Bibliography of Studies Using the Test of Variables of Attention — T.O.V.A.


Background: Poor behavioural inhibition is the central impairment in attention deficit hyperactivity disorder (ADHD). At present, there is no reliable objective measure to detect ADHD. A proper pinpointing evaluation for ADHD depends mainly on the history from parents, family members as well as teachers and schoolmates, by means of questionnaires and conduct rating scales. Objective: The aim of this study was to detect continuous performance task (CPT) (test of variants of attention) changes in children suffering from ADHD compared with normal children. Patients and Methods: CPT, Conner s’ parent rating scales, Wexler intelligence scale were done for two groups of children each containing 39 children, a group of ADHD children and the other a normal control group. Results: We found a significant difference between the mean total IQ score among the ADHD patients group compared with control group. Comparing both groups revealed statistically significant increase in omission, commission and reaction time among patients. A significant negative correlation was found between age on one side and IQ, hyperactivity and psychosomatic subscales, hyperactivity and total DSM-IV scores on the other hand and between commission and opposition, restlessness subscales and ADHD index and also between reaction time and restlessness and emotional index. There was a significant positive correlation between omission and hyperactivity and anxiety subscales, restlessness and emotional indices and DSM-IV hyperactive and total scores. In addition, there was a significant positive correlation between perfectionism and commission and also between reaction time and inattention and social problems subscales. Conclusions: CPT can have a substantial role in objective identification of ADHD.


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 theses 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.

Introduction: The effect of a single dose of methylphenidate (MPH) on cognitive measures and decision-making processes was assessed in a sample of adults with ADHD and in a control sample. Methods: Thirty-two adults satisfying DSM-IV criteria for ADHD and 26 healthy controls performed several cognitive tasks. Half of the participants received MPH prior to performing the tasks, and the other half received placebo in a randomized, double-blind manner. Results: The average digit-span test score was higher in the groups receiving MPH compared to the groups receiving placebo, while diagnosis did not have an effect upon scores. In decision-making tasks, however, MPH did not have an effect upon performance, whereas in one of the tasks the average proportion of risky choices was higher in ADHD adults compared to controls. Conclusion: Our data therefore demonstrates that (a) MPH is capable of enhancing specific aspects of cognitive performance and (b) this enhancement is not specific to ADHD.


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 were enrolled in the study. 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 burden with decreased neurocognitive ability suggests that both measures reflect disease severity and are not independent.

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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 back 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.


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, 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) in interviews, the Autism Spectrum Quotient and the Temperament and Character Inventory, neuropsychological tests by subscales from the Wechsler scales, continuous performance tests (Tower of London and Happ's cartoons). Results. The AS assessment had substantial inter-rater reliability over time (Cohen's k score 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.


Due to the well-established incentives for feigning ADHD symptoms (i.e., access to medications), researchers and clinicians have begun investigating how to ensure good effort in ADHD evaluations. Undergraduates participated in a clinical interview to confirm presence or absence of ADHD. One hundred thirteen undergraduates, 30 with a confirmed ADHD diagnosis, 29 ADHD simulators, 28 normal incentive controls, and 26 high incentive controls, returned for testing approximately a week later, and took two continuous performance tasks (Conner’s CPT-2 and the Test of Variables of Attention), an effort test (Green’s Medical Symptom Validity Test), and two questionnaires (Conner’s Adult ADHD Rating Scale and the Generalized Self Efficacy Scale). ADHD participants did not perform significantly differently than controls on the continuous performance tests. Simulators performed significantly worse than ADHD participants and controls on all scores on the continuous performance tests, and most CAARS scores. The CAARS Clinical Infrequency Index (CII) and Malingering Index (MI) were not significantly different between ADHD and simulator participants. Embedded measures of effort were created for the CPT-2 and TOVA, which showed good sensitivity and specificity. The embedded measure developed for the TOVA compared favorably to the TOVA SEI. Participants failing the MSVT did not perform significantly differently from those passing the MSVT on the continuous performance tests. Sixty-six percent of simulators failed the MSVT, while only 2% of the participants in the other groups failed. The MSVT may be too easy or short to be the most appropriate standalone effort measure for this population. Continuous performance test embedded measures of effort showed higher sensitivity than the MSVT, and are thought to provide a good adjunct to traditional effort tests in ADHD assessment. The lack of difference between the AMID and control groups on the continuous performance tasks is thought to be due to sample bias. Future research should replicate these embedded measures and investigate whether the Word Memory Test, which is longer than the MSVT, is a more appropriate test for this population.


Recent research has identified a transitional state between the cognitive changes of normal aging and Alzheimer’s disease (AD), known as mild cognitive impairment (MCI). MCI patients experience memory loss to a greater extent than one would expect for age, yet they do not meet currently accepted criteria for clinically probable AD. An issue currently under investigation is whether MCI represents the preclinical stages of AD or a distinct and static cognitive aetiology. In an attempt to address this issue, the present investigations are adopting a convergent approach to the detection of preclinical AD, where multiple risk factors are considered when making a diagnosis. Currently, one of the most important tools when assessing early cognitive changes is neuropsychological evaluation. MCI subjects typically record neuropsychological performance between that of healthy older individuals and demented patients. Tests assessing new learning, delayed recall and attention/executive function seem to provide valuable information for screening and diagnosis of MCI and early AD if interpreted properly. Recommendations concerning methodological issues and the early management of neuropsychological MCI studies were made.

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 center’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.


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 noncigarette-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. Kindsch, 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

Background: Infection with severe malaria in African children is associated with not only a high mortality but also a high risk of cognitive deficits. There is evidence that interventions done a few years after the illness are effective but nothing is known about those done immediately after the illness. We designed a study in which children who had suffered from severe malaria three months earlier were enrolled into a cognitive intervention program and assessed for the immediate benefit in cognitive, academic and behavioral outcomes. Methods: This parallel group randomised study was carried out in Kampala City, Uganda between February 2008 and October 2010. Sixty-one Ugandan children aged 5 to 12 years with severe malaria were assessed for cognition (using the Kaufman Assessment Battery for Children, second edition and the Test of Variables of Attention), academic skills (Wide Range Achievement Test, third edition) and psychopathologic behaviour (Child Behaviour Checklist) three months after an episode of severe malaria. Twenty-eight were randomised to sixteen sessions of computerised cognitive rehabilitation training lasting eight weeks and 33 to a non-treatment group. Post-intervention assessments were done a month after conclusion of the intervention. Analysis of covariance was used to detect any differences between the two groups after post-intervention assessment, adjusting for age, sex, weight for age z score, quality of the home environment, time between admission and post-intervention testing and pre-intervention score. The primary outcome was improvement in attention scores for the intervention group. This trial is registered with Current Controlled Trials, number ISRCTN53183087. Results: Significant intervention effects were observed in the intervention group for learning mean score (SE), [93.89 (4.00) vs 106.38 (4.32), P = 0.04] but for working memory the intervention group performed poorly [27.42 (0.66) vs 25.34 (0.73), P = 0.04]. No effect was observed in the other cognitive outcomes or in any of the academic or behavioural measures. Conclusions: In this pilot study, our computerised cognitive training program three months after severe malaria had an immediate effect on cognitive outcomes but did not affect academic skills or behaviour. Larger trials with follow-up after a few years are needed to investigate whether the observed benefits are sustained.
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 three cognitive abilities: working memory, reasoning, and spatial learning. Exploratory factor analysis (EFA) was used to identify loadings of academic performance measures onto a single latent cognitive factor. Structural equation models (SEM) were used to determine the nature of the association between cognition and each academic performance measure (p < 0.0001). Working memory, visual spatial skills, and academic performance were highly correlated; spatial learning 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 cognition 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 predicted better by 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 malaria with neurological involvement was 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.
strongly associated with the latent variable labeled 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 neuro-disability 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 test 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 Maze Memory with KABC-II's Simultaneous 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.


Background: Legg-Calvé-Perthes disease (LCPD) is an idiopathic hip osteonecrosis prevalent in children < age 15 years. The etiology remains incompletely understood, partly because of multiple potential environmental risk factors and partly because of lack of genetic markers. It has been hypothesized that hyperactivity may induce
mechanical stress and/or vascular damage at a fragile joint. Objectives: To assess children with LCPD for markers of attention deficit hyperactivity disorder (ADHD) relative to their unaffected comparably aged siblings to exclude the contribution of hyperactive behavior versus environmental and/or genetic factors in LCPD. Methods: All children followed in the Pediatric Orthopedic Clinic, and their comparably aged siblings, were recruited. ADHD was assessed using the TOVA computerized test and DSM-IV criteria. Quality of life and sleep disorders as ancillary tests were assessed using the Child Health Questionnaire (Parent Form 50), Pediatric Outcomes Data Collection Instrument, and Pediatric Daytime Sleepiness Scale. Results: Sixteen children with LCPD (age 9.1 ± 3.3, 75% males) were compared with their closest-aged siblings (age 9.3 ± 2.6, 30% males). Mean TOVA scores of children with LCPD (-3.79 ± 2.6) and of their non-LCPD siblings (-3.6 ± 4.04) were lower relative to the general population (0 ± 1.8, P <0.0001). Both group means were in the ADHD range, implying that 73% of this LCPD cohort and 53% of their non-LCPD siblings performed in the ADHD range, relative to 3.6% incidence expected in the general population (P <0.0001). Other test results were similar in both groups. Conclusions: Our findings in a small cohort of children with LCPD and their comparably aged siblings do not support an association between LCPD and ADHD. ADHD markers were equally high in the LCPD children and siblings.


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 content. 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.


AIM: Epilepsy is associated with difficulties in cognition and behavior in children. These problems have been attributed to genetic predisposition, psychosocial stress, and/or antiepileptic drugs. In a previous study, we found baseline cognitive differences between children with partial versus generalized and convulsive versus non-convulsive seizures. Measures in that study focused primarily on IQ scores. In the present study, we assessed baseline function with respect to new learning, attention, and memory, thus providing a more comprehensive profile than our previous study. METHOD: We examined 57 children (42 females, 15 males), aged 6 to 17 years (mean 10y 1mo, SD 2y 9mo), with new-onset, idiopathic epilepsy, using tests of cognitive function reflective of new learning, memory, and attention. Seizures were classified as generalized convulsive (n=5), generalized non-convulsive (n = 18), or focal (n = 34). Focal seizures were divided into unilateral versus bilateral independent foci, and presence versus absence of secondary generalization. RESULTS: Attention was a particular area of weakness across all groups. The Vocabulary score of an intelligence screen was higher for the focal seizure groups (p = 0.012), primarily because of a difference between the unilateral focal and the primary generalized groups (p< 0.047). Children with generalized, non-convulsive seizures performed significantly worse than the focal group on a measure of short-term auditory memory (p = 0.019). All groups performed poorly on a test of visual-motor speed. INTERPRETATION: These findings suggest intrinsic abnormalities in children with new-onset, idiopathic epilepsy at baseline.


Recent literature has emphasized the need to evaluate 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 and 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 Bruninks-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

**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 a non-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.


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 subtest, i.e., 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 \((p<0.025)\) then um berD BTO VArquersasgn tan predtor frn pared orn orm af 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, 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 brain-derived neurotrophic factor (BDNF), and increased 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).
correlates with abnormal Test of Variables of Attention (TOVA) in adults and predicts early cognitive decline in a clinical setting. *Advances in Therapy, 23*(4), 582–600.

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 norm. Significant differences were observed in the latency of responses (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<.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.

Brewis, A. (2002). Social and biological measures of hyperactivity and inattention: are they describing similar underlying constructs of child behavior? *Social Biology, 49*(1-2), 99–115. 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.

Brewis, A., Schmidt, K., & Casas, C. A. S. (2003). Cross-cultural study of the childhood developmental trajectory of attention and impulse control. *International Journal of Behavioral Development, 27*(2), 174–181. 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 being applied to other cultures in diverse settings.

Objective: This study examined performance on the Test of Variables of Attention (TOVA) and Freedom From Distractibility Index (FFDI) of the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) among children with and without Attention-Deficit/Hyperactivity Disorder (ADHD). It was hypothesized children with ADHD would score lower than children without ADHD on these measures when controlling for IQ. Method: Participants were 50 children divided into an ADHD (n = 25) or No Diagnosis group (n = 25). All were administered the visual TOVA and the WISC-III in a university mental health services setting. 66% of subjects were male and mean age was 10.66 (s=2.85), with mean education of 5.08 years (s=2.62). Most subjects (70%) classified themselves as Caucasian. Results: Four one-way ANCOVAs controlling for IQ were conducted at an alpha level of 0.0125 (0.05/4) to maintain the family-wise error rate. Significant differences were found between groups on TOVA Response Time (RT), Response Time Variability, or the FFDI. Conclusions: Results were consistent with past findings regarding performance on TOVA-CE among ADHD children. Limitations of the present study were small sample size, and participants with co-morbid diagnoses.

Bron, T. I., Bijlenga, D., Boonstra, A. M., Breuk, M., Pardoen, W. F., Beekman, A. T., & Kooij, J. J. (2014). OROS-Methylphenidate Efficacy on Specific Executive Functioning Deficits in Adults with ADHD: A Randomized, Placebo-Controlled Cross-over Study. European Neuropsychopharmacology: The Journal of the European College of Neuropsychopharmacology, 24(4), 519–28. Attention-deficit/hyperactivity disorder (ADHD) is linked to impaired executive functioning (EF). This is the first study to objectively investigate the effects of a long-acting methylphenidate on neurocognitive test performance of adults with ADHD. Twenty-two adults with ADHD participated in a 6-weeks study examining the effect of osmotic-release oral system methylphenidate (OROS-mph) on continuous performance tests (CPTs; objective measures), and on the self-reported ADHD rating scale (subjective measure) using a randomized, double-blind, placebo-controlled cross-over design. OROS-mph significantly improved reaction time variability (RTV), commission errors (CE) and d-prime (DP) as compared to baseline (Cohen’s d > .50), but did not affect hit reaction time (HRT) or omission errors (OE). Compared to placebo, OROS-mph only significantly influenced RTV on one of two CPTs (p < .05). Linear regression analyses showed predictive ability of more beneficial OROS-mph effects in ADHD patients with higher EF severity (RTV: beta = .670, t = 2.097, p = .042; omission errors (OE): beta = -.098, t = -4.759, p < .001), and with more severe ADHD symptoms (RTV: F = 6.363, p = .019; HRT: F = 3.914, p = .061). Side effects rates were substantially but non-significantly greater for OROS-mph compared to placebo (77% vs. 46%, p = .063). OROS-mph effects indicated RTV as the most sensitive parameter for measuring both neuropsychological and behavioral deficits in adults with ADHD. These findings suggest RTV as an endophenotypic parameter for ADHD symptomatology, and propose CPTs as an objective method for monitoring methylphenidate titration.

Brown, F. C., Roth, R. M., & Katz, L. J. (2015). Allocentric but not egocentric visual memory difficulties in adults with {ADHD} may represent cognitive inefficiency. Psychiatry Research, 228(3), 649 – 658. 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.

Byas-Smith, M. G., Chapman, S. L., Reed, B., & Cotsonis, G. (2005). The effect of opioids on driving and psychomotor performance in patients with chronic pain. The Clinical Journal of Pain, 21(4), 345–52. 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.


The LiSN & Learn auditory training software was developed specifically to improve binaural processing skills in children with suspected central auditory processing disorder who were diagnosed as having a spatial processing disorder (SPD). SPD is defined here as a condition whereby individuals are deficient in their ability to use binaural cues to selectively attend to sounds arriving from one direction while simultaneously suppressing sounds arriving from another. As a result, children with SPD have difficulty understanding speech in noisy environments, such as in the classroom.

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.

Carter, C. S., Krener, P., Chaderjian, M., Northcutt, C., & Wolfe, V. (1995). Asymmetrical visual-spatial attentional performance in ADHD: evidence for a right hemispheric deficit. Biological Psychiatry, 37(11), 789–797. 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.

Carter, C. S., P. Krener, M. Chaderjian, C. Northcutt, and V. Wolfe. (1995). Asymmetrical Visual-Spatial Attentional Performance in ADHD: Evidence for a Right Hemispheric Deficit. Biological Psychiatry 37, no. 11 (1995): 789–97. 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.

Cassidy, A. R., White, M. T., DeMaso, D. R., Newburger, J. W., & Bellinger, D. C. (2016). Processing Speed, Executive Function, and Academic Achievement in Children With Dextro-Transposition of the Great Arteries: Testing a Longitudinal Developmental Cascade Model. Neuropsychology. 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 data, χ²(3) = 1.581, RMSEA = 0, CFI = 1, 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.

Chae, P. (1999). Correlation study between WISC-III scores and TOVA performance. *Psychology in the Schools*, 36(3), 179–185. 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.

Chae, P. K., Jung, H.-O., & Noh, K.-S. (2001). Attention deficit hyperactivity disorder in Korean juvenile delinquents. *Adolescence*, 36(144), 707. 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.

Chae, P. K., Kim, J.-H., & Noh, K.-S. (2003). Diagnosis of ADHD Among Gifted Children in Relation to KEDI-WISC and T.O.V.A. Performance. *Gifted Child Quarterly*, 47(3), 192–201. 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% 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.

Chen, S.-T., Shen, T.-W., & Chen, S.-J. (2011). Electromyography Change During the Test of Variables of Attention TOVA in Patients with Major Depressive Disorder. *European Psychiatry*, 26, Supplement 1, 617 – 618. 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.

OBJECTIVES: The purpose of the study was to evaluate how the visual and auditory TOVA along with the IQ scores can differentiate the attentional deficit, both in children with ADHD only and in children with clinical diagnoses other than ADHD. METHODS: Forty-seven children were divided into two groups, who were diagnosed as ADHD only and non-ADHD. One child & adolescent psychiatrist and one clinical psychologist were involved in the diagnostic process. Psychological tests battery including TOVA- visual and auditory was applied to all children. The raw data from the results was analyzed statistically by ANCOVA. RESULTS: ADHD children were significantly scored lower in total IQ scores, as well as in all the subscores of IQ tests except similarities and vocabulary, though all of the children were classified within normal limit in terms of total IQ scores. Among the subscores of the IQ tests, the scores of arithmetic, digit span and coding were more significantly lower in ADHD group. And the ADHD children were significantly more impaired in performance in the variables of commission for the first half & total with visual TOVA, in the variables of commission for the second half & total with auditory TOVA. CONCLUSION: The ADHD children could be differentiated by the variables of both commission and variability of auditory TOVA. Assuming that the subscores of arithmetic, digit span and coding in the IQ test, as well as the variables of commission and variability of auditory TOVA reflect the ability of impulse control, the results suggest that the ADHD children would be more impaired in impulse-control than the children diagnosed other than ADHD.

Background and objectives: The purpose of this study is to examine the reliability of the clinical use of the self-built decision support system, diagnosis-supported attention deficit hyperactivity disorder (DS-ADHD), in an effort to develop the DS-ADHD system, by probing into the development of indicating patterns of past screening support systems for ADHD. Methods: The study collected data based on 107 subjects, who were divided into two groups, non-ADHD and ADHD, based on the doctor’s determination, using the DSM-IV diagnostic standards. The two groups then underwent Test of Variables of Attention (TOVA) and DS-ADHD testing. The survey and testing results underwent one-way ANOVA and split-half method statistical analysis, in order to further understand whether there were any differences between the DS-ADHD and the identification tools used in today’s clinical trials. Results: The results of the study are as follows: 1) The ROC area between the TOVA and the clinical identification rate is 0.787 (95% confidence interval: 0.701–0.872); 2) The ROC area between the DS-ADHD and the clinical identification rate is 0.867 (95% confidence interval: 0.801–0.933). Conclusions: The study results show that DS-ADHD has the characteristics of screening for ADHD, based on its reliability and validity. It does not display any statistical differences when compared with TOVA systems that are currently on the market. However, the system is more effective and the accuracy rate is better than TOVA. It is a good tool to screen ADHD not only in Chinese children, but also in western country.

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.
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 (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.


Conducting cognitive assessment tests throughout normal daily life offers new opportunities to early detect changes in cognitive efficiency. Such tests would allow identification of early symptoms of cognitive impairment, monitor the progress of disease processes related to cognitive efficiency and reduce the risk of cognitive overload. Reaction time tests are known as simple and sensitive tests for detecting variation in cognitive efficiency. A drawback of existing reaction time tests is that they require the full attention of a test person, which prohibits the measurement of cognitive efficiency during daily routine tasks. In this contribution we present the design, implementation and empirical evaluation of two wearable reaction time tests that can be operated throughout everyday life. We designed and implemented wearable watch-like devices, which combine the generation of haptic stimuli and the recognition of an gestures as the subject’s response. For the evaluation of the wearable interface, we conducted a user study with 20 subjects to investigate to what extent we can measure changes in length and variability of user’s reaction time with the wearable interfaces compared to traditional desktop-based tests. Based on the achieved statistical results, we conclude that the presented wearable reaction time tests are suitable to measure factors that influence length and variability of reaction times.


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.


Early life trauma (ELT) has been shown to impair affective control and attention well into adulthood. Neuroimaging studies have further shown that ELT was associated with decreased white matter integrity in the prefrontal areas in children and adults. However, no study to date has looked at the relationship between white matter integrity and affective control in individuals with and without a history of ELT. To examine this, we tested 240 Veterans with (ELT N = 80) and without (NoELT N = 160) a history of childhood sexual abuse, physical abuse or family violence. Affective control was measured with the Affective Go/No-Go (AGN) and attention was indexed with the Test of Variable Attention (TOVA). White matter integrity was measured using fractional anisotropy (FA). Results showed greater number of errors on the AGN in ELT compared to NoELT. There was no difference on the TOVA. While
there were no mean differences in FA, there was an interaction between FA and reaction time to positive stimuli on the AGN where the ELT group showed a positive relationship between FA and reaction time in right frontal and prefrontal areas, whereas the NoELT group showed a negative or no association between FA and reaction time. This suggests that ELT may be associated with a distinct brain-behavior relationship that could be related to other determinants of FA than those present in healthy adults.

Corman, C., Greenberg, L., & Crosby, R. (2000). The assessment of medication effects in attention deficit disorder using the test of variables of attention (TOVA). CyberPsychol. Behavior, 3(3), 509–515. 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 childhood database.

Cornelius, Marie D., Natacha M. De Genna, Sharon L. Leech, Jennifer A. Willford, Lidush Goldschmidt, and Nancy L. Day. (2011). Effects of Prenatal Cigarette Smoke Exposure on Neurobehavioral Outcomes in 10-Year-Old Children of Adolescent Mothers. Neurotoxicology and Teratology 33(1), 137–44. doi:10.1016/j.ntt.2010.08.006. In this prospective study, teenager mothers (mean age = 16; range = 12–18; 70% African American) were interviewed about their tobacco use during pregnancy. When their children were ten, mothers reported on their child behavior and the children completed neuropsychological battery. We examined the association between prenatal cigarette smoke exposure (PCSE) and offspring neurobehavioral outcomes on data from the ten-year phase (n = 336). Multivariate regression analyses were conducted to test if PCSE predicted neurobehavioral outcomes, adjusting for demographic characteristics, maternal psychological characteristics, prenatal exposure to other substances, and exposure to environmental tobacco smoke. Independent effects of PCSE were found. Exposed offspring had more delinquent, aggressive and externalizing behaviors (CBCL). They were more active (Routh, EAS, SNAP) and impulsive (SNAP), and had more problems with peers (SNAP). On the Stroop test, deficits were observed in both baseline response processing measures and on the more complex interference task that requires both selective attention and response inhibition. The significant effects of PCSE on neurobehavioral outcomes were found for exposure to as few as 10 cigarettes per day. These results are consistent with results from an earlier assessment when the children were age 6, demonstrating that the effects of prenatal tobacco exposure can be identified early and are consistent through middle childhood.


Dang, L., Samanez-Larkin, C., Young, G., Cowan, R., Kessler, J., & Zald, S. (2016). Caudate asymmetry is related to attentional impulsivity and an objective measure of ADHD-like attentional problems in healthy adults. Brain Structure and Function, 221(1), 277-286. 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.


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.


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 the subgroup aged 6–12 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 greater (r = 0.28, p < 0.01) in the children with attention deficit/hyperactivity disorder (ADHD) than in the healthy controls (r = 0.29, p < 0.01). 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 EDSS/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 .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 EDS decreased from 13.83 to 10.76 (P .003) in FF group, and from 13.29 to 12.80 with PL (P diff NS). TOVA commission errors decreased by 7.13 (FF) vs 1.4 (PL) (P diff .05). Omission increased in PL from 2.33 to 5.75, and 1.54 to 1.58 (FF) (P diff NS). Reaction time increased in both groups 363 to 391 milliseconds (FF), 387 to 412 milliseconds (P 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 .004). Conclusions: Treatment of symptomatic SAR with intranasal FF decrease daytime sleepiness, less nocturnal sleep disturbance, and improved cognitive performance.

Dobrusin, S. J. (2000). *Determining the diagnostic capabilities of computer performance tests for adults with attention deficit disorder*(Doctoral Dissertation), Wayne State University, Detroit, MI.

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 each 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 CPTs 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 normals 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.

Objective: To test a common assumption underlying the clinical use of electroencephalographic (EEG) biofeedback training (neurofeedback), that the modulation of discreet frequency bands is associated with frequency-specific effects. Specifically, the proposal was assessed that enhancement of the low beta components sensorimotor rhythm (SMR: 12–15 Hz) and beta1 (15–18 Hz) affect different aspects of attentional processing. Methods: Subjects (n = 25) were randomly allocated to training with either an SMR or beta1 protocol, or to a non-neurofeedback control group. Subjects were assessed prior and subsequent to the training process on two tests of sustained attention. The neurofeedback participants were also assessed on target P300 event-related potential (ERP) amplitudes in a traditional auditory oddball paradigm. Results: Protocol-specific effects were obtained in that SMR training was associated with increased perceptual (d′) scores, and reduced omission errors and reaction time variability. Beta1 training was associated with faster reaction times and increased target P300 amplitudes, whereas no changes were evident in the control group. Conclusions: Neurofeedback training of SMR and beta1 band components led to significant and protocol-specific effects in healthy subjects. The data can be interpreted as indicating a general attention-enhancing effect of SMR training, and an arousal-enhancing effect of beta1 training.

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 test scores of the visual and auditory portions of the TOVA and the nonverbal subtests of the LNNB-111 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 (0.43 1). 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.


Digit span (DS) and visual–spatial memory span (VMS) tasks have been considered indices of auditory and visual–spatial processing, respectively, often classified as primary auditory or spatial. There has been some evidence for their modality specificity, however. We present two children who showed visual–spatial processing abnormalities (including VMS) and non-dominant manual inefficiency with normal visual–spatial perception, auditory–verbal processing and dominant fine manual skills. These children support a distinction between auditory
and visual–spatial memory span. These findings are discussed with regard to a hypothesis that the unique expression of VMS is time-limited, that visual–spatial processing becomes more verbalized as children learn to read and that these behavioral changes produce a lateral shift in cortical processing of visual–spatial information.


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.


Children with learning disabilities (LD) frequently have an EEG characterized by an excess of theta and a deficit of alpha activities. NFB using an auditory stimulus as reinforcer has proven to be a useful tool to treat LD children by positively reinforcing decreases of the theta/alpha ratio. The aim of the present study was to optimize the NFB procedure by comparing the efficacy of visual (with eyes open) versus auditory (with eyes closed) reinforcers. Twenty LD children with an abnormally high theta/alpha ratio were randomly assigned to the Auditory or the Visual group, where a 500 Hz tone or a visual stimulus (a white square), respectively, was used as a positive reinforcer when the value of the theta/alpha ratio was reduced. Both groups had signs consistent with EEG maturation, but only the Auditory Group showed behavioral/cognitive improvements. In conclusion, the auditory reinforcer was more efficacious in reducing the theta/alpha ratio, and it improved the cognitive abilities more than the visual reinforcer.


Children with learning disabilities (LD) frequently have an EEG characterized by an excess of theta and a deficit of alpha activities. NFB using an auditory stimulus as reinforcer has proven to be a useful tool to treat LD children by positively reinforcing decreases of the theta/alpha ratio. The aim of the present study was to optimize the NFB procedure by comparing the efficacy of visual (with eyes open) versus auditory (with eyes closed) reinforcers. Twenty LD children with an abnormally high theta/alpha ratio were randomly assigned to the Auditory or the Visual group, where a 500 Hz tone or a visual stimulus (a white square), respectively, was used as a positive reinforcer when the value of the theta/alpha ratio was reduced. Both groups had signs consistent with EEG maturation, but only the Auditory Group showed behavioral/cognitive improvements. In conclusion, the auditory reinforcer was more efficacious in reducing the theta/alpha ratio, and it improved the cognitive abilities more than the visual reinforcer.

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.

The present study examined effects of current and past regular cigarette smoking in young adult subjects. One hundred and twelve 17–21-year-old subjects, assessed since infancy, were evaluated using a battery of neurocognitive tests for which commensurate measures were obtained at 9–12 years of age, prior to the initiation of regular smoking. Smokers, determined by urinalysis and self-report, were categorized as heavy (> 9 cigarettes per day) and light (< 9 cigarettes per day) current smokers and former smokers, the latter having smoked cigarettes regularly in the past but not for at least 6 months. A third of the subjects were currently smoking cigarettes regularly with half of these being heavy smokers. Among former smokers, the average duration of smoking was slightly less than 2 years. Overall IQ, memory, processing speed, vocabulary, attention and abstract reasoning were the primary outcomes with comparisons being made between each of the three user groups and a control group who never smoked regularly. After accounting for potentially confounding factors including clinical assessment, marihuana use and pre-drug performance in the relevant cognitive domain, current regular smokers did significantly worse than non-smokers in a variety of cognitive areas predicted upon verbal/auditory competence including receptive and expressive vocabulary, oral arithmetic, and auditory memory. This impact of current smoking appears to behave in a dose–response and duration-related fashion. In contrast, former smokers differed from the non-smokers only in the arithmetic task. These results suggest that regular smoking during early adulthood is associated with cognitive impairments in selected domains and that these deficits may be reversed upon cessation. Together, the findings add to the body of evidence to be used in persuading adolescents and young adults against the initiation of smoking and, if currently smoking, the advantages of stopping.


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’s Brain Powered Games (BPG) package that would be suitable 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 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.** One of the disorders that affects school performance the most is isolated attention deficit disorder or attention deficit associated with hyperactivity or impulsivity disorder. This disorder poses difficulties to the students themselves, both in the verbal area and in reasoning and calculus, as well as to their teachers, as a consequence of the students’ disruptive behaviors. The criteria established by the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, revised are one of the most widely accepted procedures to diagnose the deficit, distinguishing three subtypes: inattentive, hyperactive-impulsive, and combined. The main goal of this investigation is to determine whether there are differential patterns of cortical activation and executive control for these three types of subjects with Attention Deficit Hyperactivity Disorder (ADHD) and for the control group (without ADHD). The sample was made up of 220 students, ages between 6 and 12 years: 56 in the control group, 54 predominantly with attention deficit disorder, 53 predominantly with hyperactivity-impulsivity disorder, and 57 with combined. The results obtained show that the four groups of subjects were significantly different in the two variables of cortical activation assessed (central and prefrontal) and in the five variables of executive control (inattention, impulsivity, response time, variability, and general executive control index). Multiple group comparisons confirm the proposed hypotheses. The results reveal a new path of great interest concerning an objective and reliable diagnostic assessment, and a pharmacological and behavioral intervention adapted to each specific situation.


**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 hemoencefalography (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.

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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; n = 36) and in healthy controls (n = 35). Sustained attentional control and response inhibition were examined with the Test of Variables of Attention (T.O.V.A.). Delayed responses, increased reaction time variability, and higher omission error rate to Go signals in ADHD patients relative to controls indicated fluctuating levels of attention in the patients. Furthermore, an increment in NoGo commission errors when Go stimuli increased relative to NoGo stimuli suggests reduced inhibition of task-irrelevant stimuli in conditions demanding frequent responding. The ADHD group reported significantly more cognitive and behavioral executive problems than the control group on the Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A). There were overall not strong associations between task performance and ratings of everyday executive function. However, for the ADHD group, T.O.V.A. omission errors predicted self-reported difficulties on the Organization of Materials scale, and commission errors predicted informant reported difficulties on the same scale. Although ADHD patients endorsed more symptoms of depression and anxiety on the Achenbach System of Empirically Based Assessment (ASEBA) than controls, ASEBA scores were not significantly associated with T.O.V.A. performance scores. Altogether, the results indicate multifaceted alteration of attentional control in adult ADHD, and accompanying subjective difficulties with several aspects of executive function in everyday living. The relationships between the two sets of data were modest, indicating that the measures represent non-redundant features of adult ADHD.


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 and 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.


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 IIe 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 Abbreviated 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.


Greene, L. R., Mahrou, M. L., Espe-Pfeiffer, P., Escalona, A., Mleko, A., Devaraju-BackhausCollen (2000) Correlation of the (TOVA) with the WISC-III. Archives of Clinical Neuropsychology, 15(8), 785. 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). Twenty-five children with attention disorders were included in the study. EEG–BFB sessions significantly improved the attention, behavior, and school study results in 19 (76%) children. In these cases, a significant increase in the amplitude of the inhibitory component in the frontocentral leads and improvement of the TOVA parameters were found.


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 suppression 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.

Harch, H., Moore, K., Wickham, G., Maples, P. G., Andrews, S. R., Fogarty, E. F., Amen, D., Pezzullo, J. C., Luciani, J., … Van Meter, K. W. (2012). A phase I study of improvements abnormal physical exam findings, cognitive testing, and quality military cohort with chronic blast regional cerebral blood flow after 1 and 40 HBOT sessions. Forty 1.5 ATA HBOT sessions i matter ROIs after 40 HBOT sessions, and SPECT statistical parametric mapping analysis (diffuse improvements in coefficient of variation in all white matter and some gray (GAD symptoms (Rivemead PCSQ: 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.

Hagen, H., Moore, K., Wickham, G., & Maples, W. C. (2008). Effect of the EYEPOR® SYSTEM on VISUAL FUNCTION in ADHD CHILDREN A PILOT STUDY, 19(2), 37–41. 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.


Harch, P. G., Hagen, H., Andrews, S. R., Fogarty, E. F., Pezzullo, J. C., Luciani, J., … Van Meter, K. W. (2012). A study of low-pressure hyperbaric oxygen therapy for blast-induced post-concussion syndrome and post-traumatic stress disorder. Journal of Neurotrauma, 29(1), 168–185. 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.

T.O.V.A. Bibliography

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.

Hassan, A., & Janzen, T. (1996). Simultaneous EEG recording during a continuous performance task (CPT). Biofeedback Self-Regul., 21(4), 364–365. Seventeen 10-12-year-old boys were tested with CPT in an effort to validate the Test of Variables of Attention (TOVA)® 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, C2, 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 predictors.
Recent findings suggest that traumatic brain injury (TBI) entails risk for acquired Attention-Deficit/Hyperactivity Disorder (ADHD) symptomatology, yet there are indications that the nature of attentional impairments in children with TBI and ADHD may differ. In addition, previous research has found that inhibitory deficits were related to activity levels in children with TBI and ADHD. Thus, this study compared the attentional profiles and ADHD symptomatology in groups of children with history of TBI or ADHD. It was hypothesized that children with TBI and ADHD would differ in their performances within several domains of attention including: sustained attention, focused/selective attention, working memory, and processing speed. It was also expected that groups would differ in hyperkinesis but not in attention deficit symptoms, with the group of children with ADHD being significantly more hyperactive. Fifty-six participants were identified retrospectively from medical records of a university-affiliated children's hospital. Children who sustained a moderate to severe TBI (n = 24) were compared to children diagnosed with ADHD (n = 32). Both groups of children were evaluated with the following measures: Test of Everyday Attention for Children (TEACh; Manly, Robertson, Anderson, & Nimmo-Smith, 1999), Test of Variables of Attention (TOVA; Greenberg & Dupuy, 1993), Wechsler Intelligence Scale for Children-III (WISC-III; Wechsler, 1994), and the Conners' Parent Rating Scale-Revised (CPRS-R:L; Conners, 1997; completed by caregivers). As expected, children with ADHD were rated as more hyperactive than children with TBI, but contrary to my hypothesis both groups demonstrated elevated levels of inattention. Consistent with previous research, 18% of the TBI sample scored in the range suggestive of ADHD-Predominantly Inattentive Type according to strict cut-off scores from the CPRS-R:L. The hypotheses of this study suggesting that children with TBI would perform more poorly than children with ADHD on focused/selective attention, working memory, and processing speed tasks were not supported. Children with ADHD also did not differ from children with TBI on sustained attention tasks. Finally, the neurobehavioral correlates of attention did not differ between the two groups. Findings from this study underscore the importance of developing specific interventions for children with TBI and ADHD.


Fifty subjects with mild head injury involved in personal injury litigation and 2 subjects referred for evaluation of their disability status underwent comprehensive neuropsychological examination including the Test of Variables of Attention (TOVA). Group status was determined by performance on symptom validity testing. Twenty-six subjects who failed symptom validity testing formed the probable malingerer (PM) group, while 26 subjects who passed symptom validity testing comprised the not malingerer (NM) group. Subjects in the PM group performed significantly worse on all TOVA variables relative to subjects in the NM group. Discriminant function analyses revealed that TOVA omission errors >=3 errors was the best predictor of group status. Malingering research employing a group of probable clinical malingerers has direct generalizability to real-world settings.


Attention Deficit Hyperactivity Disorder (ADHD) is a behavioral disorder characterized by developmentally inappropriate levels of inattention, impulsivity, and/or hyperactivity. Interviews, behavior rating scales, behavioral observation, and laboratory tasks have been employed to evaluate the presence of ADHD symptoms. The continuous performance test (CPT) is a laboratory test commonly used in clinical and research settings with individuals suspected of having ADHD. The CPT is a type of vigilance task that requires monitoring for a particular stimulus embedded in a series of stimuli. Typically, CPTs are presented visually. Little research exists that compares performance between the auditory and visual modalities. This study was designed to determine if there are differences in CPT performance based on modality of presentation. Fifty-three ADHD subjects between the ages of 6 and 15 participated in the study. Each child completed two standardized and normed CPTs, with an auditory and visual version. Total correct and commission errors were compared across modalities and tests (the Gordon Diagnostic System and the Test of Variables of Attention) using Z-scores which were adjusted for the child's age. ADHD children obtained significantly more correct on the two auditory CPTs, relative to the visual CPTs. Commission errors were significantly lower only on the auditory Test of Variables of Attention, relative to the
other measures. The effect of age and medication on performance was also investigated. Normal children display a developmental trend in performance, with older subjects detecting more targets and committing fewer errors. Similar to normal children, performance in this sample of ADHD children improved with age. With the exception of the Test of Variables of Attention commissions, there were significant improvements with age. Results suggest that the CPTs employed in this study may have limited utility when assessing adolescents for ADHD, due to the finding that this group detected a high number of correct targets with few errors. Methylphenidate is a commonly prescribed stimulant used to treat the symptoms of ADHD. Medication has been demonstrated to improve both auditory and visual CPT performance. To determine whether methylphenidate improves performance similarly across modality, thirty-two subjects were recruited to participate twice, once while taking a placebo and once while taking methylphenidate. Methylphenidate was found to enhance performance equally across modality.


The hypothesis 'whether subjects with attention-deficit/hyperactivity disorder (ADHD), who showed under-reactivity of the hypothalamic-pituitary-adrenal (HPA) axis to stress, would make more commission errors in attention tasks', was examined. Forty-three boys, with ADHD, who visited the psychiatric outpatient clinic, at Kangbuk Samsung Hospital, were the subjects of this study. Both pre- and post-test morning saliva samples were collected from the patients at the Korean Educational Development Institute-Wechsler Intelligence Scale for Children (KEDI-WISC), and Tests of Variables of Attention (T.O.V.A.) performed. The Standard scores of the T.O.V.A were compared between the patients with decreases, or increases, in the salivary cortisol levels after the test. Decreases, or increases in the salivary cortisol levels after the test were shown in 28 and 15 patients, respectively. The patients with decreased cortisol levels after the test tended to make more commission errors in compared with those with increased cortisol levels. The patients with the decreased cortisol levels after test had more omission errors in the first quarter of the test, and more commission errors in the second half of the test compared to those with the increased cortisol levels. Subjects who show decreased salivary cortisol levels after stress make more commission errors in attention tests. This suggests that the blunted HPA axis response to stress is related to the impulsivity in patients with ADHD.


Background: Low-level environmental exposure to lead has been associated with both reduced intelligence and symptoms of attention deficit/hyperactivity disorder (ADHD). However, few studies have estimated the association of lead and intelligence independent of ADHD, and it is not clear from previous studies whether lead is associated with both inattention and impulsivity ADHD symptoms. Objectives: We estimated mutually adjusted associations of environmental lead exposure with both intelligence and ADHD symptoms, and associations between lead and specific ADHD-related domains. Methods: Blood lead concentrations were measured in a general population of 1,001 children 8–11 years of age. We used multivariable linear regression models to estimate associations of blood lead concentrations with IQ scores, teacher and parent ratings of ADHD symptoms, and measures of inattention and impulsivity. Models were adjusted for demographic variables and other environmental exposures (blood levels of mercury and manganese, urinary concentrations of cotinine, phthalate metabolites, and bisphenol A). Results: Associations of blood lead with lower IQ and higher impulsivity were robust to adjustment for a variety of covariates. When adjusted for demographic characteristics, other environmental exposures, and ADHD symptoms or IQ, a 10-fold increase in blood lead concentration was associated with lower Full-Scale IQ (~7.23; 95% CI: −13.39, −1.07) and higher parent- and teacher-rated hyperactivity/impulsivity scores (ADHD Rating Scale, 1.99; 95% CI: 0.17, 3.81 and 3.66; 95% CI: 1.18, 6.13, respectively) and commission errors (Continuous Performance Test, 12.27; 95% CI: −0.08, 24.62). Blood lead was not significantly associated with inattention in adjusted models. Conclusions: Low-level lead exposure was adversely associated with intelligence in school-age children independent of ADHD, and environmental lead exposure was selectively associated with impulsivity among the clinical features of ADHD.

OBJECTIVES: To compare the use of a self-report form of impulsivity versus a computerized test of impulsivity in the assessment of suicidal adolescent psychiatric inpatients. METHODS: Sixty consecutive 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 (IC) 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 none 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 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-IV criteria. One day before an 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.

Huang, Y.-S., Wang, L.-J., & Chen, C.-K. (2012). Long-term neurocognitive effects of methylphenidate in patients with attention deficit hyperactivity disorder, even at drug-free status. BMC Psychiatry, 12, 194. 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 and ADHD score than older ones (≥9 y/o), the latter more significantly improved 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.

Huang-Storms, L. (2008). Efficacy of neurofeedback for children with histories of abuse and neglect: Pilot study and meta-analytic comparison to other treatments (Doctoral Dissertation), University of North Texas, Denton, TX. This two-part study investigates the effectiveness of neurofeedback training for reducing behavioral problems commonly observed in abused/neglected children, and compares its efficacy to other treatment interventions with this population. Neuro-developmental sequelae of early relationship trauma are explored as an etiological framework for understanding disturbed affect-regulation, which appears central to the behavioral and emotional difficulties commonly experienced by this pediatric population. It is suggested that neurofeedback teaches children to self-regulate brain rhythmicity mechanisms, which in turn affects global improvements in behavior and mood. The pilot study utilizes records of 20 children removed from their biological homes by Child Protective Services. 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 training. A t-test analysis of pre- and post-scores was computed, and indicated significant improvements following treatment. A meta-analysis of existing literature on treatment interventions with abused/neglected children provides individual and aggregate effect sizes for 33 outcome studies with this clinical population, and contextualizes the results of the present pilot study within other empirically validated treatment modalities. Establishment of an overall effect size for treatment for this pediatric population provides a needed method of comparing research results across studies when control groups may not be ethical or feasible.

Huang-Storms, L., Bodenhamer-Davis, E., Davis, R., & Dunn, J. (2006). QEEG-Guided Neurofeedback for Children with Histories of Abuse and Neglect: Neuromodulatory Rationale and Pilot Study. Journal of Neurotherapy, 10(4), 3–16. 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 improved 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.


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 afternoon 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 Rating Scale-Revised: Long, 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’ Parent Rating Scale-Revised: Long; 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 was significant on the Conners’ Teacher Rating Scales (CTRS) and the Motion Logger Actigraph. Performance differences on the TOVA were 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 IntroductionIntroduction . 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 correlation, 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.

Kaiser, D. A., & Othmer, S. (2000). Effect of Neurofeedback on Variables of Attention in a Large Multi-Center Trial. Journal of Neurotherapy, 4(1), 5–15. 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.

Katz, M., Levine, A. A., Kol-Degani, H., & Kav-Venaki, L. (2010). A Compound Herbal Preparation (CHP) in the Treatment of Children with ADHD: A Randomized Controlled Trial. Journal of Attention Disorders, 14(3), 281–91. 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.
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 TOVA. The effect of group was not significant, and the interaction of time and group was not significant. 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.


The ability to stabilize the focus of attention, notice attention lapses, and return attention to an intended object following lapses are precursors for mindfulness. Individuals diagnosed with attention-deficit hyperactivity disorder (ADHD) are deficient in the attentional and self-control skills that characterize mindfulness. The present study assessed the relationship between mindfulness and ADHD in young adults using the Mindful Attention and Awareness Scale (MAAS), a computerized Go/No-Go task (the Test of Variables of Attention (TOVA)), the World Health Organization Adult Self-Report Scale (ASRS), a tool used as an adult ADHD screen, the Beck Anxiety Inventory (BAI), and the Beck Depression Inventory–II (BDI-II). We recruited 151 adult volunteers (ages 18 to 40); 100 with confirmed ADHD diagnoses and 51 control participants. Overall, participants with prior diagnoses of ADHD scored lower on the MAAS than controls and ASRS scores were strongly negatively correlated MAAS scores. Attention performance index, response time, and response-time variability subscales of the TOVA were positively correlated with MAAS scores and negatively correlated with ASRS scores. Intrasubject response-time variability on the TOVA, a parameter associated with attention lapses, was also strongly negatively correlated with MAAS scores. Observed self-reported mindfulness, as measured by the MAAS, was strongly related to self-reports on a clinical measure of attention disorders, anxiety, depression, and multiple indices of concentration and mind wandering on a standardized Go/No-Go task, the TOVA.


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.

Kennel, S. (2005). The effect of binaural auditory beats on inattention in children and adolescents 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. Sample. 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.


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- and 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 nonmediated 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.


Eighty-six children (ages 9–14) with attention deficit hyperactivity disorder (ADHD) participated in this study. Event-related potentials (ERPs) were recorded in auditory GO/NOGO task before and after 15–22 sessions of EEG biofeedback. Each session consisted of 20 min of enhancing the ratio of the EEG power in 15–18 Hz band to the EEG power in the rest of spectrum, and 7–10 min of enhancing of the ratio of the EEG power in 12–15 Hz to the EEG power in the rest of spectrum with C3-Fz electrodes’ placements for the first protocol and C4-Pz for the second protocol. On the basis of quality of performance during training sessions, the patients were divided into two groups: good performers and bad performers. ERPs of good performers to GO and NOGO cues gained positive components evoked within 180–420 ms latency. At the same time, no statistically significant differences between pre- and post-training ERPs were observed for bad performers. The ERP differences between post- and pretreatment conditions for good performers were distributed over frontal–central areas and appear to reflect an activation of frontal cortical areas associated with beta training.


Objective: We conducted a randomized, double-blind, controlled clinical trial to determine whether hyperbaric oxygen (HBO) improves gross motor function in children with cerebral palsy. Methods: Forty-nine children aged 3 to 8 years with spastic cerebral palsy were randomized to 40 treatments of HBO (100% oxygen at 1.5 atm) or hyperbaric air (HBA, 14% oxygen at 1.5 atm) over an 8-week period. The primary outcome was the Gross Motor Function Measure (GMFM) global score. Other outcomes included the Pediatric Evaluation of Disability Inventory (PEDI). Assessments were made before and immediately, 3 months, and 6 months after the treatment period. Within-group changes were analyzed with paired t tests or repeated measures analysis of variance. Analysis of covariance was used for between-group comparisons. Results: Forty-six children (24 HBO, 22 HBA) were analyzed at the second interim analysis, which was scheduled to take place when at least half of the required number of patients in each group had completed pre- and post- treatment testing. No changes occurred in the GMFM from pre- to post-treatment in either group or between groups. Statistically significant increases occurred in both groups on the PEDI, with no difference between groups. The study was stopped because the calculated conditional probability of obtaining a difference between groups if the study continued to the end was only between 0.5% and 1.6%. Interpretation: HBO was not effective in improving GMFM scores, and was no more effective than HBA in improving PEDI scores. These results do not support use of HBO as a therapy for cerebral palsy in young children who did not have neonatal hypoxic–ischemic encephalopathy.


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 simulation design. Group changes were analyzed with paired t tests or repeated measures analysis of variance. Analysis of covariance was used for between-group comparisons. Results: Forty-six children (24 HBO, 22 HBA) were analyzed at the second interim analysis, which was scheduled to take place when at least half of the required number of patients in each group had completed pre- and post- treatment testing. No changes occurred in the GMFM from pre- to post-treatment in either group or between groups. Statistically significant increases occurred in both groups on the PEDI, with no difference between groups. The study was stopped because the calculated conditional probability of obtaining a difference between groups if the study continued to the end was only between 0.5% and 1.6%. Interpretation: HBO was not effective in improving GMFM scores, and was no more effective than HBA in improving PEDI scores. These results do not support use of HBO as a therapy for cerebral palsy in young children who did not have neonatal hypoxic–ischemic encephalopathy.

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 (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-IIIR 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.


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 score scale 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 theses: 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 (Pult, 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: 

\[
\text{[(Quarter 1 + Quarter 3)/2] - [(Quarter 2 + Quarter 4)/2]}.
\]

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: 

\[
\text{[(Quarter 1 + Quarter 2)/2] - [(Quarter 3 + Quarter 4)/2]}.
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Essentially, this represents differences in the subject's performance over the two test conditions.


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.
T.O.V.A. Bibliography


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


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 (SEM) 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 nor, 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. 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 (SEM) 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.
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.

Li, H. Y., Huang, Y. S., Chen, N. H., Fang, T. J., & Lee, L. A. (2006). Impact of adenotonsillectomy on behavior in children with sleep-disordered breathing. *The Laryngoscope, 116*(7), 1142–1147. 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.

Li, X., Jiang, Z., & Guo, L. (2012). Research of electroencephalographic biofeedback treatment for improving spastic cerebral palsy children brain function. *Chinese J of Rehabilitation Medicine, 27*(2), 138–141, 146. 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 waves, wavesSM, Rwaves, SM, Rpowers, R power ratio, [β/β power ratio]. Before and after treatment, intelligence scale (CBIS) and the test of variables of attention (TOVA) were tested. Result: Observation group: After 3 month-EEGBF treatment, the children's waves, power ratio decreased obviously (P<0.05) waves, wavesSM, Rwaves, SM, Rpowers, R power ratio decreased obviously (P<0.05). Con group: waves, wavesSM, Rwaves, SM, Rpowers showed a significant difference (P>0.05). After treatment, in observation group the intelligence 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.

Li, X., & Wang, Y. (2000). A Preliminary Application of the Test of Variables of Attention (T.O.V.A.) in China. *Chinese Mental Health Journal, 14*(3), 149–152. Studied the application of the TOVA in children with attention deficit hyperactivity disorder (ADHD) in China. 56 children with ADHD (aged 8-13 years) (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) of 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 assessing its internal consistency 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 aetopathogenesis 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-CTP), 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-CTP 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-CTP 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.

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 sign that adverse affect in individual 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 person's 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). Com mision errors, 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
Manor, I., Meidad, S., Zalsman, G., Zemishlany, Z., Tyano, S., & Weizman, A. (2011). When Does It End? 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.


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 ± 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 adults 55 years or older, diagnosed with ADHD for the first time. Attention-deficit/hyperactivity disorder characteristics seemed to persevere; middle aged or older ADHD patients had similar clinical-demographic characteristics and a similar response to MPH as younger adults. No significant adverse effects were noted.


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

ABSTRACT: One particular candidate gene, the dopamine D4 receptor (DRD4), has been the focus of intense study regarding ADHD since the original investigation by La Hoste et al, an observation confirmed by a recent metaanalysis. However, two previous studies from Israel failed to observe this association. We have now recruited an additional sample and, overall, in the combined sample of 178 triads we observe using the transmission disequilibrium test, preferential transmission of the short allele. Additionally, we now report the effect of the DRD4 repeat region on the Test of Variables of Attention (TOVA), a widely used computerized continuous performance test. Probands with the short exon III repeat performed significantly worse on the TOVA measured both by errors of commission and response time variable. Intriguingly, a 'dose effect' was observed. Increasing repeat size is accompanied by a reduced number of errors of commission and a significant difference is observed between the 2 vs 7 repeats. On the whole, our results lend credence to the notion that the relationship between the DRD4 receptor and ADHD is complex and may be reflecting linkage disequilibrium between the 7 or long DRD4 exon III repeats and a ‘true’ risk allele in this gene or a neighboring locus.


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). Similar 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.
(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.


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.

Mleko, A. L., Mahrou, M. L., Espe-Pfeifer, P., Escalona, A. M., Greene, L., Devearju-Backhaus, S., & Golden, C. (2000). Relationship between (PIC) constructs and the (TOVA). Archives of Clinical Neuropsychology, 15(8), 786. 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 change (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, < .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 years) 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.


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.


OBJECTIVE: To assess effects of OROS methylphenidate on cognitive and academic tasks in 9 to 12 year olds with attention-deficit/hyperactivity disorder (ADHD). METHODS: A double-blind, within-subject, crossover design was used to compare OROS methylphenidate with placebo in a laboratory classroom setting on several cognitive and academic tasks for 68 children who met randomization criteria. RESULTS: Performance on the following measures was significantly better when children received individually optimized OROS methylphenidate than placebo: math fluency and accuracy measured by the Permanent Product Math Test, ADHD symptoms observed in the laboratory setting, computerized indices of attention and impulsivity as measured by the Test of Variables of Attention (TOVA), and visual-spatial working memory (Finger Windows Backwards). Study medication was well tolerated; adverse events were generally consistent with previous reports. CONCLUSIONS: OROS methylphenidate improves performance on measures of attention and vigilance, behavior, and working memory in a laboratory school setting in 9 to 12 year olds with ADHD.


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 outpatients' 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-bp 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 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 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.


We investigated the association of three single nucleotide polymorphisms (SNP) of the norepinephrine transporter (NET) gene SLC6A2, T-182C (rs2242446), A-3081T (rs28386840), and G-1287A (rs5569) with the prevalence of attention-deficit/hyperactivity disorder (ADHD), its clinical severity, and other disease-related characteristics in a Korean population. The genotype, allele frequency and haplotype of 103 ADHD patients and 173 controls were analyzed for these three SNPs. All participants completed the Korean version of the ADHD Rating Scale (K-ARS). The ADHD group also completed the Korean Educational Development Institute–Wechsler Intelligence Scale for Children (KED-WISC) and the Continuous Performance Test (CPT) in a drug-naïve state. The logistic regression analysis revealed no significant differences in the genotype distribution or allele frequencies of each SNP between the ADHD group and the control. In the haplotype analysis, the most common T-A-G haplotype was related to an increased risk of ADHD in females (P = 0.002). There was no statistical significance between clinical features of ADHD and any specific allele of each SNP after multiple test correction except lower omission error in non-A girl carriers (GG type) of G-1287A (carrier 76.75 ± 18.74, non-carrier 55.00 ± 9.26, t = 3.026, P = 0.007, Bonferroni-corrected P = 0.042). Some values related A-3081 and G-1287A showed a trend approaching the significance level when analyzed separately by gender. Even though it was not statistically meaningful after multiple test correction, G allele might have some protective effect against development of ADHD symptoms and this finding was consistent with previous studies.

Oral, E., Canpolat, S., Yildirim, S., Gulec, M., Aliyev, E., & Aydin, N. (2012). Cognitive functions and serum levels of brain-derived neurotrophic factor in patients with major depressive disorder. *Brain Research Bulletin, 88*(5), 454–459. 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 between cognitive performances and BDNF levels except in the TMT, Part B. 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 Variables T.O.V.A. (scores in the experimental group were lower on 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 years) and 24 undergraduates without ADHD (mean age 19.42 years) 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.


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 endophenocogntype 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 Mirsky 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-Though 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.

This study tested 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 - 3rd Edition (WISC–III),
Raven Progressive Matrices, Wechsler Individual Achievement Test (WIAT), Child Behavior Checklist and Profiles (CBCL-P), the computerized performance Test of Variables of Attention (T.O.V.A), 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.


Objective: There is a lack of evidence-based diagnostic paradigms and personalized interventions for preschoolers with ADHD. This study aimed to evaluate the performance of preschoolers diagnosed with ADHD on a continuous performance test (CPT) before and after a single methylphenidate (MPH) challenge. Method: The Test of Variables of Attention (TOVA)—a CPT—was administered to 61 preschoolers (5.64 ± 0.69 years; 74% boys) with ADHD before an oral MPH dose of 0.3 or 0.5 mg/kg. Base TOVA performance was compared with post-MPH TOVA performance. Results: A high rate of omission errors and several significant correlations between TOVA values and CRS scores were found at baseline. A single MPH administration improved TOVA performance significantly and was well tolerated. Conclusion: TOVA assessment may assist in the evaluation of the effect of MPH in preschoolers with ADHD and may help in planning interventions for them.


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.
Poettker, J. A., Othmer, S. F., Othmer, S., & Pollak, Y. (2004). Assessment of Communication Improvement after Neurofeedback Therapy [PowerPoint Slides]. Undergraduate Research, Scholarship, Creative Activity Awards at Eastern Illinois University, Illinois. Electroencephalogram (EEG) neurofeedback is a new, alternative treatment option that is used to train the brain in order to regulate body functions. Brainwave patterns are monitored as neurofeedback teaches the brain to control certain frequencies of activity. There is evidence of neurofeedback's effectiveness in improving symptoms associated with attention deficit hyperactivity disorder (ADHD), learning disability (LD), and auditory memory functioning. Researchers are beginning to test neurofeedback for the treatment of other cognitive problems.

Pollak, Y., Shomaly, H. B., Weiss, P. L., Rizzo, A. A. & Gross-Tsur, V. (2010). Methylphenidate Effect in Children with ADHD Can Be Measured by an Ecologically Valid Continuous Performance Test Embedded in Virtual Reality. CNS Spectrum, 15(2), 125–30. Background: Continuous performance tasks (CPTs) embedded in a virtual reality (VR) classroom environment have been shown to be a sensitive and user-friendly assessment tool to detect cognitive deficits related to attention-deficit/hyperactivity disorder (ADHD). The aim of the current study was to compare the performance of children with ADHD on a VR-CPT while on and off treatment with methylphenidate (MPH) and to compare the VR-CPT to a currently used CPT, Test of Variables of Attention (TOVA). Methods: Twenty-seven children with ADHD underwent the VR-CPT, the same CPT without VR (no VR-CPT), and the TOVA, 1 hour after the ingestion of either placebo or 0.3 mg/kg MPH, in a double-blind, placebo-controlled, crossover design. Immediately following CPT, subjects described their subjective experiences on the Short Feedback Questionnaire. Results: MPH reduced omission errors to a greater extent on the VR-CPT compared to the no VR-CPT and the TOVA, and decreased other CPT measures on all types of CPT to a similar degree. Children rated the VR-CPT as more enjoyable compared to the other types of CPT. Conclusions: It is concluded that the VR-CPT is a sensitive and user-friendly assessment tool in measuring the response to MPH in children with ADHD.

Pollak, Y., Weiss, P. L., Rizzo, A. A., Weizer, M., Shriki, L., Shaley, R.S., & Gross-Tsur, V. (2009). The Utility of a Continuous Performance Test Embedded in Virtual Reality in Measuring the Effectiveness of MPH Treatment in Boys with ADHD. Journal of Developmental & Behavioral Pediatrics, 30(1), 2-6. BACKGROUND: Continuous performance tasks (CPT) are popular in the diagnostic process of attention deficit hyperactivity disorder (ADHD), providing an objective measure of attention for a disorder with otherwise subjective criteria. AIMS: The study aimed to: 1) examine whether the VR-CPT is sensitive to methylphenidate (MPH); 2) assess how the virtual reality (VR) environment is experienced. METHODS: Twenty boys, 9-17 years, with ADHD underwent 3 CPTs: VR-CPT, the same CPT without VR (no VR-CPT), and the Test of Variables of Attention (T.O.V.A.). Subsequently, those with ADHD repeated the tests 1 hour following MPH ingestion. Immediately following the CPT, the subjects described their subjective experiences on the Short Feedback Questionnaire. Results were analyzed using ANOVA with repeated measures. RESULTS: MPH reduced the omission and commission errors on all tests to a similar degree. Subjective feelings of enjoyment were most positive for VR-CPT. CONCLUSION: The VR-CPT is a sensitive and user-friendly assessment tool for evaluating the effectiveness of MPH treatment in boys with ADHD.

Putman, J. A., Othmer, S. F., Othmer, S., & Pollack, V. E. (2005). TOVA Results Following Inter-Hemispheric Bipolar EEG Training. Journal of Neurotherapy, 9(1), 37-52. 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.

Ramirez, J. R. (1997). Attentional deficits in youth boxing: Effects of repeated mild closed head injuries (Doctoral Dissertation). University of Massachusetts Amherst, Massachusetts. 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 reaction 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.

Reinecke, M. A., Beebe, D. W., & Stein, M. A. (1999). The third factor of the WISC-III: It's (probably) not freedom from distractibility. *Journal of the American Academy of Child & Adolescent Psychiatry, 38*(3), 322-328. 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.

Romans, S. M., Roeltgen, D. P., Kushner, H., & Ross, J. L. (1997). Executive function in girls with turner’s syndrome. *Developmental neuropsychology, 13*(1), 23-40. Investigated executive function and attention abilities in 105 girls with Turner’s syndrome ([TS] aged 7-16.9 years) 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.

Rosengren, K. S. (2005). Performance of intellectually gifted children on three measures of attention deficit hyperactivity disorder. Dissertation Abstracts International: Section B: The Sciences and Engineering, 65 (12-B), 6672. 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.

Rossiter, T. (2004). The effectiveness of neurofeedback and stimulant drugs in treating AD/HD: Part II. replication. Applied Psychophysiology & Biofeedback, 29(4), 233-243. 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 ADHD 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.

Rossiter, T. (2002). Neurofeedback for AD/HD: A ratio feedback case study and tutorial. Journal of Neurotherapy, 6(3), 9-35. 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 < \(\alpha\) = 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

Cognitive and motor processes are essential for optimal athletic performance. Individuals trained in different skills and sports may have specialized cognitive abilities and motor strategies related to the characteristics of the activity and the effects of training and expertise. Most studies have investigated differences in motor-related cortical potential (MRCP) during self-paced tasks in athletes but not in stimulus-related tasks. The aim of the present study was to identify the differences in performance and MRCP between skilled and novice martial arts athletes during two different types of tasks: a sustained attention task and a transient attention task. Behavioral and electrophysiological data from twenty-two martial arts athletes were obtained while they performed a continuous performance task (CPT) to measure sustained attention and a cued continuous performance task (c-CPT) to measure transient attention. MRCP components were analyzed and compared between groups. Electrophysiological data in the CPT task indicated larger prefrontal positive activity and greater posterior negativity distribution prior to a motor response in the skilled athletes, while novices showed a significantly larger response-related P3 after a motor response in centro-parietal areas. A different effect occurred in the c-CPT task in which the novice athletes showed strong prefrontal positive activity before a motor response and a large response-related P3, while in skilled athletes, the prefrontal activity was absent. We propose that during the CPT, skilled athletes were able to allocate two different but related processes simultaneously according to CPT demand, which requires controlled attention and controlled motor responses. On the other hand, in the c-CPT, skilled
Schatz, A. M., Ballantyne, A. O., & Trauner, D. A. (2001). Sensitivity and Specificity of a Computerized Test of Attention in the Diagnosis of Attention-Deficit/Hyperactivity Disorder. *Assessment, 8*(4), 357-365. 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.

Schatz, A. M., Weimer, A. K., & Trauner, D. A. (2002). Brief Report: Attention Differences in Asperger Syndrome. *Journal of Autism and Developmental Disorders, 32*(4), 333-336. 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 years) 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.

Schuerholz, L. J., Singer, H. S., & Denckla, M. B. (1998). Gender study of neuropsychological and neuromotor function in children with Tourette syndrome with and without attention-deficit hyperactivity disorder. *Journal of child neurology, 13*(6), 277-282. 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 Automated 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.

Scott, W. C., Kaiser, D., Othmer, S., & Sideroff, S. I. (2005). Effects of an EEG biofeedback protocol on a mixed substance abusing population. *American Journal of Drug & Alcohol Abuse, 31*(3), 455-469. 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.

Shaffer, R. J., Jakokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Stemmer, P. J., Jr. (2001). Effect of interactive METRONOME training on children with ADHD. American Journal of Occupational Therapy, 55(2), 155-166. 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 hours 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.

Shapiro, E., Lockman, L., Knopman, D., and Krivit, W. (1994). Characteristics of the Dementia in Late-Onset Metachromatic Leukodystrophy. Neurology, 44, 662-665. Article abstract-Patients with metachromatic leukodystrophy (MLD) of juvenile or adult onset present with behavioral abnormalities. In nine patients, diagnosed between ages 11 and 33 years, behavior and neuropsychological test results disclosed a pattern of dementia combining features associated with both frontal and white matter abnormalities. All the patients had been considered to have a psychiatric disorder prior to the diagnosis of MLD, even though none had any of the cardinal features of schizophrenia or other major psychosis. Early diagnosis of late-onset MLD is important to provide access to appropriate effective therapy.

Shapiro, E., Lipton, M., and Krivit, W. (1992). White Matter Dysfunction and Its Neuropsychological Correlates: A Longitudinal Study of a Case of Metachromatic Leukodystrophy Treated with Bone Marrow Transplant. Journal of Clinical and Experimental Neuropsychology, 14(4), 610–24. doi:10.1080/01688639208402848. A 10-year-old white female who had received a bone marrow transplant (BMT) at 57 months of age as treatment for late infantile onset metachromatic leukodystrophy (MLD), a neurodegenerative autosomal recessive storage disease, showed stabilization of the cognitive degenerative process and demonstrated a partial pattern of cognitive deficits and behavioral abnormalities that has been called NLD (nonverbal learning disabilities) associated with white matter disease. A pattern of good rote memory, reading skills, and concrete language contrasted with poor visual spatial skills, mathematics, and abstract problem solving. She did not show the usual speech prosody and social deficits associated with NLD.

Shucard, D., Benedict, R., Tekok-Klic, A., & Lichter, D. (1997). Slowed Reaction Time during a Continuous Performance Test in Children with Tourette’s Syndrome. Neuropsychology, 11(1), 147–155. The phenomenology of Tourette’s syndrome (TS) not only includes tics but also apparent deficits in attention. These attentional deficits in TS likely involve anomalies in frontal-striatal circuits. In this study, performance of 22 boys with TS and 22 age-matched boys without TS was compared on a continuous performance test (CPT) of attention. TS children demonstrated a normal capacity for discriminating targets from nontargets during the task, but showed significantly slower reaction times than controls. Severity of complex vocal tics was predictive of reaction time performance. Possible explanations for these findings are discussed and include the presence of attentional difficulties in TS, interference associated with tic suppression, a conservative strategy taken by TS children, and a general impairment of motor performance.

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).


Although the development of Attention Deficit Hyperactivity Disorder (ADHD) after traumatic brain injury (TBI) has been described, it is unknown whether children with TBI and ADHD have greater neuropsychological impairments than children with TBI alone. This study examines attention, executive functioning, and memory in children with TBI-only and TBI + ADHD. Caregivers of 82 children with severe TBI completed structured psychiatric interviews at enrollment to diagnose premorbid ADHD and one-year after injury to diagnose post-injury ADHD. Children underwent neuropsychological testing one year after injury. One memory measure significantly differentiated children with TBI-only from children with newly developed ADHD [secondary ADHD (S-ADHD)] and those with premorbid ADHD that persisted after injury [persisting ADHD (P-ADHD)]. Compared with the TBI-only group, children with TBI + ADHD had worse performance on measures of attention, executive functioning, and memory. Results reveal that in children with severe TBI, the behavioral diagnosis of ADHD is associated with more difficulty in attention, executive functioning, and memory. Additionally, results suggest greater deficits in memory skills in the S-ADHD group compared with the P-ADHD group. Although findings provide preliminary support for distinguishing P-ADHD from S-ADHD, further research is needed to investigate neuropsychological differences between these subgroups of children with severe TBI.


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

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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, pre-vs. 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.

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OBJECTIVE: To evaluate the short-term efficacy and side effects associated with two methylphenidate hydrochloride (MPH) dosing patterns. METHODS: Twenty-five boys with attention deficit hyperactivity disorder (ADHD) participated in a 5-week, triple-blind, placebo-controlled, crossover evaluation of MPH administered twice (b.i.d.) versus thrice (t.i.d.) per day (mean dose = 8.8 +/- 5 mg, .30 +/- .1 mg/kg/dose). Four dosing conditions (placebo, titration [gradual increase to target dose], b.i.d., and t.i.d.) were used. Dependent measures obtained on a weekly basis included: parent and teacher ratings of child behavior, parent-child conflicts, parent report of stimulant side effects, child self-report of mood symptoms, a sleep log, laboratory measures of attention, and actigraphic recording of sleep activity. RESULTS: All dosing conditions resulted in significant effects on ADHD symptoms when compared with baseline. Relative to placebo, t.i.d. dosing was characterized by improvement on the greatest number of behavioral measures, and both b.i.d. and t.i.d. were generally more effective than titration. Direct comparisons of b.i.d. and t.i.d. dosing revealed that t.i.d. was associated with greater improvement on the Conners Parent Rating Scale Impulsivity/Hyperactivity factor, with a similarly marginally significant effect for the ADD-H Teacher Rating Scale Hyperactivity factor. The analysis of clinically significant change favored a three-times-a-day dosing schedule over placebo on both parent and teacher ratings of impulsivity/hyperactivity and attention. Compared with placebo, appetite suppression was rated, on average, as more severe in the t.i.d. and titration conditions, but not in the b.i.d. condition. However, the number of subjects who exhibited any or severe appetite suppression did not differ significantly between the b.i.d. and t.i.d. schedules. Although there was no difference in sleep duration for children on b.i.d. and t.i.d. schedules, total sleep time appeared to decrease slightly on t.i.d. relative to placebo according to both parent ratings and actigraphic assessment. There were no significant differences between b.i.d. and t.i.d. on any other side effects or sleep variables. CONCLUSIONS: For many children with ADHD, t.i.d. dosing may be optimal. There are few differences in acute side effects between b.i.d. and t.i.d. MPH dosing. The dosing schedule should be selected according to the severity and time course of ADHD symptoms rather than in anticipation of dosing schedule-related side effects.

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 seven 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 ADHD/PI 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 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.

Sun, H., Sourina, O., Yang, Y., Huang, G.-B., Denk, C., & Klanner, F. (2014). Machine Learning Reveals Different Brain Activities in Visual Pathway during TOVA Test. In J. Cao, K. Mao, E. Cambria, Z. Man, & K.-A. Toh (Eds.) (pp. 245–262). Presented at the International Conference on Extreme Learning Machine 2014, Singapore. 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 = 0.005 < 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.


Postconcussion syndrome (PCS) has been used to describe a range of residual symptoms that persist 12 months or more after the injury, often despite a lack of evidence of brain abnormalities on magnetic resonance imaging and computed tomography scans. In this clinical case series, the efficacy of quantitative EEG-guided neurofeedback in 40 subjects diagnosed with PCS was investigated. Overall improvement was seen in all the primary (Symptom Assessment-45 Questionnaire, Clinical Global Impressions Scale, Hamilton Depression Scale) and secondary measures (Minnesota Multiphasic Personality Inventory, Test of Variables for Attention). The Neuroguide Traumatic Brain Index for the group also showed a decrease. Thirty-nine subjects were followed up long term with an average follow-up length of 3.1 years (CI = 2.7-3.3). All but 2 subjects were stable and were off medication. Overall neurofeedback treatment was shown to be effective in this group of subjects studied.

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.


According to DSM-IV, personality disorder constitutes a class only when personality traits are inflexible and maladaptive and cause either significant functional impairment or subjective distress. Classical treatment of choice for personality disorders has been psychotherapy and/or psychopharmacotherapy. Our study is to determine if subjects with antisocial personality disorders will benefit from quantitative EEG (qEEG) guided neurofeedback treatment. Thirteen subjects (9 male, 4 female) ranged in age from 19 to 48 years. All the subjects were free of medications and illicit drugs. We excluded subjects with other mental disorders by clinical assessment. Psychotherapy or psychopharmacotherapy or any other treatment model was not introduced to any of the subjects during or after neurofeedback treatment. For the subject who did not respond to neurofeedback, training was applied with 38 sessions of LORETA neurofeedback training without success. Evaluation measures included qEEG analysis with Nx Link data base, MMPI, T.O.V.A tests and SA-45 questionaries at baseline, and at the end of neurofeedback treatment. Lexicor qEEG signals were sampled at 128 Hz with 30 minutes-neurofeedback sessions completed between 80-120 sessions depending on the case, by Biolex neurofeedback system. At baseline and after every 20 sessions, patients were recorded with webcam during the interview. Twelve out of 13 subjects who received 80-120 sessions of neurofeedback training showed significant improvement based on SA-45 questionaries, MMPI, T.O.V.A. and qEEG/Nx Link data base (Neurometric analysis) results, and interviewing by parent/family members. Neurofeedback can change the view of psychiatrists and psychologists in the future regarding the treatment of personality disorders. This study provides the first evidence for positive effects of neurofeedback treatment in antisocial personality disorders. Further study with controls is warranted.

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 Behavior 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.


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 psychophysiologic 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.

This paper summarizes data from a review of neurofeedback (NFB) training with 150 clients with Asperger’s Syndrome (AS) and 9 clients with Autistic Spectrum Disorder (ASD) seen over a 15 year period (1993-2008) in a clinical setting. The main objective was to investigate whether electroencephalographic (EEG) biofeedback, also
called neurofeedback (NFB), made a significant difference in clients diagnosed with AS. An earlier paper (Thompson et al. 2009) reviews the symptoms of AS, highlights research findings and theories concerning this disorder, discusses QEEG patterns in AS (both single and 19-channel), and details a hypothesis, based on functional neuroanatomy, concerning how NFB, often paired with biofeedback (BFB), might produce a change in symptoms. A further aim of the current report is to provide practitioners with a detailed description of the method used to address some of the key symptoms of AS in order to encourage further research and clinical work to refine the use of NFB plus BFB in the treatment of AS. All charts were included for review where there was a diagnosis of AS or ASD and pre- and post-training testing results were available for one or more of the standardized tests used. Clients received 40-60 sessions of NFB, which was combined with training in metacognitive strategies and, for most older adolescent and adult clients, with BFB of respiration, electrodermal response, and, more recently, heart rate variability. For the majority of clients, feedback was contingent on decreasing slow wave activity (usually 3–7 Hz), decreasing beta spindling if it was present (usually between 23 and 35 Hz), and increasing fast wave activity termed sensorimotor rhythm (SMR) (12-15 or 13-15 Hz depending on assessment findings). The most common initial montage was referential placement at the vertex (CZ) for children and at FCz (midway between FZ and CZ) for adults, referenced to the right ear. Metacognitive strategies relevant to social understanding, spatial reasoning, reading comprehension, and math were taught when the feedback indicated that the client was relaxed, calm, and focused. Significant improvements were found on measures of attention (T.O.V.A. and IVA), core symptoms (Australian Scale for Asperger’s Syndrome, Conners’ Global Index, SNAP version of the DSM-IV criteria for ADHD, and the ADD-Q), achievement (Wide Range Achievement Test), and intelligence (Wechsler Intelligence Scales). The average gain for the Full Scale IQ score was 9 points. A decrease in relevant EEG ratios was also observed. The ratios measured were (4-8 Hz)/(13-21 Hz)(2), (4-8 Hz)/(16-20 Hz), and (3-7 Hz)/(12-15 Hz). The positive outcomes of decreased symptoms of Asperger’s & ADHD (including a decrease in difficulties with attention, anxiety, aprosodias, & social functioning) plus improved academic and intellectual functioning, provide preliminary support for the use of neurofeedback as a helpful component of effective intervention in people with AS.

Thompson, M., Thompson, L., & Reid-Chung, A. (2015). Treating Postconcussion Syndrome with LORETA Z-Score Neurofeedback and Heart Rate Variability Biofeedback: Neuroanatomical/Neurophysiological Rationale, Methods, and Case Examples. Biofeedback (Online), 43(1), 15-26. 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.

Thorpe, T. (1997). EEG biofeedback training in a clinical sample of school age children treated for attention deficit hyperactivity disorder (neurofeedback). Dissertation Abstracts International: Section B: The Sciences and Engineering, 58(3-B), 1550. 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, aged 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 disorders. 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.


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 gymasia 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.


Background: All fish contain methyl mercury (MeHg), a known neurotoxicant at adequate dosage. There is still substantial scientific uncertainty about the consequences, if any, of mothers consuming fish with naturally-acquired levels of MeHg contamination. In 1989-1990, we recruited the Main Cohort of the Seychelles Child Development Study to assess the potential developmental effects of prenatal MeHg exposure. We report here on associations with neurodevelopmental outcomes obtained at 22 and 24 years of age. Methods: Neurodevelopmental tests at 22 years included the Boston Naming Test, Cambridge Neuropsychological Test Automated Battery (CANTAB), and the Profile of Mood States. At 24 years, we administered the Stroop Word-Color Test, the Barkley Adult ADHD Rating Scale, the Test of Variables of Attention, and the Finger Tapping test. We also administered a healthy behaviors survey at both ages. Primary analyses examined covariate-adjusted associations in multiple linear regression models with prenatal MeHg exposure. In secondary analyses we also examined associations with recent postnatal MeHg exposure. Results: We did not observe adverse associations between
pre-natal MeHg exposure and any of the measured endpoints. Some measures of attention, executive function, and delayed recall showed improved performance with increasing exposure. Secondary analysis did not show consistent patterns of association with postnatal exposure. Conclusions: Our cohort has been examined at ten different ages over 24 years of follow-up. Findings suggest that prenatal and recent postnatal MeHg exposure from ocean fish consumption is not adversely associated with neurobehavioral development at levels that are about ten times higher than typical U.S. exposures.

Vaurio, Linnea, Edward P. Riley, and Sarah N. Mattson. (2011). Neuropsychological Comparison of Children with Heavy Prenatal Alcohol Exposure and an IQ-Matched Comparison Group. *Journal of Neuropsychiatry and Clinical Neuroscience, 23*(2), 169-176. An objective in current research on children with fetal alcohol spectrum disorders (FASD) is to determine neurobehavioral profiles to identify affected individuals. Deficits observed when children with FASD are compared to typically developing controls may be confounded by lower IQ scores in the subjects with FASD. To determine if prenatal alcohol exposure is associated with neurobehavioral deficits after controlling for IQ differences, multivariate analyses were conducted to compare alcohol-exposed (ALC) subjects to a comparison group closely matched on IQ (IQc). The initial analysis included a broad neuropsychological battery with measures of language, executive function, visual–motor integration, motor ability, and academic achievement. Additional, in depth comparisons focused on visual sustained attention, verbal learning and memory and parent/guardian-reported behavior problems. Group differences (ALC < IQc) were found on verbal learning and parent-rated behavior problems. Group differences were marginally significant (measures within the broad neuropsychological comparison) or not significant (visual attention, retention of verbal material) on the remaining comparisons. Therefore, some deficits (e.g., verbal learning and behavior problems) in children with heavy prenatal alcohol exposure cannot be explained by the lower FSIQ observed in the population. These areas of relative weakness could be useful in distinguishing children with FASD from other children with lowered IQ.

Vermilion, K., Peterson, J., & Duane, D. (2002). Cognition and affect in patients with cervical dystonia without tremor. In *Movement Disorders*, 17, S281–S281. 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+] 71%, mean age at evaluation 58 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 (ROCF), 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 (ROCF) 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.

Voigt, R. G., Llorente, A. M., Jensen, C. L., Fraley, J. K., Berretta, M. C., & Heird, W. C. (2001). A Randomized, Double-Blind, Placebo-Controlled Trial of Docosahexaenoic Acid Supplementation in Children with Attention-Deficit/Hyperactivity Disorder. *The Journal of Pediatrics, 139*(2), 189-196. 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<0.001). 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 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 follow-up. 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.
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.


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 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.

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.

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 = -.4676, p < .05), TOVA Response Time (r = -.6208, p < .01), and TOVA Variability (r = -.5017, p < .05). For the on-MPH group, Delta (r = -.5087, p < .05), and Theta (r = -.5408, p < .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
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, Agler, M-Flynn, and Pelham Scale). Conclusion: In children with ADHD with or without comorbid LD, behavior and performance improved during treatment with OROS methylphenidate.

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 (i.e., within 7 days of injury) and at 3 months postinjury. Parents rated PCS, motivation and affective lability, and behavioral adjustment. Baseline ratings assessed premorbid function 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.


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.


Studied the application of the TOVA in children with attention deficit hyperactivity disorder (ADHD) in China. 56 children with ADHD (aged 8-13 years) (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 years) 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 specificity 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: 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 (i.e., within 7 days of injury) and at 3 months postinjury. Parents rated PCS, motivation and affective lability, and behavioral adjustment. Baseline ratings assessed premorbid function 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.
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. Future research directions will also be discussed.


Objective: Psychostimulants have been found to be beneficial in treating 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) based on the Alertness, Cognitive Response Speed, and Cognitive Symptoms subscales of the T.O.V.A. was administered at baseline and at subsequent follow-up periods. 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 and little symptom report and CPT performances significantly improve with Provigil. The implications of this case study, and future research directions will be discussed.


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.

Zalsman, G., Pumeranz, O., Peretz, G., Ben-Dor, D. H., Dekel, S., Horesh, N., ... & Apter, A. (2003). Attention Patterns in Children with Attention Deficit Disorder with or without Hyperactivity. The Scientific World Journal, 3, 1093-1107. 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.

Zhang, S., Wang, D., Afzal, N., Zhang, Y., & Wu, R. (2016). Rhythmic Haptic Stimuli Improve Short-term Attention. IEEE Transactions on Haptics, 99. 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.