormalities. A few showed increased delta over the cortex. Some of the subjects were very poor in reading and some had illegible handwriting, and most subjects had academic failures, impulsive behavior, and very poor attention, concentration, memory problems, and social skills. This case series shows the impact of QEEG-guided NF training on these clients’ clinical outcomes. Fourteen out of 23 subjects formerly took medications without any improvement. Twenty-three subjects ranging from 7-16 years old attending private learning centers were previously diagnosed with mental retardation (severity of degree: from moderate to mild) at various university hospitals. Evaluation measures included QEEG analysis, WISC-R (Wechsler Intelligence Scale for Children-Revised) IQ test, TOVA (Test of Variables of Attention) test, and DPC-P (Developmental Behaviour Checklist) were filled out by the parents. NF trainings were performed by Lexicor Biolex software. NX-Link was the commercial software reference database used to target the treatment protocols, along with the clinical judgment of the first author. QEEG signals were sampled at 128 samples per second per channel and electrodes were placed according to the International 10-20 system. Between 80 and 160 NF training sessions were completed, depending on the case. None of the subjects received any special education during NF treatment. Two subjects with the etiology of epilepsy were taking medication, and the other 21 subjects were medication-free at the baseline. Twenty-two out of 23 patients who received NF training showed clinical improvement according to the DPC-P with QEEG reports. Nineteen out of 23 patients showed significant improvement on the WISC-R, and the TOVA. For the WISC-R test, 2 showed decline on total IQ due to the decline on some of the subtests, 2 showed no improvement on total IQ although improvement was seen on some of the subtests, however even these cases showed improvement on QEEG and DPC-P. This study provides the first evidence for positive effects of NF treatment in mental retardation. The results of this study encourage further research.


Schizophrenia is sometimes considered one of the most devastating of mental illnesses because its onset is early in a patient’s life and its symptoms can be destructive to the patient, the family, and friends. Schizophrenia affects 1 in 100 people at some point during their lives, and while there is no cure, it is treatable with antipsychotic medications. According to the Clinical Antipsychotic Trials for Interventions Effectiveness (CATIE), about 74% of the patients who have discontinued the first medication prescribed within a year will have a relapse afterward. This shows an enormous need for developing better treatment methods and better ways to manage the disease, since current therapies do not have sufficient impact on negative symptoms, cognitive dysfunction, and compliance to treatment. In this clinical case series, we investigate the efficacy of quantitative electroencephalography (qEEG)-guided neurofeedback (NF) treatment in this population, and whether this method has an effect on concurrent medical treatment and on the patients. Fifty-one participants (25 males and 26 females) ranging from 17 to 54 years of age (mean: 28.82 years and SD: 7.94 years) were included. Signed consent was received from all patients. Most of the participants were previously diagnosed with chronic schizophrenia, and their symptoms did not improve with medication. All 51 patients were evaluated using qEEG, which was recorded at baseline and following treatment. Before recording the qEEG, participants were washed out for up to 7 half-lives of the medication. After Food and Drug Administration (FDA)-approved Nx-Link Neurometric analysis,
qEEGs suggested a diagnosis of chronic schizophrenia for all participants. This was consistent with the clinical judgment of the authors. The participants’ symptoms were assessed by means of the Positive and Negative Syndrome Scale (PANSS). Besides the PANSS, 33 out of 51 participants were also evaluated by the Minnesota Multiphasic Personality Inventory (MMPI) and the Test of Variables of Attention (TOVA), both at baseline and following treatment. Each participant was prescribed an NF treatment protocol based on the results of their qEEG neurometric analysis. Each session was 60 minutes in duration, with 1 to 2 sessions per day. When 2 sessions were administered during a single day, a 30-minute rest was given between the sessions. Changes in the PANSS, MMPI, and TOVA were analyzed to evaluate the effectiveness of NF treatment. The mean number of sessions completed by the participants was 58.5 sessions within 24 to 91 days. Three dropped out of treatment between 30 and 40 sessions of NF, and one did not show any response. Of the remaining 48 participants 47 showed clinical improvement after NF treatment, based on changes in their PANSS scores. The participants who were able to take the MMPI and the TOVA showed significant improvements in these measures as well. Forty were followed up for more than 22 months, 2 for 1 year, 1 for 9 months, and 3 for between 1 and 3 months after completion of NF. Overall NF was shown to be effective. This study provides the first evidence for positive effects of NF in schizophrenia.


This study examines the relation between neurologic, behavioral, and performance indicators of attention-deficit-hyperactivity disorder. Twenty-three males age nine to 11 years with attention-deficit-hyperactivity disorder, including symptoms of hyperactivity, and 23 matched controls served as participants. Differences between groups were investigated using referential 19-channel quantitative electroencephalogram, behavioral rating scale data, and continuous performance test data. Results from the behavioral data were consistent with previous research. Behavioral ratings for participants with attention-deficit-hyperactivity disorder were significantly more negative than controls. Control participants performed significantly better on the continuous performance test, with fewer errors, faster reaction times, and less variability in reaction time. Electroencephalogram results indicated differences between participants with attention-deficit-hyperactivity disorder and control participants primarily in the alpha bandpass, with evidence of increased alpha in posterior regions during baseline for the group with attention-deficit-hyperactivity disorder. Additionally, participants with attention-deficit-hyperactivity disorder manifested decreased alpha in left frontal regions when reading. The results are discussed in terms of possible differences in electroencephalographic data as a function of degree of hyperactivity, as well as the impact of task specificity on the electroencephalogram.


The psychophysiological and behavioral effects of methylphenidate were assessed in boys with attention deficit hyperactivity disorder between the ages of 9 and 11 years. The effects of methylphenidate on the EEG during baseline and cognitive tasks were evaluated using spectral analysis. Both subjective (rating scales) and objective (continuous performance) measures were administered and analyzed in conjunction with the electrophysiologic data. Although methylphenidate induced regional changes in the EEG under certain task-specific conditions, it had no global effects. Behavioral and performance measures improved with methylphenidate.

OBJECTIVE: To precisely describe movement abnormalities in seated children with attention-deficit hyperactivity disorder (ADHD) while they were engaged in a continuous performance task (CPT).

METHOD: Diagnoses were made by using structured interviews (Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version) and DSM-IV criteria. Movement patterns of 18 boys with ADHD (9.3 +/- 2.4 years) and 11 normal controls (8.6 +/- 1.8 years) were recorded using an infrared motion analysis system that tracked the position of four markers 50 times per second to a resolution of 0.04 mm. RESULTS: Boys with ADHD moved their head 2.3 times more often than normal children (p < .002), moved 3.4 times as far (p < .01), covered a 3.8-fold greater area (p < .001), and had a more linear and less complex movement pattern (p < .00004). They responded more slowly and with greater variability on the CPT. Complexity of head movement and variability in response latency significantly correlated with teacher ratings. A predefined composite of movement and attention discriminated 16 of 18 patients from 11 of 11 controls. CONCLUSIONS: The relative inability of boys with ADHD to sit still can be objectively verified, and "fidgeting" appears to consist of more frequent, larger amplitude, whole body movements.


A review of records was carried out to examine the results obtained when people with Attention Deficit Disorder (ADD) received 40 sessions of training that combined neurofeedback with the teaching of metacognitive strategies. While not a controlled scientific study, the results, including pre- and post-measures, are consistent with previously published research concerning the use of neurofeedback with children. A significant addition is that a description of procedures is included. The 111 subjects, 98 children (age 5 to 17) and 13 adults (ages 18 to 63), attended forty 50-min sessions, usually twice a week. Feedback was contingent on decreasing slow wave activity (usually 4-7 Hz, occasionally 9-11 Hz) and increasing fast wave activity (15-18 Hz for most subjects but initially 13-15 Hz for subjects with impulsivity and hyperactivity). Metacognitive strategies related to academic tasks were taught when the feedback indicated the client was focused. Some clients also received temperature and/or EDR biofeedback during some sessions. Initially, 30 percent of the children were taking stimulant medications (Ritalin), whereas 6 percent were on stimulant medications after 40 sessions. All charts were included where pre- and post-testing results were available for one or more of the following: the Test of Variables of Attention (TOVA, n = 76), Wechsler Intelligence Scales (WISC-R, WISC-III, or WAIS-R, n = 68), Wide Range Achievement Test (WRAT 3, n = 99), and the electroencephalogram assessment (QEEG) providing a ratio of theta (4-8 Hz) to beta (16-20 Hz) activity (n = 66). Significant improvements (p < .001) were found in ADD symptoms (inattention, impulsivity, and variability of response times on the TOVA), in both the ACID pattern and the full-scale scores of the Wechsler Intelligence Scales, and in academic performance on the WRAT 3. The average gain for the full scale IQ equivalent scores was 12 points. A decrease in the EEG ratio of theta/beta was also observed. These data are important because they provide an extension of results from earlier studies (Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Linden, Habib, & Radojevic, 1996). They also demonstrate that systematic data collection in a private educational setting produces helpful information that can be used to monitor students' progress and improve programs. Because this clinical work is not a controlled scientific study, the efficacious treatment components cannot be determined. Nevertheless, the positive outcomes of decreased ADD symptoms plus improved academic and intellectual functioning suggest that the use of neurofeedback plus training in metacognitive strategies is a useful combined intervention for students with ADD. Further controlled research is warranted.

Media attention has highlighted the critical problem of concussion injuries in sport and the challenge of treating and rehabilitating individuals with traumatic brain injury. The authors present a framework for the treatment of traumatic brain injury, using low-resolution electromagnetic tomography Z-score based neurofeedback and heart rate-variability biofeedback. The article advocates a comprehensive assessment process including the use of a 19-channel quantitative electroencephalogram, a heart rate variability baseline, and symptom severity questionnaires for attention deficit/hyperactivity disorder, depression, and anxiety. The initial medical assessment, neuropsychological assessment, and evoked potential studies also have potential for a more precise assessment of deficits in brain activation patterns, which assists the targeting of neurofeedback training.


The present study examined EEG biofeedback efficacy in relation to age, medication status and EEG training protocol for the treatment of Attention-Deficit/Hyperactivity Disorder (ADHD). A nonrandomized correlational and mixed model factorial design was instituted. Measures from the Test of Variables of Attention (T.O.V.A.; Greenberg, 1987), a computerized performance test, served as dependent variables. Existing clinical data were obtained from 22 offices in which Neurocybernetics EEG biofeedback equipment (EEG Spectrum, Inc., Encino, CA) was utilized. A standardized clinical EEG biofeedback protocol was instituted, including the augmentation of SMR (12-15 Hz) or low beta (15-18 Hz) with concurrent inhibition of theta (4-7 Hz) and high beta (22-30 Hz) EEG spectral bands. The sample consisted of 118 girls and boys, age 5 to 16, who participated in an average of 20 sessions and were diagnosed with ADHD and in about half of the instances with selected comorbid conditions. Analyses were restricted to individuals who had a pre-training deficit (i.e., below 100) on the T.O.V.A. measures of inattention, impulsivity and/or response time variability, resulting in sample sizes of 96, 91 and 113 respectively. A child’s age did not correlate significantly with improvement on measures of inattention and impulsivity. For these same measures, no significant differences were found across EEG training protocol conditions yet post-hoc analyses revealed significant differences on variability (p<.05). The findings suggest that a combination of SMR/beta training may be better than either alone in effecting a measure of sustained attention. Results also show no significant effect of gender, comorbid conditions or medication status on inattention or impulsivity measures. Although, for patients showing a deficit in impulsivity, medical management in addition to EEG biofeedback appears to be beneficial. Encouragingly, EEG biofeedback treatment in general resulted in significant improvement.


We compared the results of a computerized attention test (TOVA) in 38 children with insulin dependent diabetes mellitus in relation to various spontaneously occurring blood glucose levels. Testing was performed at the following blood glucose levels: 8.3 mmol/l (hyperglycaemia). The attention (sum of errors and response time) varied significantly with the blood glucose level (P = 0.002). The highest number of errors of omission and the longest response time was observed during the test run with hypoglycaemia. Age, sex, age at manifestation of the disease, metabolic control and the results of the intelligence test had no significant influence on these results. We found that attention in children with diabetes was significantly reduced compared to TOVA norms especially during mild hypoglycaemia (P < 0.001). Irrespective of the blood glucose levels, reaction time and the variability of the reaction time differed significantly between TOVA norms and diabetic children (P < 0.01). CONCLUSION: In children with diabetes mellitus a significant reduction in attention was found at mild hypoglycaemia but as well at
low normal blood glucose levels. Attention deficits due to transient lowering of blood glucose may therefore occur in diabetic children even before they are aware of hypoglycaemic symptoms.


Introduction: Using a wearable, electronic eye-frame we developed as a real-time ocular monitoring system, we validated oculometric measures as an index of clinical causes of driver inattention and drowsiness. Methods: In an IRB-approved study, 31 subjects (9 Controls, 7 OSH/OSA, 8 Narcolepsy, 7 ADD/ADHD) completed a 36-hour sleep deprivation cycle. Every 6 hours, a drive simulator Session was synchronized with oculometric and EEG, followed by objective (TOVA, MWT) and subjective (SSS) measures of alertness/performance. Results: Repeated-Measures ANOVA revealed significant linear trends for both alertness and performance measures, confirming the sleep-deprivation effect throughout the sessions. Narcoleptic subjects performed significantly worse in the drive simulator, followed by the ADD/ADHD group while the Control and OSH/OSA group had similar performance. We applied Multiple Regression Analysis to predict drive simulator performance from oculometrics, and determined that Session 4 had significant regression with PERCLOS and EBR accounting for 54.2% of the variation in Off-Road Accidents, 52.1% in Road-Edge Excursion, and 32.7% in Collisions. PERCLOS and EBR remained strong predictors of Off-Road Accidents during Session 5, but accounted for only 17% of the variance in Collisions and were not significant for Road-Edge Excursions. Conclusion: Oculometric variables were sensitive to sleep-deprivation with predictive circadian effects on the performance/vigilance relationship. These results contribute to an early design of a Composite Oculometric Fatigue Index (COFI) and Safety Response Algorithm that will be integrated into different real world operator domains.


Normative values of attention, impulsivity, response time, and response time variability were determined for seven- to ten-year-old children with the continuous performance Test of Variables of Attention (TOVA). An age-related increase in attention and a decrease in impulsivity, response time, and its variability were revealed. Differences in TOVA scores were studied for students of gymnasia and schools providing general education.


Veterans with chronic posttraumatic stress disorder were evaluated for a history of blast concussion, controlling for confounding conditions. Electroencephalograms were analyzed by discriminant function for traumatic brain injury. A difference was found in discriminant scores between veterans with and without blast concussion. More members of the blast group had attentional symptoms and attentional dysfunction. Combat veterans with a remote history of blast injury have persistent electroencephalographic features of traumatic brain injury as well as attentional problems. The authors hypothesize that these constitute a type of chronic postconcussive syndrome that has cognitive and mood symptoms overlapping those of posttraumatic stress disorder.


**BACKGROUND:** Increasing evidence supports n-3 fatty acid (FA) supplementation for patients with psychiatric disorders, such as attention deficit hyperactivity disorder. However, the exact metabolic fate of dietary eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) on different glyceride carriers remains unclear. **OBJECTIVE:** We investigated whether conjugation of EPA and DHA to phospholipid (PL-n-3) or to triacylglycerol (fish oil; FO) affects their incorporation in blood compartments and influences executive functioning. **DESIGN:** Children aged 8-13 y with impaired visual sustained attention performance received placebo, 250 mg/d EPA + DHA esterified to PL-n-3 (300 mg/d phosphatidylserine), or FO for 3 mo in a randomized double-blind manner. Main outcome measures included plasma and erythrocyte FA profile and continuous performance test results (Test of Variables of Attention; TOVA). **RESULTS:** Sixty of the 83 children enrolled completed the interventions (n = 18-21 per group). There was an enrichment of EPA (1.5-2.2-fold), docosapentaenoic acid (DPA; 1.2-fold), and DHA (1.3-fold) in the PL fraction in the plasma of FO- and PL-n-3-fed children. In erythrocytes, only PL-n-3 resulted in a significant reduction (approximately 30%) of very-long-chain saturated FAs (C20-24) and in an increase (1.2- and 2.2-fold, respectively) in linoleic acid and DPA. Total TOVA scores increased in the PL-n-3 (mean +/- SD: 3.35 +/- 1.86) and FO (1.72 +/- 1.67) groups but not in the placebo group (-0.42 +/- 2.51) (PL-n-3 > FO > placebo; P < 0.001). A significant correlation between the alterations in FAs and increased TOVA scores mainly occurred in the PL-n-3 group. **CONCLUSION:** Consumption of EPA+DHA esterified to different carriers had different effects on the incorporation of these FAs in blood fractions and on the visual sustained attention performance in children.


**Objective:** To assess family history of movement and mood disorder and personality qualities of cognition and affect in a referral population of patients with cervical dystonia without tremor (CDnoT). Methods: We analyzed 165 CDnoT (71% female, 29% CD plus another dystonic site [CD*], mean age at evaluation 52 years with mean duration CD 8 years) patients for: family history, psychiatric and movement disorder; scores on MMPI, Hamilton Depression or Spielberger Anxiety Rating Scales, neuropsychological performances on Rey Auditory Verbal Learning Test (AVLT), Three Letter Cancellation Task (LCT), Digit Span (DS), Rey-Osterrieth Complex Figure Test (ROCFT), Conners’ Continuous Performance Test (CPT), Test of Variables of Attention (TOVA), and Wisconsin Card Sorting Test (WCST). Results: Family history: anxiety 15 (9%), depression 58 (35%), OCD 16, alcoholism 55, psychosis 9, NonPD tremor 53 (32%), dystonia 16 (10%), scoliosis 28 (17%), PD 17 (10%). Personal affective state-anxiety 84 (50%), depression 103 (62%). Cognition (age adjusted)-impaired AVLT 19/138 (14%), impaired verbal memory 15/138 (11%), impaired auditory digital memory (DS) 11/89 (12%), impaired visual vigilance (LCT) 87/135 (64%), impaired visuospatial memory (ROCFT) 19/126 (15%), impaired visual attention (TOVA/CPT) 7/18 (39%), impaired executive function (WCST) 25/35 (69%). Conclusions: Like CD/T (Vermilion, Johnson, Duane, 2002), CDnoT patients have a high rate of dystonia and scoliosis but a relatively lower rate of ET. Anxiety and depression is very prevalent in both CDnoT patients and their first degree relatives. Cognitive deficits are most prevalent in frontal lobe tasks of vigilance and executive function. These may reflect dysfunction within basal ganglion to frontal cortex systems impaired by the pathophysiology of dystonia.

OBJECTIVE: To determine whether docosahexaenoic acid (DHA) supplementation for 4 months decreases the symptoms of attention-deficit/hyperactivity disorder (ADHD). STUDY DESIGN: Sixty-three 6- to 12-year-old children with ADHD, all receiving effective maintenance therapy with stimulant medication, were assigned randomly, in a double-blind fashion, to receive DHA supplementation (345 mg/d) or placebo for 4 months. Outcome variables included plasma phospholipid fatty acid patterns, scores on laboratory measures of inattention and impulsivity (Test of Variables of Attention, Children's Color Trails test) while not taking stimulant medication, and scores on parental behavioral rating scales (Child Behavior Checklist, Conners' Rating Scale). Differences between groups after 4 months of DHA supplementation or placebo administration were determined by analysis of variance, controlling for age, baseline value of each outcome variable, ethnicity, and ADHD subtype. RESULTS: Plasma phospholipid DHA content of the DHA-supplemented group was 2.6-fold higher at the end of the study than that of the placebo group (4.85 +/- 1.35 vs 1.86 +/- 0.87 mol % of total fatty acids; P < .001). Despite this, there was no statistically significant improvement in any objective or subjective measure of ADHD symptoms. CONCLUSION: A 4-month period of DHA supplementation (345 mg/d) does not decrease symptoms of ADHD.


The purpose of this study was to evaluate the ability of the test of variables of attention (TOVA) to distinguish between 6- to 12-year-old Japanese male children with attention deficit hyperactivity disorder (ADHD group; n=17) meeting DSM-IV and ICD-10 criteria, and age-matched, normal Japanese male controls (control group; n=19). The TOVA is a computer-administered, visual continuous performance test that provides measures of attention. The ADHD group had significantly higher means than the control group in all variables: omission errors, commission errors, response time, response time variability, anticipatory responses, and multiple response. Control children exhibited age-related changes in two variables: response time and response-time variability, but no age-related changes were observed in any variables in the ADHD group. This preliminary study indicates that the TOVA makes a useful contribution to the diagnosis of Japanese male children with ADHD.


There are few effective prophylactic measures employed for the treatment of migraines. Pharmacological advances have offered symptomatic or abortive treatment of acute migraines. Unfortunately, medications carry side effect warnings and contraindications. The science of peripheral biofeedback is more than 100 years old and has been effectively used to control migraines since the early 1970s. EEG biofeedback, or neurofeedback, has been utilized for nearly 40 years and is the newest generation of biofeedback. However, instead of training a person to control peripheral measures, the therapist teaches control of brain waves. Migraine headaches are considered to be caused in part by an instability in brain wave frequencies that can be corrected through brain wave training. Whereas pharmacological interventions may bring with them side effects and restrictions, neurofeedback is virtually risk-free. Since the brain is "trained" directly, there is no need for a medication to be metabolized, to cross the blood-brain barrier, or to be secreted by the body. Such traditional treatments can create complications for the patient beyond the targeted headaches. Anecdotal reports have indicated neurofeedback as a useful and safe intervention for migraines, but no empirical research has been published. The purpose of this research is to explore the effectiveness of neurofeedback as a treatment and/or prophylaxis for migraine pain. In this study, experimental and control groups consisted of two adult women each (N = 4), having one or more migraines weekly for 2 years. Subjects maintained migraine headache diaries and received pre-treatment Tests of Variables of Attention (T.O.V.A.) and MMPI-2's. Controls received delayed treatment. Two-tailed t tests compared pre- and post-treatment headache intensity, frequency, and MMPI-2 data. Technical
difficulties precluded comparison of T.O.V.A. data. Subject compliance was variable. Although there were no significant differences between pretreatment headache frequency and intensity compared to data after the 7th and 14th treatments, positive trends were evident. There was significant improvement on post-treatment Social Introversion, $t(2) = 21.00, p < .05$ and Masculinity/Femininity Scales, $t(2) = -17.00, p < .05$ on experimental group MMPI-2 scores. There were insignificant but positive changes here as well. Future research is expected to provide a larger sample with more exacting measures and requirements.


BACKGROUND AND PURPOSE—: The aim of this pilot study was to assess attention deficits in patients with aneurysmal subarachnoid hemorrhage using the test of variables of attention (TOVA). This is a computer-based continuous performance test providing objective measures of attention. We also compared the TOVA results with the attention and concentration domains of Montgomery Åsberg Depression Rating Scale and Montreal cognitive assessment, 2 examiner-administered neuropsychological instruments. METHODS—: Nineteen patients with moderate to good recovery (Glasgow outcome scale, 4–5) were assessed using the TOVA, Montgomery Åsberg Depression Rating Scale, and Montreal cognitive assessment. The measurements were done when the patients visited the hospital for a routine magnetic resonance imaging control of the aneurysm. RESULTS—: TOVA performance was pathological in 58%. The dominating pattern was a worsening of performance in the second half of the test, commonly a failing to react to correct stimuli. We found no correlation between TOVA and the performance in concentration and attention domains of Montgomery Åsberg Depression Rating Scale and Montreal cognitive assessment. CONCLUSIONS—: Attention deficits, measured by the TOVA, were common after subarachnoid hemorrhage. This should be further studied to improve outcome.


The long-term effects of monotherapy with levodopa or the dopamine agonist pergolide on the motor/sensory, behavioral, and cognitive variables in seven children with restless legs syndrome/periodic limb movements in sleep (RLS/PLMS) and attention-deficit-hyperactivity disorder (ADHD) were investigated. Five of the seven children had previously been treated with stimulants that had either been determined to be ineffective or to have intolerable side effects. Dopaminergic therapy improved the symptoms of RLS and reduced the number of PLMS per hour of sleep ($P = 0.018$) and associated arousals ($P = 0.042$) for the entire group. After treatment, three children no longer met the criteria for ADHD, and three reverted to normal on the Test of Variable Attention. ADHD improved in all seven as measured by the Connors parent rating scale ($P<0.04$) and the Child Behavior Checklist ($P<0.05$). A significant improvement also occurred in the visual, but not verbal, memory scores on the Wide Range Assessment of Memory and Learning ($P<0.001$). Five of seven children continue on dopaminergic therapy 3 years after treatment initiation, with good response. We postulate that the improvement in ADHD may be the result of the amelioration of RLS/PLMS and its associated sleep disturbance. Alternatively, ADHD and RLS/PLMS may share a common dopaminergic deficit.

Objective: This study investigated the gender differences in behavioral symptoms, as rated by various informants, and in neuropsychological performance, among patients with attention-deficit/hyperactivity disorder (ADHD) treated with methylphenidate during 24 months in a clinical setting. Methods: Study participants comprised 128 boys (mean age: 13.2±2.4 years) and 26 girls (mean age: 12.8±1.0 years) with ADHD. All patients were prescribed short-acting oral methylphenidate, taken two or three times daily; each dose ranged between 0.3 and 1.0 mg/kg. At the baseline and 6, 12, 18, and 24 months later, behavioral symptoms were evaluated using the parent and teacher forms of the Swanson, Nolan, and Pelham Version IV (SNAP-IV) scale for ADHD and the ADHD Rating Scale (completed by a child psychiatrist). In addition, neuropsychological function was assessed using the Test of Variables of Attention (TOVA) at each interval. Results: Although both the boys and girls exhibited a significant decrease in the ADHD symptoms observed by parents and clinicians, the girls improved more than the boys did. Based on the teacher reports, neither the boys nor the girls exhibited significant decreases in ADHD symptoms. The symptoms rated by teachers were more severe in the boys than in the girls throughout the first 12 months; however, the gender difference lessened after 12 months. Based on the TOVA assessment, a composite score (containing response time, response time variability, and ADHD score obtained using the TOVA) did not indicate differences between genders. However, another composite score (containing omission errors, commission errors, and response sensitivity) suggested significant improvement only in the boys. Conclusions: The results suggested that according to a longitudinal follow-up, behavioral and neuropsychological changes among patients with ADHD might differ between genders. Gathering multidimensional information from patients with ADHD is essential in determining how gender modifies the functional outcome of ADHD.


Objective: This study investigated the trends in neurocognitive function and behavioral symptoms among patients with attention-deficit/hyperactivity disorder (ADHD) during 24 months of treatment with methylphenidate in a clinical setting. Methods: Study participants consisted of 181 ADHD patients with a mean age of 13.4 – 2.5 years (ages ranged from 8 to 18 years; 151 boys and 30 girls) who were prescribed oral short-acting methylphenidate two or three times daily, with each dose ranging between 0.3 and 1.0 mg/kg. At baseline and 6, 12, 18, and 24 months from baseline, neurocognitive function was assessed using the Test of Variables of Attention (TOVA) on the day the patient was off medication, and behavioral symptoms were evaluated using the Swanson, Nolan, and Pelham Version IV Scale for ADHD (SNAP-IV) parent form, the SNAP-IV teacher form, and the ADHD-Rating Scale (completed by a child psychiatrist). Results: Of the 181 ADHD patients at the initial visit, 103 (56.9%) completed the study. During the 24-month methylphenidate treatment, only the commission errors in TOVA significantly improved; however, the omission errors, response time, response time variability, response sensitivity, and ADHD score did not. The behavioral symptoms of ADHD, observed by various informants, all declined substantially, and were significantly correlated with each other during the long-term followup. The severity of teacher ratings was lower than that of parent and psychiatrist ratings. However, the teacher-rated inattention symptoms showed the strongest correlations with TOVA performance. Conclusions: Findings suggest that neurocognitive deficits in ADHD patients, except inhibition ability, might be long lasting in realistic settings. In addition, obtaining behavior profile assessments from multiple informants, especially from teachers, is vital for establishing a complete understanding of ADHD patients.

Current assessment devices used in the diagnosis of children with ADHD have been primarily standardized behavior rating scales that are observation-based. The use of continuous performance tests adds a measure that directly accesses the child’s impulsivity and ability to attend. The purpose of this investigation was to examine the contributions of two continuous performance tests, the TOVA I and TOVA II in the diagnosis of children with ADHD. Specifically, consideration of how both verbal and auditory forms of stimuli presentation augment accurate detection of ADHD. The predictive and divergent validity of the TOVA I and TOVA II was assessed. The results supported the ability of both tests to identify children with ADHD, with the combined use of both tests being the most effective discriminator.


Research has indicated that Continuous Performance Tests (CPTs) can differentiate Attention-Deficit/Hyperactivity (ADHD) subjects from controls without any psychiatric illness. However, CPTs have neither accurately differentiated ADHD children from those with other psychiatric disorders—nor differentiated subtypes of ADHD from each other. The Test of Variables of Attention (TOVA), a new CPT, has several advantages over its predecessors which may allow the TOVA to be more effective in this differentiation process. Data from ADHD subjects was selected from children who were administered the TOVA as part of their evaluation for ADHD at Lakeland Mental Health Center in Moorhead, MN, the Child Evaluation and Treatment Program in Grand Forks, ND, and the Behavioral Health Clinic at the St. Cloud Hospital in St. Cloud, MN. Learning Disordered subjects’ data was obtained from a previous study by Clay et al. (1996). Children with no history of psychiatric illness were recruited by offering research participation credit to University of North Dakota students who agreed to have their children participate in this study. Results were evaluated by using a group (ADHD-C, ADHD-I, Learning Disordered, and non-patient control) by TOVA quartile (1, 2, 3, 4) mixed ANOVA on all TOVA variables (using age-corrected standard scores). In addition, I computed the Positive Predictive Power (PPP), Negative Predictive Power (NPP), and Sensitivity of the TOVA variables in order to determine the diagnostic utility of these measures. Finally, to test a theory that “high consistency” ADHD children might outperform controls, each group was divided into halves based upon the group’s response time variability scores (by a simple median split). A group by consistency (high variability vs. low variability) ANOVA was conducted on the remaining TOVA variables (errors of omission, errors of commission, and response time). Results of the PPP/NPP analyses suggested that some TOVA variables are useful in differentiating ADHD children from non-patient controls, but not useful in differentiating ADHD from LD children. Also, TOVA data do not appear to be able to differentiate ADHD subtypes from each other. Finally, the data provided little support for the theory that a subgroup of “high consistency” ADHD children would outperform controls on other TOVA variables.


The present study explored the relationship between the intelligence of young adults and their performance on the Test of Variables of Attention (TOVA). The study also examined whether significant differences existed between adults with and without attention-deficit/hyperactivity disorder (ADHD) on TOVA errors of omission, errors of commission, mean correct response time, and variability, as well as on performance on the freedom from distractibility (FD) factor on the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Seventy-nine adults participated in the study, including 17 with ADHD and 62 college students without ADHD. Pearson product-moment correlations indicated that none of the correlations between Full Scale IQ (FSIQ) and TOVA variables were significant. Analysis of variance results revealed that adults with ADHD made more errors of omission on the TOVA than did controls. Between-group differences were not found on the remaining dependent variables.

Investigated the performance of adults with attention deficit hyperactivity disorder (ADHD) relative to adults with Developmental Reading Disorder (DRD) and controls on a battery of executive function tasks (Wisconsin Card Sorting Test [WCST], Test of Variables of Attention, Tower of Hanoi, and Ravens Progressive Matrices) and several self-report ADHD rating scales. The psychometric properties of three ADHD rating scales were also explored: Wender Utah Rating Scale (M. Ward et al, 1993), Patient Behavior Checklist (R. A. Barley, 1990), and the Adult Rating Scale (L. Weyandt et al, 1995). Ss were 21 individuals (mean age 25.9 yrs) with ADHD, 19 (mean age 21.5 yrs) with DRD, and 24 controls (mean age 23.4 yrs). Results reveal a significant difference between groups, with the DRD group committing more WCST errors (total and perseveration) than the remaining groups. Group differences were also found on the ADHD ratings scales, with the ADHD group reporting higher ratings. Findings support the psychometric properties of all three scales, suggesting they are measuring symptoms specific to ADHD rather than general psychological functioning.


The present study investigated the construct validity of the Internal Restlessness Scale (IRS), a self-report instrument developed to measure feelings of restlessness in young adults with ADHD, and the relationship between the IRS and a neuropsychological, behavioral task (i.e., continuous performance test). Pearson product-moment correlations indicated that the IRS correlated significantly with the self-report rating scales (both those specifically measuring ADHD symptoms and those measuring overall psychological symptoms and intelligence), but not with behavioral measures purported to measure the constructs of attention and impulsivity. Furthermore, the correlations between the IRS and other ADHD rating scales were significantly higher than the correlations between the IRS and non-ADHD rating scales. Overall, results support the construct validity of the IRS.


Swartwood et al. (1998) reported no consistent relationship between the cortical EEG and performance scores on the Test of Variables of Attention (TOVA) in a group of ADHD boys between the ages of 9 and 11 years. Relationships were examined with and without the administration of methylphenidate (MPH). Recently, when TOVA scores were compared against age-dependent QEEG measures from a referential database, significant relationships were found for both on- and off-MPH conditions (Lubar, White, Swartwood, & Swartwood, in press). The participants for this study were from those of the previous work (Swartwood et al., 1998). Twenty-one males between 9 and 11 years of age, with a diagnosis of ADHD with hyperactivity were evaluated. EEG assessments were obtained during an eyes open baseline and were evaluated using the NeuroRep Analysis and Report System (Hudspeth, 1997). Reports yield statistical results for z-score analyses of QEEG recordings using Four-Band Spectral Coherence, Phase, and Power measurements. Statistical results are based upon comparisons against Thatcher's Lifespan EEG Reference Database (LSRDB) and Thatcher's Mild Traumatic Brain Injury Discriminant Function (MTBI) (Hudspeth, 1997; Thatcher, Walker, Gerson, & Geisler, 1989; Thatcher, Walker, & Giudice, 1987). The LSRDB is a control sample and all statistical inferences are limited to the sample (Hudspeth, 1997). For the off-MPH group, abnormalities in Delta were negatively correlated with standard scores for
TOVA Omissions ($r = -0.4676$, $p < 0.05$), TOVA Response Time ($r = -0.6208$, $p < 0.01$), and TOVA Variability ($r = -0.5017$, $p < 0.05$). For the on-MPH group, Delta ($r = -0.5087$, $p < 0.05$), and Theta ($r = -0.5408$, $p < 0.05$) abnormalities were negatively correlated with TOVA Response Time. For the off-MPH group, it appears that slow wave activity is overrepresented in inattentiveness, information processing speed, and variability in attention. For both drug conditions, increases in slow activity in the delta and theta bandpasses are correlated with slower response time, which in turn likely reflects decreased information processing speed (Lubar et al., in press). Further examination revealed that the increased slow wave activity was not likely due to physical artifact. In summary, age-dependent QEEG measures may reveal meaningful relationships in EEG data which may not be readily discernible otherwise.


Objective: To assess the effect of Osmotic-Release Oral System (OROS) methylphenidate (MPH) on a variety of measures evaluating academic performance, cognition, and social behavior in children with attention-deficit/hyperactivity disorder (ADHD). Methods: This double-blind, randomized, placebo-controlled, crossover laboratory school study enrolled 78 children aged 9–12 years with ADHD who responded to OROS MPH. After determining individualized OROS MPH dosing (18–54 mg/day), 71 subjects received blinded treatment (OROS MPH or placebo then vice versa) on each of 2 laboratory school days, separated by 1 week. Primary efficacy was measured by Permanent Product Measure of Performance at 4 hours after study drug administration. Results: Treatment with OROS MPH resulted in statistically significant improvement in Permanent Product Measure of Performance and Swanson, Kotkin, Agler, M-Flynn, and Pelham scores, measures of response time, and of working memory compared to placebo. Other measures did not meet all pre-established criteria for significance (maintenance of the overall type I error rate at 5%). Adverse events were consistent with previous reports of stimulant medications used in the management of ADHD. There were no discontinuations due to adverse events, and no serious adverse events or deaths. Conclusions: OROS MPH dosed to reduce core symptoms of ADHD to within the normal range also improved performance on a variety of academic tasks in school-aged children compared to placebo. Adverse effects reported were consistent with prior studies.


This study evaluated (1) how autonomic response (e.g., skin conductance, heart rate) can be used to discriminate between subgroups of Attention Deficit Hyperactive Disorder (ADHD) and (2) the effect of teaching breathing retraining on the low arousal subgroup. ADHD behaviors are hypothesized to be the result of patterns of autonomic reaction to attention demanding conditions. The ability to discriminate different arousal patterns between subjects displaying different behaviors, and the dramatic improvement in attention from an autonomic intervention, support the hypothesis. Study One. Thirty five subjects were classified as either pure inattentive, mixed inattentive/impulsive or normal based on the results of the Test of Variables of Attention (T.O.V.A.). Skin conductance and heart rate were evaluated for the three different subgroups during the T.O.V.A., used as a calibrated cognitive challenge. Subjects in the inattentive group showed a statistically significant underarousal response compared to the normal or impulsive group. Subjects in the impulsive group showed a significantly different arousal pattern compared to the normal group. The results support physiological response to challenge as a discriminating measure. Study Two. Respiratory training was given to three subjects for six weeks to ascertain the effect of modification of the abnormal arousal level on attention. Retesting showed the
trained subjects had dramatic, clinically and statistically significant improvements, compared to untreated controls, in their T.O.V.A. scores, as well as the Attention Deficit Scales for Adults (ADSA). A six month follow up, with a questionnaire evaluating attention behavior, continued to support the findings. The results show that (1) one can identify an inattentive subpopulation who show underarousal response to challenge, and (2) subjects trained with breathing exercises improve their attention, resulting in dramatic improvement in T.O.V.A. and ADSA scores. This supports the underarousal hypothesis for the inattentive group and suggests that optimal arousal is an important criterion for normal attention. Intervention results support the arousal theory and suggest that behavioral arousal modification may be a powerful treatment methodology for some subgroups.


Objective: To explore treatment response to Osmotic Release Oral System ® (OROS) methylphenidate in children with ADHD with and without comorbid learning disability (LD). Method: Data were analyzed from two 6-week, double-blind, randomized, placebo-controlled, crossover studies evaluating individually determined doses of OROS methylphenidate versus placebo in 135 children (ages 9 to 12 years) with ADHD with or without an LD in reading, math, or both. The sample was demographically diverse, with 31% females and more than 40% minority, predominantly African American and Hispanic. On two laboratory school days, participants received either OROS methylphenidate or placebo and were given a battery of cognitive and behavioral tests. Results : Treatment with OROS methylphenidate led to improvement in ADHD Rating Scale scores for participants with or without comorbid LD. Both groups performed better during treatment with OROS methylphenidate than placebo on measures of cognitive skills (i.e., Test of Variables of Attention, Finger Windows Backwards), academically related tasks (i.e., Dynamic Indicators of Basic Early Literacy Skills, Test of Handwriting Skills–Revised, Permanent Product Math Test), and observed classroom behavior (i.e., Swanson, Kotkin, Alger, M-Flynn, and Pelham Scale). Conclusion: In children with ADHD with or without comorbid LD, behavior and performance improved during treatment with OROS methylphenidate.


Attention-deficit/hyperactivity disorder (ADHD) is a common mental disorder in children. Unfortunately, reliable means of measuring attention and impulsivity to help with diagnoses are scarce. The test of variables of attention (TOVA) is a computer-administered continuous performance test measuring attention and impulsivity, designed to avoid confounding arising from language processing skills or short-term memory problems. Some evidence has indicated the TOVA can be useful in diagnosing ADHD. This study examines its validity and reliability in helping diagnose Taiwanese ADHD children. The study included 31 ADHD children (24 males, seven females) from a northern Taiwan children's hospital and 30 normal controls (18 males, 12 females) from the local community. The TOVA and the Child Behavior Checklist (CBCL) were administered to all children. TOVA scores for omissions, commissions, response time, response time variability, D' and ADHD scores were analyzed. Results showed a mean internal consistency of 0.81 for all six TOVA variables across conditions, with moderate convergent and discriminant validities. Groups showed significant differences in response time variability, D' and ADHD scores, with the normal group outperforming the ADHD group. Significant group differences were also found in all CBCL subscale scores except somatic complaints. The ADHD group obtained a clinically significant score on the hyperactivity subscale of the CBCL. The findings partially support the usefulness of the TOVA in assessing attention and impulsivity problems for a Taiwanese sample. Future studies should increase the sample size, use multiple measures, and collect behavior ratings from both parents and teachers.

A visual stimulus is proposed for use in studies of attention and reaction time and for assessing medication effects, especially in Attention Deficit Disorders (with and without hyperactivity). The advantages of the proposed stimulus are detailed in light of the desirability of developing and norming standardized sustained and selective attention and vigilance tasks that could be used routinely in many clinics.


Recent studies have provided increasing evidence that symptoms associated with childhood attention deficit disorder (ADD) may persist into adolescence and adulthood and that psychostimulant medications may have ameliorative effects in such adolescents and adults. These medication studies are limited by their exclusive reliance on clinical judgments and self-reporting as the means of documenting and determining efficacy. As important as clinical judgment and self-reporting are in clinical psychopharmacological research, they should not be the sole bases for making decisions to extend the use of psychoactive agents either to a different diagnostic category or to other age groups. Specifically, in the case of ADD in adolescents and adults, it is important to obtain valid and reliable objective data that can reflect the possible effects of psychostimulant medication on primary target symptoms, such as attention span, distractibility, and impulsivity. The Clinical Studies Unit of the Department of Psychiatry, University of Minnesota, has an ongoing clinical research program for the assessment and treatment evaluation of children with ADD. We have begun to assess an increasing number of adolescents and adults, using the same paradigm that is used with the children and the same attentional time tasks. In this article, cases are presented of adolescents and adults with ADD who demonstrated a positive clinical response to methylphenidate (Ritalin). These cases are compared with children with ADD who had a positive response to psychostimulant medication. Similarities are pointed out with respect to the effect of the medications on performance of attentional tasks and on reaction time. The need to undertake systematic and comprehensive research, including objective performance measures, into adult ADD is illustrated.


Psychostimulants have been found to be beneficial in treating the sequelae associated with TBI. The literature also discusses that psychostimulants may have a restorative effect for some TBI patients. Four patients (ages 40-48) diagnosed with MTBI followed through an outpatient neuropsychological practice were initially treated with psychostimulants 13 to 42 months post-accident, Baseline and psychostimulant treatment responses were identified through the TOVA, a continuous performance test. A follow-up baseline TOVA was used to assess the efficacy of continued psychostimulant use three to 19 months after psychostimulant treatment had begun. Each patient demonstrated improved cognitive performances on follow-up baseline testing, with two patients able to discontinue the use of psychostimulant medication altogether. Implications and future research directions are discussed.

Psychostimulants are frequently used for the treatment of attention difficulties and various neurological illnesses including traumatic brain injury. Continuous Performance Tests (CPTs) have been shown to be sensitive to brain damage and dysfunction. CPTs have also been shown to be valuable means of assessing the therapeutic response of psychostimulants. This presentation will discuss the efficacy of psychostimulants with patients diagnosed with mild traumatic brain injury (MTBI). A model for assessing medication titration trials will be discussed utilizing the Test of Variables of Attention (TOVA). Specific case studies will be presented. The implications of evaluating and treating patients in this manner will be discussed, including how it may impact the patient’s treatment and recovery.


Psychostimulants have been found to be beneficial in treating the sequelae associated with traumatic brain injury including memory difficulties, attention/concentration abilities, processing speed difficulties, and anger. Continuous Performance Tests (CPTs) have long been shown to be sensitive to brain damage and dysfunction, and have been shown to be valuable means of assessing the therapeutic response of psychostimulants. This paper will present data on a model utilizing a CPT, the Test of Variables of Attention (TOVA), as a means for assessing the efficacy of psychostimulant trials when attempting to treat attention and processing speed difficulties in a sample of patients diagnosed with mild traumatic brain injury (MTBI). Baseline and psychostimulant challenge testing data from 35 patients diagnosed with MTBI will be presented. The implications of evaluating and treating patients in this manner will be discussed, including how it may impact upon the patient’s treatment and recovery. This data is presented as part of an ongoing study assessing the utility of psychostimulant titration trials on the treatment of the sequelae associated with MTBI. Future research directions will also be discussed.


Objective: Psychostimulants have been found to be beneficial in the treatment of the sequelae associated with traumatic brain injury (TBI) including attention difficulties, slowed processing speed, memory complaints, and emotional changes. Much of the research in this area has focused specifically on the use of Ritalin (Methylphenidate). More recently, Provigil (Modafinil) has been used to treat TBI related symptoms, although the literature on the use of Provigil in this regard is limited. The purpose of this case study is to present data on a patient diagnosed with a TBI who was treated with Ritalin and later treated with Provigil. Method: The patient is a 24 year old male diagnosed with a TBI who was followed separately by outpatient psychiatry and neuropsychology practices. A Continuous Performance Test (CPT) was utilized to compare the efficacy of treating the patient’s cognitive symptoms with Ritalin versus Provigil. Results: The patient demonstrated a mixed response to treatment with Ritalin and reported little to no associated improvement in his daily TBI related symptoms. The patient demonstrated significant improvement on CPT testing and reported improved symptom complaints in his everyday life associated with trial on Provigil. Conclusion: Despite a poor treatment response to Ritalin trials, the patient’s symptom report and CPT performances significantly improve with Provigil. The implications of this case study, and future research directions will be discussed.

The objective of this study was to differentiate the attention patterns associated with attention deficit disorder with or without hyperactivity using continuous performance test (CPT). The diagnoses were based on the DSM-III, III-R, and IV criteria and of the 39 children who participated in the study, 14 had attention deficit disorder with hyperactivity (ADDH) and 11 had attention deficit disorder without hyperactivity (ADDWO), while 14 normal children served as a control group. Attention patterns were examined according to the performance of subjects on the CPT and parental scores on the ADHD Rating Scale, the Child Attention Profile, and the Conners Rating Scale. CPT performances were assessed before and after administration of 10 mg methylphenidate. We found as hypothesized that the CPT differentiated between the ADDH and ADDWO groups. However, contrary to our expectations, the ADDH children made more omission errors than the ADDWO children; they also showed more hyperactivity and impulsivity. The performance of both groups improved to an equal degree after the administration of methylphenidate. It is concluded that different subtypes of the attention deficit disorders are characterized by different attention profiles and that methylphenidate improves scores on test of continuous performance.


The diagnosis of attention-deficit hyperactivity disorder (ADHD) is occasionally biased by the subjectivity of symptoms and reports of parents and teachers. The advent of continuous performance tests raised expectations that the diagnosis of ADHD will be more standardized and accurate. In this study, the authors looked for the validity of the ADHD scores obtained by the Test of Variables of Attention in 230 children who were referred to their ADHD clinic between 2005 and 2007. Based on clinical evaluations, 179 children were diagnosed with affirmed or suspected ADHD. Among the 179 children with ADHD, the Test of Variables of Attention was suggestive of ADHD in 163 participants (91.1% sensitivity), but it was also suggestive for ADHD in 78.4% of the children without ADHD. With a low specificity of 21.6%, the authors feel that the Test of Variables of Attention is not reliable enough to serve as a screening diagnostic tool for ADHD.


Brainwave entrainment using rhythmic visual and/or auditory stimulation has shown its efficacy in modulating neural activities and cognitive ability. In the presented study, we aim to investigate whether rhythmic haptic stimulation could enhance short-term attention. An experiment with sensorimotor rhythm (SMR) increasing protocol was performed in which participants were presented sinusoidal vibrotactile stimulus of 15Hz on their palm. Test of Variables of Attention (T.O.V.A.) was performed before and after the stimulating session. Electroencephalograph (EEG) was recorded across the stimulating session and the two attention test sessions. SMR band power manifested a significant increase after stimulation. Results of T.O.V.A. tests indicated an improvement in the attention of participants who had received the stimulation compared to the control group who had not received the stimulation. The D prime score of T.O.V.A. reveals that participants performed better in perceptual sensitivity and sustaining attention level compared to their baseline performance before the stimulating session. These findings highlight the potential value of using haptics-based brainwave entrainment for cognitive training.