T.O.V.A. Bibliography — Journal Articles

Abdel Kader, A., Mohamed, N., El Sayed, B., Amin, O., & Halawa, I. (2016). Continuous Performance Task in Attention Deficit Hyperactivity Disorder Children. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery, 53*(1), 19–22.
Background: Poor behavioral 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, Conners' parent rating scale and Wechsler 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 the 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.

Accornero, V. H., Amado, A. J., Morrow, C. E., Xue, L., Anthony, J. C., & Bandstra, E. S. (2007). Impact of prenatal cocaine exposure on attention and response inhibition as assessed by continuous performance tests. *Journal of Developmental and Behavioral Pediatrics: JDBP*, *28*(3), 195–205.
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.

Agay, N., Yechiam, E., Carmel, Z., & Levkovitz, Y. (2010). Non-Specific Effects of Methylphenidate (Ritalin) on Cognitive Ability and Decision-Making of ADHD and Healthy Adults. *Psychopharmacology* 210, 4, 511–19.
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.

Agay, N., Yechiam, E., Carmel, Z., & Levkovitz, Y. (2014). Methylphenidate Enhances Cognitive Performance in Adults with Poor Baseline Capacities Regardless of Attention-Deficit/Hyperactivity Disorder Diagnosis. *Journal of Clinical Psychopharmacology*, *34*(2), 261–265.

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

Aggarwal, A., & Lillystone, D. (2000). A follow-up pilot study of objective measures in children with attention deficit hyperactivity disorder. *Journal of Paediatrics and Child Health*, *36*(2), 134–138.
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.

Ahmed, A., Shapiro, E., Rudser, K., Kunin-Batson, A., King, K., & Whitley, C. B. (2016). Association of somatic burden of disease with age and neuropsychological measures in attenuated mucopolysaccharidosis types I, II and VI. *Molecular Genetics and Metabolism Reports*, *7*, 27–31.
Introduction: The mucopolysaccharidoses (MPSs) are a group of rare genetic lysosomal disorders with progressive multisystem involvement. An MPS-specific physical symptom scale was developed and introduced a Physical Symptom Score (PSS) to quantify the somatic disease burden across MPS I, II and VI. Hypothesis: Somatic burden of disease in patients with attenuated MPS I, II and VI as measured by the PSS will be positively associated with age and negatively associated with neuropsychological functions [i.e. full scale intelligence quotient (FSIQ) and attention]. Materials and methods: Forty-eight patients with attenuated MPS I (n = 24), II (n = 14), and VI (n = 10) aged 6 to 32 years on enzyme replacement therapy who were enrolled in “Longitudinal Studies of Brain Structure and Functions in MPS Disorders” across seven centers. Somatic disease burden was measured by the PSS. Neuropsychological functions were measured by the Wechsler Abbreviated Scale of Intelligence (WASI) and Test of Variables of Attention (TOVA). Results: PSS was positively associated with age in attenuated MPS I (P b 0.001), MPS II (P b 0.01) and MPS VI (P b 0.05). There was a negative association of PSS with FSIQ in attenuated MPS I (P b 0.001) and in MPS VI (P b 0.001) but not with MPS II. Although attention scores were below average in all groups, a significant negative association between PSS and one measure of sustained attention (TOVA d prime) was found only in MPS VI. Conclusions: Physical Symptom Score increased with age in attenuated MPS I, II and VI, reflecting progressive somatic burden of disease despite treatment with enzyme replacement therapy. Furthermore, the association of increased somatic disease burden with decreased neurocognitive ability suggests that both measures reflect disease severity and are not independent.

Aijaz, N. J., Flaherty, E. M., Preston, T., Bracken, S. S., Lane, A. H., & Wilson, T. A. (2006). Neurocognitive function in children with compensated hypothyroidism: lack of short term effects on or off thyroxin. *BMC Endocrine Disorders*, *6*, 2.

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.

Alhambra, M., Fowler, T. P., & Alhambra, A. (1995). EEG Biofeedback: A New Treatment Option For ADD/ADHD. *Journal of Neurotherapy*, *1*(2), 39–43.

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.

Allison, C. L., Gabriel, H., Schlange, D., & Fredrickson, S. (2007). An optometric approach to patients with sensory integration dysfunction. *Optometry (St.Louis, Mo.)*, *78*(12), 644–651.

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.

Anckarsäter, H., Hofvander, B., Billstedt, E., Gillberg, I. C., Gillberg, C., Wentz, E., & Råstam, M. (2012). The sociocommunicative deficit subgroup in anorexia nervosa: autism spectrum disorders and neurocognition in a community-based, longitudinal study. *Psychological Medicine*, *42*(09), 1957–1967.

Background. A subgroup of persons with anorexia nervosa (AN) have been proposed to have sociocommunicative problems corresponding to autism spectrum disorders [ASDs, i.e. DSM-IV pervasive developmental disorders (PDDs): autistic disorder, Asperger's disorder, PDD not otherwise specified (NOS)]. Here, clinical problems, personality traits, cognitive test results and outcome are compared across 16 subjects (32%) with teenage-onset AN who meet or have met ASD criteria (AN+ASD), 34 ASD-negative AN subjects and matched controls from a longitudinal Swedish study including four waves of independent assessments from the teens to the early thirties.

Method. The fourth wave included the Structured Clinical Interview for DSM-IV (SCID)-I and the SCID-II (cluster C, i.e. 'anxious' PDs) interviews, the Asperger Syndrome Diagnostic Interview, self-assessments by the Autism Spectrum Quotient and the Temperament and Character Inventory, neurocognitive tests by subscales from the Wechsler scales, continuous performance tests, Tower of London, and Happe's cartoons. Results. The ASD assessments had substantial inter-rater reliability over time (Cohen's k between 0.70 and 0.80 with previous assessments), even if only six subjects had been assigned a diagnosis of an ASD in all four waves of the study, including retrospective assessments of pre-AN neurodevelopmental problems. The AN+ASD group had the highest prevalence of personality disorders and the lowest Morgan–Russell scores. The non-ASD AN group also differed significantly from controls on personality traits related to poor interpersonal functioning and on neurocognitive tests. Conclusions. A subgroup of subjects with AN meet criteria for ASDs. They may represent the extreme of neurocognitive and personality problems to be found more generally in AN.

Anguera, J. A., Boccanfuso, J., Rintoul, J. L., Al-Hashimi, O., Faraji, F., Janowich, J., … Gazzaley, A. (2013). Video game training enhances cognitive control in older adults. *Nature, 501*(7465), 97–101.

Cognitive control is defined by a set of neural processes that allow us to interact with our complex environment in a goal-directed manner. Humans regularly challenge these control processes when attempting to simultaneously accomplish multiple goals (i.e., multitasking), generating interference as the result of fundamental information processing limitations. It is clear that multitasking behavior has become ubiquitous in today's technologically-dense world, and substantial evidence has accrued regarding multitasking difficulties and cognitive control deficits in our aging population. Here we show that multitasking performance, as assessed with a custom-designed 3-D video game (NeuroRacer), exhibits a linear age-related decline from 20–79 years of age. By playing an adaptive version of NeuroRacer in multitasking training mode, older adults (60–85 y.o.) reduced multitasking costs compared to both an active control group and a no-contact control group, attaining levels beyond that of untrained 20 year olds, with gains persisting for six months. Furthermore, age-related deficits in neural signatures of cognitive control, as measured with electroencephalography, were remediated by multitasking training (i.e., enhanced midline frontal theta power and frontal-posterior theta coherence). Critically, this training resulted in performance benefits that extended to untrained cognitive control abilities (i.e., enhanced sustained attention and working memory), with an increase in midline frontal theta power predicting the training-induced boost in sustained attention and preservation of multitasking improvement six months later. These findings highlight the robust plasticity of the prefrontal cognitive control system in the aging brain, and provide the first evidence of how a custom designed video game can be used to assess cognitive abilities across the lifespan, evaluate underlying neural mechanisms and serve as a powerful tool for cognitive enhancement.

Anguera, J. A., Gunning, F. M., & Areán, P. A. (2017). Improving late life depression and cognitive control through the use of therapeutic video game technology: A proof-of-concept randomized trial. *Depression and Anxiety, 34*(6), 508–517.

Background—Existing treatments for depression are known to have only modest effects, are insufficiently targeted, and are inconsistently utilized, particularly in older adults. Indeed, older adults with impaired cognitive control networks tend to demonstrate poor response to a majority of existing depression interventions. Cognitive control interventions delivered using entertainment software have the potential to not only target the underlying cerebral dysfunction associated with depression, but to do so in a manner that is engaging and engenders adherence to treatment protocol. Methods—In this proof-of-concept trial (Clinicaltrials.gov #: NCT02229188), individuals with late life depression (LLD) (22; 60+ years old) were randomized to either problem solving therapy (PST, n = 10) or a neurobiologically inspired digital platform designed to enhance cognitive control faculties (Project: EVOTM, n = 12). Given the overlapping functional neuroanatomy of mood disturbances and executive dysfunction, we explored the impact of an intervention targeting cognitive control abilities, functional disability, and mood in older adults suffering from LLD, and how those outcomes compare to a therapeutic gold standard. Results—EVO participants demonstrated similar improvements in mood and self-reported function after 4 weeks of treatment to PST participants. The EVO participants also showed generalization to untrained measures of working memory and attention, as well as negativity bias, a finding not evident in the PST condition. Individuals assigned to EVO demonstrated 100% adherence. Conclusions—This study provides preliminary findings that this therapeutic video game targeting cognitive control deficits may be an efficacious LLD intervention. Future research is needed to confirm these findings.

Areces, D., Rodriguez Pérez, C., Gonzalez-Castro, P., García, T., & Cueli, M. (2017). Naming Speed and its Effect on Attentional Variables and Reading Errors Depending on the Diagnosis. Anales de Psicología, 33(2), 301–310.
Abstract: While naming speed, which is usually assessed with tests like RAN / RAS, has proven to be useful in predicting certain reading errors and attentional difficulties, the variables that predict performance in the test have not been examined yet. The objective of the present study is to test the explanatory power of certain reading and attentional variables on naming speed performance depending on the diagnosis. A sample of 132 students, divided into four groups (Control, n=34; Reading difficulties, n= 22; ADHD, n=41; and ADHD+Reading Difficulties, n=35) was used. The results show: 1) without any difficulties, naming speed is explained by IQ, age and gender; 2) in presence of reading difficulties, the variables with more explanatory power are the reading errors; 3) in presence of attentional difficulties, there are certain attentional variables like those provided by TOVA, which have shown to be more significant.

Avior, G., Fishman, G., Leor, A., Sivan, Y., Kaysar, N., & Derowe, A. (2004). The effect of tonsillectomy and adenoidectomy on inattention and impulsivity as measured by the Test of Variables of Attention (TOVA) in children with obstructive sleep apnea syndrome. *Otolaryngology–head and Neck Surgery : Official Journal of American Academy of Otolaryngology-Head and Neck Surgery*, *131*(4), 367–371.
OBJECTIVE: To evaluate children with obstructive sleep apnea syndrome (OSAS) for features of attention deficit disorder (ADD) using an objective test of inattention and impulsivity: Test of Variables of Attention (TOVA) and then to determine whether tonsillectomy and adenoidectomy (T+A) results in an improvement in TOVA scores. STUDY DESIGN AND SETTING: This study was a prospective interventional comparative trial in a tertiary care children's hospital. Nineteen children ages 5 to 14 years with OSAS, and otherwise healthy, with a clinical indication for T+A. Preoperative and 2 months postoperative OSA-18, CBCL questionnaires, and TOVA scores were evaluated. RESULTS: The preoperative TOVA scores were in the abnormal range in 12/19 (63%) of the children. The mean preoperative TOVA score was -2.9 (+/- 3.1). The mean postoperative TOVA score was -0.4 (+/-2.8). The improvement in the TOVA scores was significant (P < 0.0001, t -test). CONCLUSION: This preliminary data suggests that treatment of OSAS with T+A results in significant improvement in objective parameters of inattention and impulsivity. Significance These findings may be important in understanding the impact of OSAS and therapeutic interventions on behavioral problems in children.

Baker, L. B., Conroy, D. E., & Kenney, W. L. (2007). Dehydration impairs vigilance-related attention in male basketball players. *Medicine and Science in Sports and Exercise*, *39*(6), 976–983.
PURPOSE: To determine the effects of dehydration (DEH) on attentional vigilance in male basketball players. METHODS: The Test of Variables of Attention (TOVA; Universal Attention Disorders) was administered to 11 male basketball players (17-28 yr) at baseline (test 1), after walking (50% V O2max) in the heat (40 degrees C and 20% relative humidity) (test 2), and then after a simulated basketball game (test 3). Tests 2 and 3 were performed while subjects were either DEH (1-4%) or euhydrated (EUH). The TOVA consisted of target-infrequent and target-frequent conditions, simulating static and dynamic (such as a basketball game) environments, respectively. TOVA measures included errors of omission (OE) and commission (CE), response time (RT), and sensitivity. RESULTS: During the target-infrequent half of test 3, EUH resulted in significantly better sensitivity (+0.4+/-1.2 vs -0.9+/-1.3), faster RT (-8+/-20 vs +16+/-28), and fewer OE (-0.4+/-0.7 vs +1.3+/-2.4) compared with DEH. During the target-frequent half, EUH resulted in significantly fewer OE (-4+/-15 vs +5+/-7) and CE (-1.9+/-3.2 vs 0.6+/-1.4) in test 2 and greater sensitivity (+0.7+/-2.6 vs -0.7+/-1.1) and faster RT (-21+/-28 vs +5+/-31) than DEH in test 3. CONCLUSION: Vigilance-related attention of male basketball players was impaired by DEH, especially during the target-frequent condition of the TOVA. These results suggest that fluid replacement is essential to prevent the decline in vigilance that occurs with DEH in highly dynamic environments. Therefore, basketball players should be advised to maintain EUH for optimal concentration and attentional skills during competition.

Bandstra, E. S., Morrow, C.E., Anthony, J. C., Churchill, S. S., Chitwood, D. C., Steele, B. W., Ofir, A. Y., and Xue, L. (2001). Intrauterine Growth of Full-Term Infants: Impact of Prenatal Cocaine Exposure. *PEDIATRICS, 108*(6): 1309–19.
Objective. The objectives of this study were to estimate the effect of prenatal cocaine exposure on fetal growth and gestational age after controlling for exposure to alcohol, tobacco, and marijuana and other covariates; to evaluate whether prenatal cocaine exposure has a disproportionate adverse effect on head circumference compared with overall somatic growth; and to assess whether the effect of prenatal cocaine exposure on fetal growth is mediated

by cocaine's suspected effect on gestational age. *Methods.* The study population includes 476 neo- nates participating in the Miami Prenatal Cocaine Study, a longitudinal follow-up of in utero cocaine exposure. The sample, restricted to full-term neonates born to African-American inner-city mothers, included 253 infants exposed prenatally to cocaine (with or without alcohol, tobacco, or marijuana exposure) and 223 non–cocaine-exposed infants, of whom 147 were drug-free and 76 were exposed to varying combinations of alcohol, tobacco, or marijuana. *Results.* Evidence based on structural equations and multiple regression models supports a hypothesis of cocaine-associated fetal growth deficits (0.63 standard deviation) and an independent mild effect on gestational age (0.33 standard deviation). There was no evidence of a disproportionate adverse effect on birth head circumference once the impact on overall growth was estimated. There was evidence that some but not all of the cocaine effect on fetal growth was direct and some was indirect, acting via an intermediate influence of cocaine on gestational age. *Conclusions.* Cocaine-associated growth deficits, symmetrical and partially mediated by gestational age, were observed in this sample of inner-city African-American full-term infants prospectively enrolled at birth. Long-term implications will be the subject of future re- ports from this longitudinal investigation.

Bandstra, E. S., Morrow, C. E., Anthony, J. C., Accornero, V. H., & Fried, P. A. (2001). Longitudinal investigation of task persistence and sustained attention in children with prenatal cocaine exposure. *Neurotoxicology and Teratology*, *23*(6), 545–559.

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

Bangirana, Paul, Peter Allebeck, Michael J Boivin, Chandy C John, Connie Page, Anna Ehnvall, and Seggane Musisi. (2011). Cognition, Behaviour and Academic Skills after Cognitive Rehabilitation in Ugandan Children Surviving Severe Malaria: A Randomised Trial. *BMC Neurology*.

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.

Bangirana, P., John, C. C., Idro, R., Opoka, R. O., Byarugaba, J., Jurek, A. M., & Boivin, M. J. (2009). Socioeconomic predictors of cognition in Ugandan children: implications for community interventions (Cognition in Ugandan Children). *PloS ONE*, *4*(11), e7898.

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

Bangirana, P., Menk, J., John, C. C., Boivin, M. J., & Hodges, J. S. (2013). The Association between Cognition and Academic Performance in Ugandan Children Surviving Malaria with Neurological Involvement. *PLoS ONE*, *8*(2), e55653.

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

Bangirana, P., Musisi, S., Boivin, M. J., Ehnvall, A., John, C. C., Bergemann, T. L., & Allebeck, P. (2011). Malaria with Neurological Involvement in Ugandan Children: effect on cognitive ability, academic achievement and behaviour. *Malaria Journal*, *10*, 334.

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.

Bangirana, P., Ruel, T. D., Boivin, M. J., Pillai, S. K., Giron, L. B., Sikorskii, A., … Achan, J. (2017). Absence of neurocognitive disadvantage associated with paediatric HIV subtype A infection in children on antiretroviral therapy. Journal of the International AIDS Society, 20(2), e25015.

Introduction Infection with HIV subtype A has been associated with poorer neurocognitive outcomes compared to HIV subtype D in Ugandan children not eligible for antiretroviral therapy (ART). In this study, we sought to determine whether subtype-specific differences are also observed among children receiving ART. Materials and Methods Children were recruited from a clinical trial in which they were randomized to receive either lopinavir (LPV)- or non-nucleoside reverse transcriptase inhibitor (NNRTI)- based ART (NCT00978068). Age at initiation of ART ranged from six months to six years. HIV subtype was determined by PCR amplification and population sequencing of the pol region derived from peripheral blood mononuclear cell DNA, followed by application of the REGA and Recombinant Identification Programme algorithms. General cognition was assessed using the Kaufman Assessment Battery for Children (Second Edition), attention using the Test of Variables of Attention, and motor skills using the Bruininks-Oseretsky Test of Motor Proficiency (Second Edition). Home environment was assessed using the Home Observation for the Measurement of the Environment (HOME). Age-adjusted test z-scores were entered into a regression model that adjusted for sex, socio-economic status score, HOME score, years of schooling, and ART treatment type. Results One hundred and five children were tested; median (interquartile range) age was 7.05 years (6.30 to 8.44), CD4 count was 867.7 cells/mm3 (416.0 to 1203.5), and duration on ART was 4.03 years (3.55 to 4.23). Seventy-eight children had HIV subtype A and 27 had subtype D; the groups had comparable home and socio-economic status, except that there were more males among children infected with subtype A than D (64.7% vs. 35.3%, p = 0.02). There were no differences between the subtypes in general cognition (estimated mean difference: 0.20; 95% CI: −0.11 to 0.50); p = 0.21), attention (−0.18, 95% CI: −0.60 to 0.24, p = 0.41) and motor skills (1.60, 95% CI: −0.84 to 4.04, p = 0.20). Conclusions Our results imply that ART may diminish the neurocognitive disadvantage seen in treatment-naïve HIV-infected children with subtype A.

Bangirana, P., Sikorskii, A., Giordani, B., Nakasujja, N., & Boivin, M. J. (2015). Validation of the CogState battery for rapid neurocognitive assessment in Ugandan school age children. *Child and Adolescent Psychiatry and Mental Health, 9*, 38.

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 5-13years) were assessed using CogState, the Kaufman Assessment Battery for Children, 2nd edition (KABC-II) and the Test of Variables of Attention (TOVA) at baseline and 8-weeks later. Correlations were run between CogState and the KABC-II and TOVA to evaluate its concurrent and convergent validity. Factor analysis was used to evaluate construct validity of CogState. Correlations between baseline and 8-weeks CogState scores were used to determine the test-retest reliability while general linear models were used to assess associations with sociodemographic factors. Results Significant correlations were observed between CogState's One Card Learning, One Back Memory and Card Detection with the TOVA and between CogState's Maze Chase and One Back Memory with KABC-II's Simultaneous Processing. CogState had a three-factor structure with Processing Speed, Processing Accuracy and Maze Chase and Maze Learning. CogState had low to moderate test-retest reliability in Ugandan children with correlations ranging from 0.32 to 0.57. Age, sex and education were associated with CogState outcomes. Conclusions CogState is a valid and reliable test battery for rapid computer-based neurocognitive assessment in Ugandan children and can thus be used in this cultural context.

Berman, J., Aran, A., Berenstein-Weyel, T., & Lebel, E. (2016). Exploring the Association between Legg-Calvé-Perthes Disease and Attention Deficit Hyperactivity Disorder in Children. *IMAJ* 18.

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 (≤ -1.8) 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

Bernstein, G. A., Carroll, M. E., Crosby, R. D., Perwien, A. R., Go, F. S., & Benowitz, N. L. (1994). Caffeine effects on learning, performance, and anxiety in normal school-age children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *33*(3), 407–415.

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

Bernstein, G. A., Carroll, M. E., Dean, N. W., Crosby, R. D., Perwien, A. R., & Benowitz, N. L. (1998). Caffeine withdrawal in normal school-age children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *37*(8), 858–865.
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.

Bhandari, T., Thompson, B. C. N. Lynda, T., & Reid-Chung, A. (2013). Treating Postconcussion Syndrome Using Neurofeedback: A Case Study. *Biofeedback (Online)*, *41*(4), 174–182.
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.

Bhise, V., Burack, G., and Mandelbaum, D. (2009). Baseline Cognition, Behavior, and Motor Skills in Children with New-Onset, Idiopathic Epilepsy. *Developmental Medicine & Child Neurology, 52*(1), 22–26. doi:10.1111/j.1469-8749.2009.03404.x.
AIM: Epilepsy is associated with difficulties in cognition and behavior in children. These problems have been attributed to genetics, ongoing seizures, psychosocial issues, underlying abnormality of the brain, 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 mea- sure 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.

Bloch, Y., Fixman, M., Maoz, H., Bloch, A. M., Levkovitz, Y., Ratzoni, G., … Gal, G. (2012). Can Computerized Cognitive Tests Assist in the Clinical Diagnosis of Attention-Deficit Hyperactivity Disorder? *The Journal of Neuropsychiatry and Clinical Neurosciences, 24*(1), 111–114.
A group of 34 children and adolescents suspected of having attention-deficit hyperactivity disorder were referred for a computerized evaluation that included sustained attention, working memory, planning, and set-shifting.

Although only sustained attention had reasonable specificity, all tests had questionable contribution to the diagnostic evaluation.

Bodnar, L. E., Prahme, M. C., Cutting, L. E., Denckla, M. B., & Mahone, E. M. (2007). Construct validity of parent ratings of inhibitory control. *Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence*, *13*(4), 345–362.

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

Boivin, M. J., Bangirana, P., Byarugaba, J., Opoka, R. O., Idro, R., Jurek, A. M., & John, C. C. (2007). Cognitive Impairment After Cerebral Malaria in Children: A Prospective Study. *PEDIATRICS*, *119*(2), e360–e366.

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

Boivin, M. J. (2002). Effects of early cerebral malaria on cognitive ability in Senegalese children. *Journal of Developmental and Behavioral Pediatrics: JDBP*, *23*(5), 353–364.

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.

Boivin, M. J., Barlow-Mosha, L., Chernoff, M., Laughton, B., Zimmer, B., Joyce, C., … Palumbo, P. (2017). Neuropsychological performance in African children with HIV enrolled in a multi-site anti-retroviral clinical trial. AIDS, 1.

Objective & design: Children with HIV infection (HIV+) are at neuropsychological risk, but few studies have evaluated this at multiple sites in low and middle income countries (LMICs). We compared neuropsychological outcomes at enrollment (>5 yrs age) among HIV+, HIV-uninfected perinatally-exposed (HEU), and HIV unexposed (HU) children from 4 sub-Saharan countries. Methods: IMPAACT P1060 compared Nevirapine (NVP) versus Lopinavir/Ritonavir (LPVr)-based ART in HIV-infected children 6 to 35 months of age. This study (P1104 s) enrolled P1060 children at 5-11 years of age and evaluated their neuropsychological performance over 2 years using the KABC-II, TOVA, BOT-2, and parent-reported BRIEF. Cohorts were compared using GEE least-squares means adjusted for site, child age and gender, and personal and social characteristics for child and caregiver. Results: 611 (246 HIV+, 183 HEU, 182 HU) of the 615 enrolled at 6 sites (South Africa [3], Zimbabwe, Malawi, Uganda) were available for analysis. Mean age was 7.2 years, 48% male, 69% in school. Unadjusted and adjusted comparisons were consistent. HIV+ children performed significantly worse than HEU and HUU on KABC-II, TOVA, BOT-2 ($P < 0.001$), but not on the BRIEF. HUU and HEU cohorts were comparable on cognitive outcomes. HIV+ children initiated on ARV treatment before one year of age had significantly better only in BOT-2 total motor proficiency compared to those started after. Conclusions: Significant cognitive deficits were documented among HIV+ children. Earlier HIV treatment, neuropsychological monitoring and rehabilitative interventions are needed. Subsequent testing for 2 more years will help evaluate how HIV infection and exposure affect the developmental trajectory.

Boivin, M. J., Chounramany, C., Giordani, B., Xaisida, S., Choulamountry, L., Pholsena, P., … Olness, K. (1996). Validating a Cognitive Ability Testing Protocol with Lao Children for Community Development Applications, *10*(4), 588–599.
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.

Boivin, M. J., Ruel, T. D., Boal, H. E., Bangirana, P., Cao, H., Eller, L. A., Charlebois, E., Havlir, D. V., Kamya, M. R., Achan, J., Akello, C., & Wong, J. K. (2010). HIV-subtype A is associated with poorer neuropsychological performance compared with subtype D in antiretroviral therapy-naive Ugandan children. *AIDS (London, England)*, *24*(8), 1163–1170.
BACKGROUND: HIV-subtype D is associated with more rapid disease progression and higher rates of dementia in Ugandan adults compared with HIV-subtype A. There are no data comparing neuropsychological function by HIV subtype in Ugandan children. DESIGN: One hundred and two HIV-infected antiretroviral therapy (ART) naive Ugandan children 6-12 years old (mean 8.9) completed the Kaufman Assessment Battery for Children, second edition (KABC-2), the Test of Variables of Attention (TOVA), and the Bruininks-Oseretsky Test for Motor Proficiency, second edition (BOT-2). Using a PCR-based multiregion assay with probe hybridization in five different regions (gag, pol, vpu, env, gp-41), HIV subtype was defined by hybridization in env and by total using two or more regions. Analysis of covariance was used for multivariate comparison. RESULTS: The env subtype was determined in 54 (37 A, 16 D, 1 C) children. Subtype A and D groups were comparable by demographics, CD4 status, and WHO stage. Subtype A infections had higher log viral loads (median 5.0 vs. 4.6, $p = 0.02$). Children with A performed more poorly than those with D on all measures, especially on KABC-2 Sequential Processing (memory) ($p = 0.01$), Simultaneous Processing (visual-spatial analysis) ($p = 0.005$), Learning ($p = 0.02$), and TOVA visual attention ($p = 0.04$). When adjusted for viral load, Sequential and Simultaneous Processing remained significantly different. Results were similar comparing by total HIV subtype. CONCLUSION: HIV subtype A children demonstrated poorer neurocognitive performance than those with HIV subtype D. Subtype-specific neurocognitive deficits may reflect age-related differences in the neuropathogenesis of HIV. This may have important implications for when to initiate ART and the selection of drugs with greater central nervous system penetration.

Bounias, M., Laibow, R. E., Bonaly, A., & Stubblebine, A. N. (2001). EEG-NeuroBioFeedback Treatment of Patients with Brain Injury: Part 1: Typological Classification of Clinical Syndromes. *Journal of Neurotherapy*, *5*(4), 23–44.

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.

Boyd, W., & Campbell, S. (1998). The Use of EEG Biofeedback to Treat ADHD in a School Setting. *Investigations in Neuromodulation, Journal of Neurotherapy*, *2*(4), 65–71.

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.

Braverman, E. R., Blum, K., Damle, U. J., Kerner, M., Dushaj, K., & Oscar-Berman, M. (2013). Evoked Potentials and Neuropsychological Tests Validate Positron Emission Topography (PET) Brain Metabolism in Cognitively Impaired Patients. *PLoS ONE*, *8*(3), e55398.

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.

Braverman, E. R., Chen, A. L.-C., Chen, T. J., Schoolfield, J. D., Notaro, A., Braverman, D., Kerner, M., Blum, S. H., Arcuri, V., Varshavskiy, M., Damle, U., Downs, B. W., Waite, R. L., Oscar-Berman, M., Giordano, J., & Blum, K. (2010). Test of variables of attention (TOVA) as a predictor of early attention complaints, an antecedent to dementia. *Neuropsychiatric Disease and Treatment, 6*, 681-690.

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 ($p < 0.025$). The number of SDB TOVA quarters was a significant predictor for "impaired" or "normal" group membership for visual memory ($p < 0.015$), but not for the other three WMS-III components. For males, the partial correlation between the number of attention complaints and the number of SDB TOVA quarters was also significant ($r = 0.251$, $p < 0.005$). For the 152 females with a significant number of attention complaints, no significant differences between SDBs and normals were observed ($p > 0.15$). This is the first report, to our knowledge, which provides evidence that TOVA is an accurate predictor of early attention complaints and memory impairments in a clinical setting. This finding is more robust for males than for females between the ages of 40 and 90 years.

Braverman, E. R., Chen, T. J., Schoolfield, J. D., Notaro, A., Braverman, D., Kerner, M., Blum, S. H., Arcuri, V., Varshavskiy, M., Damle, U., Downs, B. W., Waite, R. L., Oscar-Berman, M., Giordano, J., & Blum, K. (2006). Delayed P300 latency 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 normal (TOVA ≥ 0) for attention failure (i.e., omissions [$p < .010$] and commissions [$p < .005$]) but not for response time or for variability. Males with >2 SD-BL quarters had significantly delayed P300 latency and age-adjusted P300 latency compared with males who had 0 SD-BL quarters ($p < .020$) and 1 SD-BL quarter ($p < .005$). In females, the means for P300 latency and age-adjusted P300 latency were significantly delayed for those grouped as SD-BL than for those labeled normal for response time ($p < .001$) and variability ($p < .010$), but not for omissions or for commissions. Females with >2 SD-BL quarters had significantly delayed P300 latency and age-adjusted P300 latency compared with females who had 0 SD-BL quarters ($p < .005$) and 1 SD-BL quarter ($p < .010$). Results suggest that TOVA abnormalities may be an indicator of delayed P300 and attention disorder. Recent research correlates TOVA abnormalities with impaired WMS scores of early dementia. Coupling of TOVA assessment findings with results of P300, Mini-Mental Status Exam, and WMS-III may allow for enhanced accuracy in the diagnosis and evaluation of the complex pathway of failing attention, memory, and cognition that leads to dementia.

Braverman, E. R., Chen, T. J., Prihoda, T., Sonntag, W., Meshkin, B., Downs, B., Mengucci, J., Blum, S., Notaro, A., Arcuri, V., Varshavskiy, M. & Blum, K. (2007). Plasma growth hormones, P300 event-related potential and test of variables of attention (TOVA) are important neuroendocrinological predictors of early cognitive decline in a clinical setting: Evidence supported by structural equation modeling (SEM) parameter estimates. *AGE, 29*(2), 55-67.

A review of the literature in both animals and humans reveals that changes in sex hormone have often been associated with changes in behavioral and mental abilities. Previously published research from our laboratory, and others, provides strong evidence that P300 (latency) event-related potential (ERP), a marker of neuronal processing speed, is an accurate predictor of early memory impairment in both males and females across a wide age range. It is our hypothesis, given the vast literature on the subject, that coupling growth hormones (insulin-like growth

factor-I, (IGF-I) and insulin-like growth factor binding protein 3 (IGF-BP3)), P300 event-related potential and test of variables of attention (TOVA) are important neuroendocrinological predictors of early cognitive decline in a clinical setting. To support this hypothesis, we utilized structural equation modeling (SEM) parameter estimates to determine the relationship between aging and memory, as mediated by growth hormone (GH) levels (indirectly measured through the insulin-like growth factor system), P300 latency and TOVA, putative neurocognitive predictors tested in this study. An SEM was developed hypothesizing a causal directive path, leading from age to memory, mediated by IGF-1 and IGF-BP3, P300 latency (speed), and TOVA decrements. An increase in age was accompanied by a decrease in IGF-1 and IGF-BP3, an increase in P300 latency, a prolongation in TOVA response time, and a decrease in memory functioning. Moreover, independent of age, decreases in IGF-1 and IGF-BP3, were accompanied by increases in P300 latency, and were accompanied by increases in TOVA response time. Finally, increases in P300 latency were accompanied by decreased memory function, both directly and indirectly through mediation of TOVA response time. In summary, this is the first report utilizing SEM to reveal the finding that aging affects memory function negatively through mediation of decreased IGF-1 and IGF-BP3, and increased P300 latency (delayed attention and processing speed).

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 it is applied to understanding children’s behaviour in culturally diverse settings.

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 < .050). 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.

Butte, N. F., Treuth, M. S., Voigt, R. G., Llorente, A. M., & Heird, W. C. (1999). Stimulant medications decrease energy expenditure and physical activity in children with attention-deficit/hyperactivity disorder. The Journal of Pediatrics, 135(2), 203–207.

Objective: To determine the effect of stimulant medications used to treat children with attention-deficit/hyperactivity disorder (AD/HD) on energy expenditure, fuel utilization, and physical activity. Study design: Energy expenditure and physical activity were measured, respectively, by room respiration calorimetry and microwave motion detectors in 31 children with AD/HD (26 boys and 5 girls; ages 6 to 12 years) both while they were receiving their prescribed stimulant medication and after the medication had been discontinued for at least 24 hours. Fuel utilization was calculated from calorimetry data. Results: Total and awake energy expenditure including energy expended while doing schoolwork, riding a stationary bicycle, resting, and watching a movie were from 4% to 8% lower when the children were receiving their prescribed stimulant medication. Total and awake activity were also lower while they were receiving medication (16% to 22%) and accounted for the lower rates of energy expenditure. Sleeping metabolic rate, basal metabolic rate, and fuel utilization were unaffected by medication. Conclusions: Stimulant medications decrease physical activity, and hence, decrease the activity component of total daily energy expenditure in children with AD/HD.

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.

Cameron, Sharon, and Harvey Dillon. (2011). Development and Evaluation of the LiSN & Learn Auditory Training Software for Deficit-Specific Remediation of Binaural Processing Deficits in Children: Preliminary Findings. *Journal of the American Academy of Audiology* 22(10), 678–96. doi:10.3766/jaaa.22.10.6.
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.

Canpolat, S., Kirpinar, I., Deveci, E., Aksoy, H., Bayraktutan, Z., Eren, I., … Aydin, N. (2014). Relationship of asymmetrical dimethylarginine, nitric oxide, and sustained attention during attack in patients with major depressive disorder. *The Scientific World Journal*, *2014, Vol. 14.*
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.

Carmody, D., Radvanski, D., Wadhwani, S., Sabo, M. J., & Vergara, L. (2000). EEG Biofeedback Training and Attention-Deficit/Hyperactivity Disorder in an Elementary School Setting. *Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience*, *4*(3), 5–27.
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.

Caro, X. J., & Winter, E. F. (2011). EEG biofeedback treatment improves certain attention and somatic symptoms in fibromyalgia: a pilot study. *Applied Psychophysiology and Biofeedback*, *36*(3), 193–200.
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). Abnormal processing of irrelevant information in attention deficit hyperactivity disorder. *Psychiatry Research, 56*(1), 59–70.
The presence of a selective attention deficit in children with attention deficit hyperactivity disorder (ADHD) was investigated by administering a trial-by-trial version of the Stroop Color-Naming Task to children, aged 9-12, with ADHD (n = 19) and age-matched normal control children (n = 19). Performance was evaluated on both interference and facilitation components of the task. On the standard version of the task, with equal numbers of color words and neutral words, children with ADHD showed increased Stroop interference (prolongation of color-naming times by color-incongruent stimuli) but normal amounts of facilitation (speeding of color naming by color-congruent stimuli). This finding suggests that children with ADHD show increased disruption of color-naming performance by task-irrelevant information, probably secondary to decreased attentional control over the interference process. In contrast to findings of studies in adults, both groups of children failed to use an attentional strategy to reduce interference when they were administered blocks of trials that varied their expectancy for color word trials. This precluded a direct test of the diminished control hypothesis. There were no significant correlations between abnormal Stroop performance and impairment on the Continuous Performance Test or the Wisconsin Card Sorting Test or measures of IQ or reading performance. The implications of these findings for our understanding of information-processing deficits in children with ADHD and of the neurobiological underpinnings of these deficits are discussed.

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*(11): 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 EF data, $\chi 2(3) = 1.581$, $p = .66$, 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%Y of the gifted children were identified with ADHD using the T.O.V.A., Child Behavior Check List (CBCL), and Teacher's Report Form (TRF). Significant positive correlations were found between intelligence (KEDIWISC) and omission error, commission error, and response time (RT) variability on the T.O.V.A. That is, children with a high level of intelligence made fewer omission and commission errors and responded more consistently on the T.O.V.A. than children with lower intelligence. No significant correlation was found between intelligence and response time. Overall, gifted children performed better on the T.O.V.A. than nongifted children. Specifically, with the exception of response time and response time variability, gifted children with ADHD performed better on tasks of omission error, commission error, and response sensitivity than nongifted children with ADHD. Further discussions are suggested based on the results mentioned above.

Chernoff, M., Laughton, B., Ratswana, M., Familiar, I., Fairlie, L., Vhembo, T., … Boivin, M. (2018). Validity of Neuropsychological Testing in Young African Children Affected by HIV. *Journal of Pediatric Infectious Diseases.*
Introduction Western-constructed neuropsychological tests have been used in low- and middle-income countries to assess the impact of human immunodeficiency virus/ acquired immunodeficiency syndrome (HIV/AIDS) and other chronic illnesses. We explore using such instruments cross-culturally in a sub-Saharan African setting. Methods IMPAACT P1104S was a 2-year observational study performed at six clinical sites (South Africa—three sites, Malawi, Uganda, and Zimbabwe) to assess and compare neuropsychological outcomes in three cohorts of children between the ages of 5 and 11 years: HIV-infected (HIV), HIV-exposed but uninfected (HEU), and HIV unexposed and uninfected (HU). Descriptive statistics compared sociodemographic characteristics among children at sites. Instruments included the Kaufman Assessment Battery for Children, 2nd edition (KABC-II) cognitive ability, Test of Variables of Attention (TOVA) attention/impulsivity, Bruininks–Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2) motor proficiency tests, and Behavior Rating Inventory for Executive Function (BRIEF) executive function problems. Test characteristics were assessed using intraclass and Spearman’s nonpara- metric correlations, linear regression, and principal factor analyses. Results Of the 611 participants, 50% were males and mean age ranged

from 6.6 to 8 years. In Malawi, Uganda, and Zimbabwe, substantial proportions of families lived in rural settings in contrast to the South African sites. Intraclass correlation coefficients between weeks 0 and 48 were highest for the KABC scores, ranging between 0.42 and 0.71. Correlations among similar test domains were low to moderate but significant, with positive correlation between KABC sequential and TOVA scores and negative correlation between BRIEF and KABC scores. TOVA response time scores correlated negatively with the BOT-2 total points score. Strong and significant associations between individual measures of growth, disability, and development with all test scores were observed. Performance-based measures were markedly lower for HIV compared with HEU and HU participants, even after controlling for age, sex, and site. Factor analyses confirmed the underlying theoretical structure of the KABC scaled item scores. Conclusion The KABC, TOVA, BRIEF, and BOT-2 were valid and reliable tools for assessing the neuropsychological impact of HIV in four sub-Saharan African countries.

Cho, S. C., Son, J. W., Kim, B. N., Kim, J. W., Yoo, H. J., Hwang, J. W., … Park, T. W. (2012). Serotonin 2A Receptor Gene Polymorphism in Korean Children with Attention-Deficit/Hyperactivity Disorder. *Psychiatry Investigation, 9*(3), 269–277.

OBJECTIVE: The purpose of this study was to investigate the association between the T102C polymorphism in the serotonin 2A receptor gene and attention-deficit/hyperactivity disorder (ADHD) in Korean patients. METHODS: A total of 189 Korean children with ADHD as well as both parents of the ADHD children and 150 normal children participated in this study. DNA was extracted from blood samples from all of the subjects, and genotyping was conducted. Based on the allele and genotype information obtained, case-control analyses were performed to compare the ADHD and normal children, and Transmission disequilibrium tests (TDTs) were used for family-based association testing (number of trios=113). Finally, according to the significant finding which was showed in the case-control analyses, the results of behavioral characterastics and neuropsychological test were compared between ADHD children with and without the C allele. RESULTS: In the case-control analyses, statistically significant differences were detected in the frequencies of genotypes containing the C allele (chi(2)=4.73, p=0.030). In the family-based association study, TDTs failed to detect linkage disequilibrium of the T102C polymorphism associated with ADHD children. In the ADHD children, both the mean reaction time and the standard deviation of the reaction time in the auditory continuous performance test were longer in the group with the C allele compared to the group without the C allele. CONCLUSION: The results of this study suggest that there is a significant genetic association between the T102C polymorphism in the serotonin 2A receptor gene and ADHD in Korean children.

Choi, B., Kim, W., & Park, N. (1994). Validity of TOVA for Evaluating the Attention of Children with ADHD: Preliminary Study. 33(6), 1306–1312.

There is no abstract available for this item.

Choi, B., & B.L., Lee. (2000). Characteristics of Attention Deficit in Children with ADHD: Results from Visual and Auditory TOVA and IQ Scores. *Journal of the Korean Neuropsychiatric Association, 39*(5), 870-878.

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.

Choi, B., Sung, Y., Han, S., & Lee, S. (1997). Altered Auditory Event Related Potentials Following Administration of Methylphenidate in Children with Attention Deficit Hyperactivity Disorder. *J Korean Neuropsychiatr Assoc., 36*(2), 281–291.

OBJECTS: Event related potential(ERF) has been recently applied to examine the neurophysiological disturbance in attention deficit hyperactivity disorder(ADHD), particularly with regard to N100 and P300 which are known as one of ERP components closely linked with cognitive function. On the basis of these aspects, this study was designed to evaluate electrophysiologic characteristics and its availability for diagnosis and treatment of ADHD children by comparison of ERP between normal controls and ADHD children before and after methylphenidate (MFD) administration. METHODS: We examined the topographic auditory ERF and T.O.V.A.(Test of variables of attention), a standardized computerized visual continuous performance test following administration of stimulant drug, MPD 10mg in 13 ADHD children and compared these results with those of 11 normal controls. RESULTS: The results were as follows: 1) Thought the difference was not spastically significant(P=0.0548), N100 latencies seemed to be longer in ADHD children than in normal controls. N100 amplitudes also seemed to be larger in ADHD children than in normal controls(P=0.0629). 2) The F300 latencies significantly shortened after MFD administration when compared with those before MPD administration in ADHD group(P<0.01). 3) ADHD group performed significantly less well than normal controls in T.O.V.A.(P<0.05). And T.O.V.A. scores significantly improved after MFD administration in ADHD group(P<0.01). 4) The N100 and P300 latencies and the T.O.V.A. scores were significantly correlated before MPD administration in ADHD group(P<0.05). 5) The F300 latencies before MFD administration were significantly correlated with the amplitudes of changes of T.O.V.A. scores after MFD administration(P<0.05). CONCLUSION: It seems that prolonged N100 latency of ADHD children can be regarded as a relatively enduring trait marker and that F300 latency may reflect attentional response ability along with therapeutic effect by stimulant.

Choi, J., Jeong, B., Lee, S. W., & Go, H. J. (2013). Aberrant development of functional connectivity among resting state-related functional networks in medication-naive ADHD children. *PloS One, 8*(12), e83516.

OBJECTIVE: The aim of this study was to investigate the compromised developmental trajectory of the functional connectivity among resting-state-related functional networks (RSFNs) in medication-naive children with attention-deficit/hyperactivity disorder (ADHD). SUBJECTS AND METHODS: Using both independent component analysis and dual regression, subject-specific time courses of 12 RSFNs were extracted from both 20 medication-naive children with ADHD, and 20 age and gender-matched control children showing typical development (TDC). Both partial correlation coefficients among the 12 RSFNs and a resting-state resource allocation index (rsRAI) of the salience network (SN) were entered into multiple linear regression analysis to investigate the compromised, age-related change in medication-naive ADHD children. Finally, correlation analyses were performed between the compromised RSFN connections showing significant group-by-age interaction and rsRAI of SN or clinical variables. RESULTS: Medication-naive ADHD subjects failed to show age-related increment of functional connectivity in both rsRAI of SN and two RSFN connections, SN-Sensory/motor and posterior default mode/precuneus network (pDMN/prec)–anterior DMN. Lower SN-Sensory/motor connectivity was related with higher scores on the ADHD Rating Scale, and with poor scores on the continuous performance test. The pDMN/prec-aDMN connectivity was positively related with rsRAI of SN. CONCLUSIONS: Our results suggest that medication-naive ADHD subjects may have delayed maturation of the two functional connections, SN-Sensory/Motor and aDMN-pDMN/prec. Interventions that enhance the functional connectivity of these two connections may merit attention as potential therapeutic or preventive options in both ADHD and TDC.

Chu, Kuo-Chung, Yu-Shu Huang, Chien-Fu Tseng, Hsin-Jou Huang, Chih-Huan Wang, and Hsin-Yi Tai. (2017). Reliability and Validity of DS-ADHD: A Decision Support System on Attention Deficit Hyperactivity Disorders. *Computer Methods and Programs in Biomedicine* 140, 241–48.

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.

Chutko, A. V., Surushkina, S. Yu., Nikishena, I. S., Yakovenko, E. A., & Anisimova, T. I. (2013). Deanol Aceglumate in Neurasthenia Treatment in Adolescents with School Disadaptation. *Current Pediatrics, 12*(5), 99.
Aim: to study clinical manifestation of neurasthenia in adolescents with school disadaptation and to assess efficacy of deanol aceglumate in treatment of this disorder. Patients and methods: 64 adolescents aged from 14 to 17 years with neurasthenia were included into the study. Control group consisted of 64 practically healthy adolescents. Diagnostic methods: subjective scale for asthenia assessment (MFI-20), visual analogue scale for asthenia manifestations assessment (10-points scale), C. D. Spielberger's state-trait anxiety test, vegetologic examination with A. M. Vein's questionnaire, psychophysiological investigation with TOVA (Test of Variables of Attention), quantitative electroencephalography. Results: vegetative dysfunction, decrease of attention level and reaction speed, as well as increased level of reactive anxiety (reliably higher than in control group of healthy participants) was revealed. The results of quantitative electroencephalography demonstrated significant decrease of alpha-rhythm spectrum power in occipital leads in comparison with respective characteristic in the control group. The results of clinical and psychological studies, performed after the treatment course, showed high clinical efficacy of deanol aceglumate in this disorder in adolescents (the improvement was achieved in 44 (68,8%) of patients). Conclusions: deanol aceglumate in treatment of asthenic disorders in adolescents with school disadaptation is characterized by high efficacy. Due to absence of its influence on anxiety level, combination of this medicine with nonbenzodiazepine anxiolytics can be suggested to increase the efficacy of the treatment.

Chutko, L. S., Surushkina, S. I., Iakovenko, E. A., Nikishena, I. S., Anisimova, T. I., & Bondarchuk, I. L. (2014). Cognitive and emotional impairments in patients with protracted anxiety-phobic disorders, *86*(12), 61.
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.

Chutko, L. S., Kornishina, T. L., Surushkina, S. Yu., Yakovenko, E. A., Anisimova, T. I., & Volov, M. B. (2018). Syndrome of autonomic dysfunction in children and adolescents. *Zhurnal Nevrologii i Psikhiatrii Im. S.S. Korsakova, 118*(1), 43.
Aim: To study clinical and pathophysiological symptoms of autonomic dysfunction syndrome in children and adolescents and assess the efficacy of its treatment with nooclerin. Material and methods: Fifty-three patients, aged from 10 to 15 years, with autonomic dysfunction syndrome were examined. All patients underwent neurological examination, assessment with the A.M. Vein's questionnaire of autonomic disorders, the 10 point Visual Analogous scale for headache and fatigue, the Spielberger-Khanin scale for anxiety, Kerdo index, Hildebrandt's coefficient, electrocardiography with clinoorthostatic test, electroencephalography, and TOVA psychophysiological test. Results and conclusion: The signs of the asthenic-autonomic syndrome were characteristic of the clinical picture of disease. EEG results demonstrated the deficit of activation effects, predominance of synchronized effects of thalamic structures which led to the insufficient activation of cortical structures. These data support the high efficacy of nooclerin.

Chutko, L. S., Surushkina, S. I., Nikishena, I. S., Iakovenko, E. A., Anisimova, T. I., Bondarchuk, I. L., & Sergeev, A. V. (2014). Asthenic disorders in children and their differentiated treatment, *114*(12), 99.
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.

Chutko, L. S., Surushkina, S. Y., Nikishena, I. S., Yakovenko, E. A., & Anisimova, T. I. (2013). Neurasthenia: State-of-the-art and therapeutic approaches. *Neurology, Neuropsychiatry, Psychosomatics, 0*(2), 42.
Objective: to study the efficacy of metaprot in the treatment of neurasthenia. Patients and methods. Thirty patients aged 18 to 45 years with neurasthenia (F48.0) were followed up. The patients were examined using a subjective asthenia rating scale (Multidimensional Fatigue Inventory (MFI-20)), a 10-point anesthesia visual analog

scale, Spielberger's self-report scale modified by Yu.L. Khanin, and a computed Test of Variables of Attention (TOVA). Metaprot was given in a dose of 0.25 g b.i.d. after morning and evening meals as two administrations for 10 days (5 days at a 2-day interval). The results of therapy were assessed on day 30 after its course. Results. There was clinical improvement in 21 (70.0%) patients after metaprot therapy. Evaluation of the patient's status using the MFI-20 showed a significant improvement in the items of general asthenia, physical asthenia, psychic asthenia, and decreased activity. Psychophysiological examination using the TOVA revealed a significant reduction in response times, as compared to the scores obtained before the treatment, and a decrease in the number of errors in the second half of the test, which allows us to state that there is a reduction in the degree of mental exhaustion and an increase in work capacity after the treatment. Psychological tests showed no significant reduction in anxiety scores. There were no adverse reactions or complications. It has been concluded that it is promising to use metaprot to treat neurasthenia.

Cinaz, Burcu, Christian Vogt, Bert Arnrich, and Gerhard Tröster. (2012). Implementation and Evaluation of Wearable Reaction Time Tests. *Pervasive and Mobile Computing* 8(6), 813–21.
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 hand 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 in comparison to well accepted, 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.

Clark, A. L., Amick, M. M., Fortier, C., Milberg, W. P., & McGlinchey, R. E. (2014). Poor Performance Validity predicts Clinical Characteristics and Cognitive Test Performance of OEF/OIF/OND Veterans in a Research Setting. *The Clinical Neuropsychologist*, *28*(5), 802–825.
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.

Colegrove, R. W., Homayounjam, H., Williams, J., & Hanken, J. (2001). Reducing the Overidentification of Childhood ADHD: A Stepwise Diagnostic Model. *The ADHD Report, 9*(4), 11, 14–16.
No abstract is available for this item.

Coles, C. D., Kable, J. A., Taddeo, E., & Strickland, D. (2018). GoFAR: improving attention, behavior and adaptive functioning in children with fetal alcohol spectrum disorders: Brief report. *Developmental Neurorehabilitation,* 1–5.
Objective: This brief report describes the GoFAR intervention designed to improve attention, behavior, and adaptive functioning in children with FASD, ages 5 to 10 years. Methods: Thirty children were randomized to one of three conditions: GoFAR; FACELAND, and CONTROL; 25 completed the interventions. Over 10 sessions children and caregivers learned a meta- cognitive strategy (FAR) designed to improve cognitive control of behavior and adaptive

functioning and practiced it during behavior analog therapy. Attention, behavior problems, and adaptive skills were measured pre- and post-intervention. Results: From pre- to post-testing the GoFAR intervention group improved on the Test of Variables of Attention (TOVA). Both intervention groups improved in Daily Living Skills. Conclusion: This pilot study demonstrated that children with FASD and their caregivers benefit from a focused intervention designed to improve effortful control of behavior. The study suggests the need for a larger clinical trial to evaluate the intervention's effectiveness.

Collet, J.-P., Vanasse, M., Marois, P., Amar, M., Goldberg, J., Lambert, J., … Majnemer, A. (2001). Hyperbaric oxygen for children with cerebral palsy: a randomised multicentre trial. *The Lancet,* 357(9256), 582–586.
Background The use of hyperbaric oxygen for children with cerebral palsy has spread worldwide, despite little scientific evidence of efficacy. We did a randomised trial to assess the efficacy and side-effects of this form of therapy in children with cerebral palsy. Methods 111 children with cerebral palsy aged 3–12 years were randomly assigned hyperbaric oxygen (n=57) or slightly pressurised room air (n=54). All children received 40 treatments over 2 months. Hyperbaric oxygen treatment was 1 h in 100% oxygen at 1·75 atmospheres absolute (ATA); children on slightly pressurised air received air at 1·3 ATA (the lowest pressure at which pressure can be felt, thereby ensuring the maintenance of masking). The main outcome measure was gross motor function. Secondary outcomes included performance in activities of daily living, attention, working memory, and speech.
Findings For all outcomes, both groups improved over the course of the study, but without any difference between the two treatments. The score on the global gross motor function measure increased by 3·0% in the children on slightly pressurised air and 2·9% in those on hyperbaric oxygen. The mean difference between treatments was -0·40 (95% CI -1·69 to 0·90, p=0·544). Other changes were seen in speech, attention, memory, and functional skills. Ear problems occurred in 27 children treated by hyperbaric oxygen and in 15 treated with hyperbaric air (p=0·004).
Interpretation In this study, hyperbaric oxygen did not improve the condition of children with cerebral palsy compared with slightly pressurised air. The improvement seen in both groups for all dimensions tested deserves further consideration.

Cooper, J. (2004). No Evidence of Sleep Apnea in Children with Attention Deficit Hyperactivity Disorder. *Clinical Pediatrics*, *43*(7), 609–614.
Summary: Children with attention deficit hyperactivity disorder (ADHD) may have a component of sleep apnea causing arousal and contributing to ADHD behavior during the day. Twenty non-ADHD children between 4 and 16 years of age were compared with 18 children with ADHD with use of nocturnal polysomnography (PSG) and psychometric tests. The psychometric testing confirmed that the control group were normal and that the ADHD children fulfilled the diagnostic criteria for ADHD. The PSG showed normal arousal indexes for the ADHD group (9.8 ± 3.9/hr) and controls (10.2 ± 3.1/hr), and normal apnea/hypnea indexes for the ADHD group (1.0 ± 2.4/hr) and controls (0.6 ± 0.9/hr). The sleep architecture was not significantly different between groups. There were no sleep abnormalities in the ADHD children that could be responsible for, or contributing to, the disorder.

Corbo, Vincent, Melissa A. Amick, William P. Milberg, Regina E. McGlinchey, and David H. Salat. (2016). Early Life Trauma Is Associated with Altered White Matter Integrity and Affective Control. *Journal of Psychiatric Research,* 79, 70–77.
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 clinician's 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.

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's behavior and the children completed a 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.

Cotman, A., & Sandman, C. (1997). Cognitive deficits and their remediation in the homeless. *Journal of Cognitive Rehabilitation*, *15*, 16–23.

There is no abstract available for this item.

Cowley, B., Holmström, É., Juurmaa, K., Kovarskis, L., & Krause, C. M. (2016). Computer Enabled Neuroplasticity Treatment: A Clinical Trial of a Novel Design for Neurofeedback Therapy in Adult ADHD. *Frontiers in Human Neuroscience, 10*(135).

We report a randomised controlled clinical trial of neurofeedback therapy intervention for ADHD/ADD in adults. We focus on internal mechanics of neurofeedback learning, to elucidate the primary role of cortical self-regulation in neurofeedback. We report initial results; more extensive analysis will follow. Methods: Trial has two phases: intervention and follow-up. The intervention consisted of neurofeedback treatment, including intake and outtake measurements, using a waiting-list control group. Treatment involved ~40 hour-long sessions 2-5 times per week. Training involved either theta/beta or sensorimotor-rhythm regimes, adapted by adding a novel 'inverse-training' condition to promote self-regulation. Follow-up (ongoing) will consist of self-report and executive function tests. Setting: Intake and outtake measurements were conducted at University of Helsinki. Treatment was administered at partner clinic Mental Capital Care, Helsinki. Randomisation: We randomly allocated half the sample then adaptively allocated the remainder to minimise baseline differences in prognostic variables. Blinding: Waiting-list control design meant trial was not blinded. Participants: 54 adult Finnish participants (mean age 36 years; 29 females) were recruited after screening by psychiatric review. 44 had ADHD diagnoses, 10 had ADD. Measurements: Symptoms were assessed by computerised attention test (T.O.V.A.) and self-report scales, at intake and outtake. Performance during neurofeedback trials was recorded. Results: Participants were recruited and completed intake measurements during summer 2012, before assignment to treatment and control, September 2012. Outtake measurements ran April-August 2013. After dropouts, 23 treatment and 21 waiting-list participants remained for analysis. Initial analysis showed that, compared to waiting-list control, neurofeedback promoted

improvement of self-reported ADHD symptoms, but did not show transfer of learning to T.O.V.A. Comprehensive analysis will be reported elsewhere.

Cueli, M., Garcia, T., Rodriguez, C., Gonzalez-Castro, P., Alvarez, L., & Alvarez, D. (2013). Examination of Blood Flow Patterns in ADHD Through a Continuous Performance Test. *REVISTA IBEROAMERICANA DE PSICOLOGÍA Y SALUD, 4*(1).

The criteria established by the DSM-IV- TR are one of the most widely accepted procedures to diagnose the TDAH. There are three different subtypes: inattentive, hyperactive-impulsive and combined. Nir-HEG enables the assessment and intervention of the disorder by measuring blood flow blood oxygenation, recorded in areas specifically selected. In this research, the instrument nir- HEG was applied to 100 subjects classified into four groups: ADHD-inattentive, hyperactive, combined subtype and control group. Simultaneously with the evaluation of blood flow, subject is evaluated with a continuous performance test (TOV A) whose duration is approximately 20 minutes. Therefore, the reason of this research is to assess the instrument over a long period of time while performing a continuous performing task (CPT). The results show statistically significant differences between the control group and the other with ADHD and among the subtypes in the variables of executive control and short evaluation with the nir-HEG. As for the long evaluation of blood oxygenation during a performance of an executive task, some differences can be seen among the subtypes with ADHD, although not statistically significant. We conclude that this measure -ratio HEG-is sufficiently stable during the 20 minutes assessed, so that in a few seconds we may be getting a valid measure.

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.

Davis, N. O., Bower, J., & Kollins, S. H. (2018). Proof-of-concept study of an at-home, engaging, digital intervention for pediatric ADHD. *PLOS ONE*, *13*(1), e0189749.

Objective Pharmacological and behavioral therapies have limited impact on the distinct neurocognitive impairments associated with ADHD, and existing cognitive training programs have shown limited efficacy. This proof-of-concept study assessed treatment acceptability and explored outcomes for a novel digital treatment targeting cognitive processes implicated in ADHD. Method Participants included 40 children with ADHD and 40 children without ADHD. Following psychiatric screening, ADHD ratings, and baseline neuropsychological measures, participants completed 28-days of at-home treatment.

Neuropsychological assessment was repeated at end-of-study along with treatment satisfaction measures. Results Eighty-four percent of treatment sessions were completed and ratings showed strong intervention appeal. Significant improvements were observed on a computerized attention task for the ADHD group and a highly impaired ADHD High Severity subgroup. There was no change for the non-ADHD group. Spatial working memory also improved for the ADHD group and the ADHD High Severity subgroup. Conclusion Findings provide preliminary support that this treatment may improve attention, working memory, and inhibition in children with ADHD. Future research requires larger-scale randomized controlled trials that also evaluate treatment impact on functional impairments.

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

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

Diamond, G., Badir, M., Sevilla, P., Inbar, D., & Gadoth, N. (2013). Comparison between neurological examination and computerized test of attention for suspected ADHD: implications for assessment of a common childhood disability. *International Journal on Disability and Human Development*, *12*(3), 289–295.
Aim: The aim of this study was to determine the role of the Test of Variables of Attention (TOVA), a computer-based continuous performance test (CPT), in assessing suspected attention-deficit/hyperactivity disorder (ADHD), a pervasive cause of disability in children and adolescents. One hundred and fifty children and adolescents referred to a community-hospital-based neurology clinic for suspected ADHD underwent a comprehensive clinical evaluation by a pediatric neurologist in addition to the TOVA test. Retrospective chart data were analyzed separately for children aged 6–12 years (n = 101) and adolescents (13–18 years) (n = 49). Parents and teachers completed (DSM-IV-TR, 2000) questionnaires for children 6–12 years old. The correlation between the neurologist's

impression of the presence of attention deficit and the TOVA scores was good in the younger group (r = 0.28, p ≤ 0.001) and weaker in the older group (r = 0.29, p ≤ 0.05). On nonparametric analysis, the neurological evaluation did not distinguish between low and high TOVA scorers in the older group. The neurologist's impression correlated more closely with the DSM-IV parent ratings (r = 0.29, p ≤ 0.01) than the teachers' (r = 0.08, p ≤ 0.05). The TOVA correlated well with clinical assessment of ADHD and has added value in the evaluation of ADHD in adolescents, for whom standardized rating scales are lacking. In younger children, an experienced clinician can usually reach an accurate diagnosis based on accepted clinical criteria, including parent and teacher reports.

Downey, K., Stelson, F., Pomerleau, O. F., & Giordani, B. (1997). Adult Attention Deficit Hyperactivity Disorder: Psychological Test Profiles in a Clinical Population. *The Journal of Nervous and Mental Disease*, *185*(1), 32–38.
Compared to attention deficit hyperactivity disorder (ADHD) in children, relatively little is known about the clinical characteristics of adults with persistent ADHD. We elected to use established tests with age-corrected norms to compare the battery of psychological and neuropsychological tests conducted on outpatients admitted to our Adult ADHD clinic. ADHD patients scored significantly higher than norms on the TPQ novelty seeking and harm avoidance scales and MMPI-2 scales F, 2, 4, 7, and 8. Further, these patients were impaired on the California verbal learning test, the attentional capacity test, and the omissions and variability subtests of the Test of Variables of Attention. Adult ADHD had high comorbidity with current depressive disorder, antisocial personality disorder, and alcohol and drug abuse/dependence. High correlations were found between patients' and independent observers' reports of ADHD symptom severity. Implications for further research are discussed.

Duane, D. D., & Vermilion, K. J. (2004). Cognition and Affect in Patients with Cervical Dystonia With and Without Tremor. *Dystonia 4: Advances in Neurology, 94*, 179–189.
No abstract is available for this item.

Egner, T., and J.H. Gruzelier. (2004). EEG Biofeedback of Low Beta Band Components: Frequency-Specific Effects on Variables of Attention and Event-Related Brain Potentials. *Clinical Neurophysiology*, 115(1),131–39. doi:10.1016/S1388-2457(03)00353-5.
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 sensitivity 'd prime' (d'), 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.

Egner, T., & Gruzelier, J. H. (2001). Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans. *Neuroreport, 12*(18), 4155–4159.
Learned enhancement of EEG frequency components in the lower beta range by means of biofeedback has been reported to alleviate attention deficit hyperactivity disorder (ADHD) symptoms. In order to elucidate frequency-specific behavioural effects and neurophysiological mediators, this study applied neurofeedback protocols to healthy volunteers, and assessed impact on behavioural and electrocortical attention measures. Operant enhancement of a 12-15 Hz component was associated with reduction in commission errors and improved perceptual sensitivity on a continuous performance task (CPT), while the opposite relation was found for 15-18 Hz enhancement. Both 12-15 Hz and 15-18 Hz enhancement were associated with significant increases in P300 event-related brain potential amplitudes in an auditory oddball task. These relations are interpreted as stemming from band-specific effects on perceptual and motor aspects of attention measures.

Eisenberg, J., & Richman, R. (2011). Heart rate variability during a continuous performance test in children with problems of attention. *The Israel Journal of Psychiatry and Related Sciences*, *48*(1), 19–24.

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.

Ezra, N., Dang, K., & Heuser, G. (2011). Improvement of attention span and reaction time with hyperbaric oxygen treatment in patients with toxic injury due to mold exposure. *European Journal of Clinical Microbiology & Infectious Diseases*, *30*(1), 1–6.

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.

Fastenau, Philip S., Lisa L. Conant, and Roger E. Lauer. (1998). Working Memory in Young Children: Evidence for Modality-Specificity and Implications for Cerebral Reorganization in Early Childhood. *Neuropsychologia, 36*(7), 643–52.

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 memory’’ or ‘‘attention’’. There has been limited evidence for their modality specificity, however. We present two children who showed visual–spatial processing deficiencies (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.

Fernández, Thalía, Jorge Bosch-Bayard, Thalía Harmony, María I. Caballero, Lourdes Díaz-Comas, Lídice Galán, Josefina Ricardo-Garcell, Eduardo Aubert, and Gloria Otero-Ojeda. (2016). Neurofeedback in Learning Disabled Children: Visual versus Auditory Reinforcement. *Applied Psychophysiology and Biofeedback, 41*(1), 27–37.

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.

Fernández, Thalía, Thalía Harmony, Antonio Fernández-Bouzas, Lourdes Díaz-Comas, Roberto A. Prado-Alcalá, Pedro Valdés-Sosa, Gloria Otero, et al. (2007). Changes in EEG Current Sources Induced by Neurofeedback in Learning Disabled Children. An Exploratory Study. *Applied Psychophysiology and Biofeedback, 32*(3),169–83.

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.

Fernandez, T., Herrera, W., Harmony, T., Diaz-Comas, L., Santiago, E., Sanchez, L., … Valdes, R. (2003). EEG and behavioral changes following neurofeedback treatment in learning disabled children. *Clinical EEG (electroencephalography)*, *34*(3), 145–152.

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.

Flint, R. W., & Turek, C. (2003). Glucose effects on a continuous performance test of attention in adults. *Behavioural Brain Research*, *142*(1-2), 217–228.

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.

Foks, M. (2005). Neurofeedback training as an educational intervention in a school setting: How the regulation of arousal states can lead to improved attention and behaviour in children with special needs. *Educational and Child Psychology*, *22*(3), 67.

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.

Forbes, G. B. (1998). Clinical utility of the test of variables of attention (TOVA) in the diagnosis of attention-deficit/hyperactivity disorder. *Journal of Clinical Psychology*, *54*(4), 461–476.
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.

Fried, M., Tsitsiashvili, E., Bonneh, Y. S., Sterkin, A., Wygnanski-Jaffe, T., Epstein, T., & Polat, U. (2014). ADHD subjects fail to suppress eye blinks and microsaccades while anticipating visual stimuli but recover with medication. *Vision Research 101*, 62-72.
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.

Fried, P. A., Watkinson, B., & Gray, R. (2005). Neurocognitive Consequences of Marihuana—a Comparison with Pre-Drug Performance. *Neurotoxicology and Teratology, 27*(2), 231–239.
In determining the effects of regular marihuana use on neurocognition, abilities within specific relevant cognitive domains prior to regular drug use have not been available. The present study examined effects of current and past regular use of marihuana in subjects for whom pre-drug performance had been ascertained in a prospective, longitudinal fashion. A total of 113 young adults, assessed since infancy, were evaluated using neurocognitive tests for which commensurate measures were obtained prior to the initiation of marihuana smoking. Marihuana users, determined by urinalysis and self-report, were categorized as light(<5 joints per week) and heavy (≥5 joints per week) current users and former users, the latter having used the drug regularly in the past (≥1 joint per week) but not for at least 3 months. A third of the subjects were using marihuana on a regular basis at the time of assessment with half being heavy users. Among former, regular users, approximately half had been smoking 5 or more joints per week. Overall IQ, memory, processing speed, vocabulary, attention, and abstract reasoning were assessed. After accounting for potentially confounding factors and pre-drug performance in the appropriate cognitive domain, current regular heavy users did significantly worse than non-users in overall IQ, processing speed, immediate, and delayed memory. In contrast, the former marihuana smokers did not show any cognitive impairments. It was concluded that residual marihuana effects are evident beyond the acute intoxication period in

current heavy users after taking into account pre-drug performance but similar deficits are no longer apparent 3 months after cessation of regular use, even among former heavy using young adults.

Fried, P.A., B. Watkinson, and R. Gray. (2006). Neurocognitive Consequences of Cigarette Smoking in Young Adults—a Comparison with Pre-Drug Performance. *Neurotoxicology and Teratology,* 28(4), 517–25.
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 predicated 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.

Frye, R. E., Hasan, K., Xue, L., Strickland, D., Malmberg, B., Liederman, J., & Papanicolaou, A. (2008). Splenium microstructure is related to two dimensions of reading skill: *NeuroReport*, *19*(16), 1627–1631.
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.

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., & Kaiser, J. (2003). Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: a comparison with methylphenidate. *Applied Psychophysiology and Biofeedback*, *28*(1), 1–12.
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.

Garcia, T., Rodriguez, C., Gonzalez-Castro, P., Alvarez, D., Cueli, M., & González-Pienda, J. A. (2013). Executive Functioning in Children and Adolescents with Attention Deficit Hyperactivity Disorder and Reading Disabilities. *International Journal of Psychology and Psychological Therapy, 13*(2), 179–194.
Attention Deficit Hyperactivity Disorder (ADHD) and Reading Disabilities (RD) are two of the most common problems at school age, which are often associated. Several studies have addressed this association. However, its

etiology is still unknown. Although RD usually have been associated with phonological and visual problems and ADHD with executive functioning impairments, several studies also have shown executive functioning de cits in children and adolescents with RD. The aim of this study was to know executive functioning in a sample of 108 children and adolescents with ADHD and ADHD with RD associated, through the administration of the Behavior Rating Inventory of Executive Functions-BRIEF in its parents form. We found a higher executive de cit in the comorbid group than in the ADHD isolated group, being working memory and planning the most relevant domains. Beyond the study of this association, knowing the executive functioning pro le in each subgroup would also be useful for designing speci c intervention programs for each population.

Giordani, B., Novak, B., Sikorskii, A., Bangirana, P., Nakasujja, N., Winn, B. M., & Boivin, M. J. (2015). Designing and evaluating Brain Powered Games for cognitive training and rehabilitation in at-risk African children. *Global Mental Health*, *2*.

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

Goez, H., Back-Bennet, O., & Zelnik, N. (2007). Differential stimulant response on attention in children with comorbid anxiety and oppositional defiant disorder. *Journal of Child Neurology*, *22*(5), 538–542.

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

Goez, H. R., Scott, O., Nevo, N., Bennett-Back, O., & Zelnik, N. (2012). Using the Test of Variables of Attention to Determine the Effectiveness of Modafinil in Children With Attention-Deficit Hyperactivity Disorder (ADHD): A Prospective Methylphenidate-Controlled Trial. *J Child Neurology 27*(12), 1547–1552.

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.

González Castro, P., Rodríguez Pérez, C., López, A., Fernández Cueli, M. S., & Álvarez Pérez, L. (2013). Attention Deficit Hyperactivity Disorder, differential diagnosis with blood oxygenation, beta/theta ratio, and attention measures. *International Journal of Clinical and Health Psychology, 13*(2), 101–109.

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.

González-Castro, P., L. Álvarez, J. C. Núñez, J. A. González-Pienda, D. Álvarez, and J. Muñiz. (2010). Cortical Activation and Attentional Control in ADHD Subtypes. *International Journal of Clinical and Health Psychology, 10*(1), 23–39.

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.

González-Castro, P., Rodríguez, C., Cueli, M., Cabeza, L., & Álvarez, L. (2013). Math Competence and Executive Control Skills in Students with Attention Deficit/Hyperactivity Disorder and Mathematics Learning Disabilities. *Revista de Psicodidactica / Journal of Psychodidactics, 19*(1), 125–143.

Attention deficit disorder with hyperactivity (ADHD) shows a high comorbidity with mathematics learning disabilities (MLD).The aim of this study was to analyze the math skills and central executive skills (attention) of 288 students diagnosed with ADHD + MLD, ADHD, MLD or without disabilities or ADHD (comparison group). A descriptive ex post facto design was used, and two assessment instruments, TEMA 3 and TOVA, were employed. The results showed significant differences in attentional variables between the two groups with ADHD and the two without this disorder, resulting in two homogeneous subgroups, one made up of the ADHD and ADHD + MLD groups, and the other of the MLD and COM groups. However, in mathematical competence, ADHD and MLD influence in formal and informal competence in different ways. We conclude that ADHD + MLD comorbidity does not condition attentional capacity, but it does condition mathematical competence.

Grane, V. A., Endestad, T., Pinto, A. F., Solbakk, A.-K., & Vaidya, C. (2014). Attentional Control and Subjective Executive Function in Treatment-Naive Adults with Attention Deficit Hyperactivity Disorder. *PLOS ONE, 9*(12), 1-27.

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.

Greenberg, L. M., & Waldman, I. D. (1993). Developmental Normative Data on the Test of Variables of Attention (T.O.V.A.). *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *34*(6), 1019–30.

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 2md 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.

Grin'-Yatsenko, V., Kropotov, Y., Ponomarev, V., Chutko, L., & Yakovenko, E. (2001). Effect of Biofeedback Training of Sensorimotor and β1EEG Rhythms on Attention Parameters. *Human Physiology*, *27*(3), 259–266.

The effects of the EEG–biofeedback (EEG–BFB) procedure, aimed at increasing the sensorimotor (12–15 Hz) and β(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.

Gross-Tsur, V., Goldzweig, G., Landau, Y. E., Berger, I., Shmueli, D., & Shalev, R. S. (2006). The impact of sex and subtypes on cognitive and psychosocial aspects of ADHD. *Developmental Medicine and Child Neurology*, *48*(11), 901–905.

We compared the effect of sex and attention-deficit-hyperactivity disorder (ADHD) subtyping in groups of females and males. One hundred and one females with ADHD (mean age 10y 4mo [SD 2y 8mo]; range 5y-18y) were classified according to subtype by Diagnostic and Statistical Manual of Mental Disorders (4th edn) criteria (inattentive [ADHD-I]; combined [ADHD-C]) and balanced by subtype to 101 males (mean age 10y 5mo [SD 2y 9mo]; range 5y 4mo-17y 6mo). All children underwent IQ and reading assessment, and 109 underwent the continuous performance task (Test Of Variables of Attention [TOVA]). Parents completed the Conners' Abbreviated Rating Scale (ABRS), the Child Behavior Checklist (CBCL), learning disability questionnaires, and reported use and efficacy of methylphenidate. Teachers completed the Swanson, Kotkin, Agler, M-Flynn, and Pelham (SKAMP) rating scale. Sex differences were found only on the CBCL; females were more impaired on the attention ($p<0.001$) and

somatization (p=0.028) subscales but not for IQ, other questionnaires, TOVA scores, methylphenidate treatment, or demographics. Females with ADHD-C, but not males, had significantly higher T-scores than females with ADHD-I on social, attention, delinquent, and aggressive behaviours. Regardless of sex, children with ADHD-C had higher scores on all CBCL subscales (p=0.047), ABRS (p<0.001), and SKAMP (p=0.03) than children with ADHD-I. The results support the supposition that ADHD in females is the same disorder as in males. ADHD subtyping was the important determinant of ADHD core symptoms; females with ADHD were found to have significant risk of psychopathology.

Gruzelier, J. H., Foks, M., Steffert, T., Chen, M. J., & Ros, T. (2014). Beneficial Outcome From EEG-neurofeedback on Creative Music Performance, Attention and Well-being in School Children. *Biological Psychology*, *95*, 86–95.
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.

Hagen, H., Moore, K., Wickham, G., & Maples, W. C. (2008). Effect of the EYEPORT® SYSTEM on VISUAL FUNCTION in ADHD CHILDREN A PILOT STUDY. *Journal of Behavioral Optometry, 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.

Halawa, I., El Sayed, B., Amin, O., Meguid, N., & Abdel Kader, A. (2017). Frontal theta/beta ratio changes during TOVA in Egyptian ADHD children. *Neurosciences, 22*(4), 287–291.
Attention deficit hyperactivity disorder (ADHD) is the most commonly identified neurobehavioral complaint in childhood, its frequency is supposed to be 6-7%. The rhythm of electroencephalography (EEG) waveform, echoes the extent of stimulation of the brain zone underneath the electrode. Slow waveform activity, indicates reduction in blood flow and energy (glucose) consumption in this brain zone. These types of brain electrical activity as well echo the rank of arousal of the individual.2 Quantitative EEG (QEEG) bids numerous benefits, it possesses supreme chronological resolution (in millisecond time domain) precise to neuronal evidence handling, embodies non-invasive reflections of excitatory and inhibitory cortical neuronal activity concomitant with ancillary hemodynamic events. Moreover, it is economical and transportable. The spatial resolution has improved considerably as channel extent improved from 20-256. Many researches focused on describing the neural correlates of ADHD, chiefly signals in QEEG. The majority of these researches synopsize that ADHD exhibit a subordinate power in alpha and beta and a superior power in delta and theta bands, moreover, raised theta/beta ratio was perceived when compared to healthy control. The aim of this study is to detect the QEEG alterations in the frontal zone throughout Tests of Variance of Attention (TOVA) in children with ADHD compared to healthy control, and to identify signals that can assist in development a credible objective diagnostic test for ADHD.

Hansen, L. M., Trudeau, D. L., & Grace, D. L. (1996). Neurotherapy and Drug Therapy in Combination for Adult ADHD, Personality Disorder, and Seizure Disorder: A Case Report. *Journal of Neurotherapy*, *2*(1), 6–14.

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

Harch, P. G., Andrews, S. R., Fogarty, E. F., Amen, D., Pezzullo, J. C., Lucarini, J., … Van Meter, K. W. (2012). A phase I 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.

Hardy, P., Collet, J., Goldberg, J., Vanasse, M., Lambert, J., Marois, P., … Lassonde, M. (2002). Neuropsychological effects of hyperbaric oxygen therapy in cerebral palsy. *Developmental Medicine & Child Neurology, 44*(7), 436–446.
We conducted a double-blind placebo study to investigate the claim that hyperbaric oxygen treatment (HBO) improves the cognitive status of children with cerebral palsy (CP). Of 111 children diagnosed with CP (aged 4 to 12 years), only 75 were suitable for neuropsychological testing, assessing attention, working memory, processing speed, and psychosocial functioning. The children received 40 sessions of HBO or sham treatment over a 2-month period. Children in the active treatment group were exposed for 1 hour to 100% oxygen at 1.75 atmospheres absolute (ATA), whereas those in the sham group received only air at 1.3 ATA. Children in both groups showed better self-control and significant improvements in auditory attention and visual working memory compared with the baseline. However, no statistical difference was found between the two treatments. Furthermore, the sham group improved significantly on eight dimensions of the Conners' Parent Rating Scale, whereas the active treatment group improved only on one dimension. Most of these positive changes persisted for 3 months. No improvements were observed in either group for verbal span, visual attention, or processing speed.

Harris, E. L., Schuerholz, L. J., Singer, H. S., Reader, M. J., Brown, J. E., Cox, C., … Denckla, M. B. (1995). Executive function in children with Tourette syndrome and/or attention deficit hyperactivity disorder. *Journal of the International Neuropsychological Society: JINS*, *1*(6), 511–516.
Tourette Syndrome (TS) in children is associated with various neurobehavioral disorders including attention deficit hyperactivity disorder (ADHD). Children with TS and ADHD show some difficulties with neuropsychological tasks, but we do not know if children with TS alone have neuropsychological deficits. To assess specific cognitive differences among children with TS and/or ADHD, we administered a battery of neuropsychological tests, including 10 tasks related to executive function (EF), to 10 children with TS-only, 48 with ADHD-only, and 32 with TS + ADHD. Children in all groups could not efficiently produce output on a timed continuous performance task [Test of Variables of Attention (TOVA) mean reaction time and reaction time variability]. Children with TS-only appeared to have fewer EF impairments and significantly higher perceptual organization scores than children with TS + ADHD or ADHD-only. These findings suggest that deficiencies in choice reaction time and consistency of timed responses are common to all three groups, but children with TS-only have relatively less EF impairment than children with TS + ADHD or ADHD-only.

Harrison, A. G., Green, P., & Flaro, L. (2012). The Importance of Symptom Validity Testing in Adolescents and Young Adults Undergoing Assessments for Learning or Attention Difficulties. *Canadian Journal of School Psychology, 27*(1), 98–113.

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

Henry, G. K. (2005). Probable Malingering and Performance on the Test of Variables of Attention. *The Clinical Neuropsychologist*, *19*(1), 121–129.

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 malingering (PM) group, while 26 subjects who passed symptom validity testing comprised the not malingering (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.

Hong, H. J., Shin, D. W., Lee, E. H., Oh, Y. H., & Noh, K. S. (2003). Hypothalamic-pituitary-adrenal reactivity in boys with attention deficit hyperactivity disorder. *Yonsei Medical Journal*, *44*(4), 608–614.

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.

Hong, S., Im, M., Kim, J., Park, E., Shin, M., Kim, B., Yoo, H., et al. (2015). Environmental Lead Exposure and Attention Deficit/Hyperactivity Disorder Symptom Domains in a Community Sample of South Korean School-Age Children. *Environmental Health Perspectives, 123*(3).

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.

Horesh, N. (2001). Self-report vs. computerized measures of impulsivity as a correlate of suicidal behavior. *Crisis*, *22*(1), 27–31.
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 (ICS) and with the Test of Variables of Attention (TOVA), a continuous performance test (CPT). The TOVA is used to diagnose adolescents with attention deficit disorder. RESULTS: There was a significant but low correlation between the two measures of impulsivity. Only the TOVA commission and omission errors differentiated between adolescent suicide attempters and nonattempters. CONCLUSIONS: Computerized measures of impulsivity may be a useful way to measure impulsivity in adolescent suicide attempters. Impulsivity appears to play a small role only in nondepressed suicidal adolescents, especially boys.

Huang, Y., Chao, C., Wu, Y., Chen, Y., & Chen, C. (2007). Acute effects of methylphenidate on performance during the Test of Variables of Attention in children with attention deficit/hyperactivity disorder. *Psychiatry and Clinical Neurosciences, 61*(3), 219–225.
This study attempted to determine the acute effects of methylphenidate (MPH) on cognitive performance using the Test of Variables of Attention (TOVA) in children with attention deficit/hyperactivity disorder (ADHD). The study subjects comprised 57 children diagnosed with ADHD aged 6–13 years. Diagnoses of ADHD and other comorbid psychiatric disorders were based on Diagnostic and Statistical Manual of Mental Disorders-fourth edition criteria following a standard interview with the Schedule for Affective Disorder and Schizophrenia for School-Age Children, epidemiologic version. The subjects' performance on the TOVA was compared before and 1 h after administration of MPH. After administration of MPH, commission scores, response time and ADHD scores improved significantly, however, there were no significant changes in omission scores, response time variability, or response sensitivity. The authors concluded that administration of one dose of MPH (0.5–1.0 mg/kg) produced more effects on impulsivity than on attention deficiency in children with ADHD, and that the second half section of the TOVA could be more sensitive than the first half in determining the acute effects of MPH therapy in children with ADHD. However, the effects of different MPH doses on the TOVA results need further investigation.

Huang, Y. S., Chen, N. H., Li, H. Y., Wu, Y. Y., Chao, C. C., & Guilleminault, C. (2004). Sleep disorders in Taiwanese children with attention deficit/hyperactivity disorder. *Journal of Sleep Research*, *13*(3), 269–277.
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 starting drug treatment for ADHD.

Huang, Y.S., Guilleminault, C., Li, H.Y., Yang, C.M., Wu, Y.Y., & Chen, N.H. (2007). Attention-deficit/hyperactivity disorder with obstructive sleep apnea: a treatment outcome study. *Sleep Medicine*, *8*(1), 18–30.
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.

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, d' and ADHD score than older ones (≥9 y/o), the latter more significantly improved in response time than the former during 12 months of treatment. Additionally, boys improved more than girls in omission error and d'. Moreover, although ADHD subtypes significantly differed in ADHD score during the treatment, MPH treatment and ADHD subtypes did not interact with each other for all TOVA indices. ADHD patients significantly improved in impulsivity and perceptual sensitivity, determined as TOVA, during MPH treatment for 12 months. Age and gender, yet not ADHD subtypes, appear to influence the MPH treatment effects in some indices of TOVA. A future study containing a comparison group is suggested to confirm whether the neurocognitive improvements are attributed to long-term effects of MPH or natural maturation of patients.

Huang-Storms, L., Bodenhamer-Davis, E., Davis, R., & Dunn, J. (2006). QEEG-Guided Neurofeedback for Children with Histories of Abuse and Neglect: Neurodevelopmental 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.

Huckeba, W., Chapieski, L., Hiscock, M., & Glaze, D. (2008). Arithmetic performance in children with Tourette syndrome: relative contribution of cognitive and attentional factors. *Journal of Clinical and Experimental Neuropsychology*, *30*(4), 410–20.

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 compos- ite 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.

Hunt, M. G., Belfer, S., & Atuahene, B. (2014). Pagophagia Improves Neuropsychological Processing Speed in Iron-Deficiency Anemia. *Medical Hypotheses*, *83*(4), 473–476.

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.

Hunt, M. G., Bienstock, S. W., & Qiang, J. K. (2012). Effects of Diurnal Variation on the Test of Variables of Attention Performance in Young Adults with Attention-Deficit/Hyperactivity Disorder. *Psychological Assessment*, *24*(1), 166–172.

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.

Hunt, M. G., Momjian, A. J., & Wong, K. K. (2011). Effects of Diurnal Variation and Caffeine Consumption on Test of Variables of Attention (TOVA) Performance in Healthy Young Adults. *Psychological Assessment, 23*(1), 226–233.
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.

Hurford, D. P., Fender, A. C., Boux, J. L., Swigart, C. C., Boydston, P. S., Butts, S. R., … Pike, M. E. (2014). Examination of the Effects of Intelligence on the Test of Variables of Attention for Elementary Students. *Journal of Attention Disorders*, 1-9.
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.

Hurford, D. P., Lasater, K. A., Erickson, S. E., & Kiesling, N. E. (2011). Examination of the Diurnal Assumptions of the Test of Variables of Attention for Elementary Students. *Journal of Attention Disorders*, *17*(3), 208–214.
Objective: To examine the diurnal assumptions of the Test of Variables of Attention (TOVA). Method: The present study assessed 122 elementary students aged 5.5 to 10.0 years who were randomly assigned to one of four different groups based on time of administration (M-M: Morning–Morning, M-A: Morning–Afternoon, A-M: Afternoon–Morning, and A-A: Afternoon–Afternoon). Morning administration occurred between 8:00 and 10:00 a.m., and afternoon administration occurred between 1:00 and 3:00 p.m. Results: Reliability was consistent across groups, and there were no significant differences between groups. Classification of the students into ADHD or non-ADHD groups was similar across groups, and the children who were identified as ADHD with the Vanderbilt ADHD Diagnostic Teacher Rating Scale were consistently classified as ADHD on the TOVA regardless of time of day. Conclusion: The results of the present study indicate that the psychometric values of the TOVA remain intact whether its administration was in the morning or afternoon.

Hyman, S. L., Shores, A., & North, K. N. (2005). The nature and frequency of cognitive deficits in children with neurofibromatosis type 1. *Neurology, 65*(7), 1037.
To assess the frequency and severity of specific cognitive deficits in children with neurofibromatosis type 1 (NF1) in a large unbiased cohort.

Jensen, P. S., & Kenny, D. T. (2004). The effects of yoga on the attention and behavior of boys with Attention-Deficit/hyperactivity Disorder (ADHD). *Journal of Attention Disorders*, *7*(4), 205–216.
Boys diagnosed with ADHD by specialist pediatricians and stabilized on medication were randomly assigned to a 20-session yoga group (*n* = 11) or a control group (cooperative activities; *n* = 8). Boys were assessed pre- and post-intervention on the Conners' Parent and Teacher Rating Scales–Revised: Long (CPRS-R:L & CTRS-R:L; Conners, 1997), the Test of Variables of Attention (TOVA; Greenberg, Cormna, & Kindschi, 1997), and the Motion Logger Actigraph. Data were analyzed using one-way repeated measures analysis of variance (ANOVA). Significant improvements from pre-test to post-test were found for the yoga, but not for the control group on five subscales of the Conners' Parents Rating Scales (CPRS): Oppositional, Global Index Emotional Lability, Global Index Total, Global Index Restless/Impulsive and ADHD Index. Significant improvements from pre-test to post-test were found for the control group, but not the yoga group on three CPRS subscales: Hyperactivity, Anxious/Shy, and Social Problems. Both groups improved significantly on CPRS Perfectionism, DSM–IV Hyperactive/ Impulsive, and DSM–IV Total .For the yoga group, positive change from pre- to post-test on the Conners' Teacher Rating Scales (CTRS) was associated with the number of sessions attended on the DSM–IV Hyperactive-Impulsive subscale and with a trend on DSM–IV Inattentive subscale . Those in the yoga group who engaged in more home practice showed a significant improvement on TOVA Response Time Variability with a trend on the ADHD score, and greater improvements on the CTRS Global Emotional Lability subscale. Results from the Motion Logger Actigraph were inconclusive. Although these data do not provide strong support for the use of yoga for ADHD, partly because the study was under-powered, they do suggest that yoga may have merit as a complementary treatment for boys with ADHD already stabilized on medication, particularly for its evening effect when medication effects are absent. Yoga remains an investigational treatment, but this study supports further research into its possible uses for this population. These findings need to be replicated on larger groups with a more intensive supervised practice program.

John, C., Bangirana, P., Byarugaba, J., Opoka, R., Idro, R., Jurek, A., … Boivin, M. (2008). Cerebral Malaria in Children Is Associated With Long-term Cognitive Impairment. *PEDIATRICS, 122*(1), E92.
Cerebral malaria affects >785000 African children every year. We previously documented an increased frequency of cognitive impairment in children with cerebral malaria 6 months after their initial malaria episode. This study was conducted to determine the long-term effects of cerebral malaria on the cognitive function of these children. Children who were 5 to 12 years of age and presented to Mulago Hospital, Kampala, Uganda, with cerebral malaria (n = 44) or uncomplicated malaria (n = 54), along with healthy, asymptomatic community children (n = 89), were enrolled in a prospective cohort study of cognition. Cognitive testing was performed at enrollment and 2 years later. The primary outcome was presence of a deficit in ≥1 of 3 cognitive areas tested. At 2-year follow-up testing, 26.3% of children with cerebral malaria and 12.5% with uncomplicated malaria had cognitive deficits in ≥1 area, as compared with 7.6% of community children. Deficits in children with cerebral malaria were primarily in the area of attention (cerebral malaria, 18.4%, vs community children, 2.5%). After adjustment for age, gender, nutrition, home environment, and school level, children with cerebral malaria had a 3.67-fold increased risk for a cognitive deficit compared with community children. Cognitive impairment at 2-year follow-up was associated with hyporeflexia on admission and neurologic deficits 3 months after discharge. Cerebral malaria is associated with long-term cognitive impairments in 1 of 4 child survivors. Future studies should investigate the mechanisms involved so as to develop interventions aimed at prevention and rehabilitation.

Jones, J. L., Zalewski, C., Brewer, C., Lucker, J., & Drayna, D. (2009). Widespread Auditory Deficits in Tune Deafness. *Ear and Hearing*, *30*(1), 63–72.
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.

Joyce, M., & Siever, D. (2000). Audio-Visual Entrainment Program as a Treatment for Behavior Disorders in a School Setting. *Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience*, *4*(2), 9–25.

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

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.

Karimui, R. Y., & Karimoi, A. Y. (2014). The Effects of Beta-I and Fractal Dimension Neurofeedback on Reaction Time. I*nternational Journal of Intelligent Systems and Applications, 6*(11), 42–48.
In this paper, we evaluate the effects of neurofeedback training protocols of the relative power of the beta-I band and the fractal dimension on the reaction time of human by the Test of Variables of Attention (TOVA) to show which of these two protocols have the great ability for the improving of the reaction time. The findings of this research show that both protocols have a good ability ($p < 0.01$) to improving of the reaction time and can create the significant difference (as mean dRT = 37.3 ms for the beta-I protocol and dRT = 19.6 ms for the fractal protocol) in the reaction time. Of course, we must express, the Beta-I protocol has the more ability to improving of the reaction time and it is able to provide a faster reaction time.

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.

Kean, J. D., Camfield, D., Sarris, J., Kras, M., Silberstein, R., Scholey, A., & Stough, C. (2013). A randomized controlled trial investigating the effects of PCSO-524®, a patented oil extract of the New Zealand green lipped mussel (Perna canaliculus), on the behaviour, mood, cognition and neurophysiology of children and adolescents (aged 6–14 years) experiencing clinical and sub-clinical levels of hyperactivity and inattention: study protocol ACTRN12610000978066. *Nutrition Journal, 12*(1).
The prevalence rate of attention-deficit/hyperactivity disorder (ADHD) within Western cultures is between 5% and 12%, and is the most common psychiatric illness among school-aged children, with an estimated 50% of these children retaining ADHD symptoms for the rest of their lives. Children with ADHD have lower blood levels of long-chain Poly Unsaturated Fatty Acids (LC PUFAs) compared with children without ADHD, and following PUFA supplementation, have shown improvements in ADHD-related symptoms. One highly promising marine based LC PUFA preparation is the Omega-3-rich Lyprinol/Omega XL which is a natural formulation containing standardised lipid extract of the New Zealand green lipped mussel (Perna canaliculus) known as PCSO-524® which contains a unique combination of free fatty acids, sterol esters, polar lipids and carotenoids. It is this unique combination of marine lipids that may assist in correcting the decreased levels of LC PUFA levels in children with symptoms of ADHD. The compound is a mixture belonging to a lipid group called sterol esters (SE). The fatty acids in the SE fraction are mainly myristic acid, palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). Lyprinol/Omega XL has previously been shown to contain a potent group of Omega-3 lipids that block the 5 - lipoxygenase metabolic pathway responsible for inflammation in the body. A randomized double blind placebo controlled trial will be utilized to assess the effects of 14 weeks administration of Lyprinol/Omega XL versus placebo in 150 children aged 6 to 14 years with high levels of hyperactivity and inattention. Additionally, a range of cognitive, mood and central electrophysiological measures will be undertaken during the 14 week supplementation trial. The primary outcome measure, the Conners' Parent Rating Scales will be completed initially at baseline, then in weeks 4, 8, 10, 14 and then again at 4 weeks

post-administration (week 18). The results will contribute to our understanding of the efficacy of marine based Omega-3 s with high antiinflammatory actions on inattention and hyperactivity in children aged 6 to 14 years.

Keith, J. R., Rapgay, L., Theodore, D., Schwartz, J. M., & Ross, J. L. (2014). An Assessment of an Automated EEG Biofeedback System for Attention Deficits in a Substance Use Disorders Residential Treatment Setting. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*.
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.

Keith, J. R., Blackwood, M. E., Mathew, R. T., & Lecci, L. B. (2016). Self-Reported Mindful Attention and Awareness, Go/No-Go Response-Time Variability, and Attention-Deficit Hyperactivity Disorder. *Mindfulness*. https://doi.org/10.1007/s12671-016-0655-0
The abilities 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. Overall, participants' 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.

Kennel, S., Taylor, A. G., Lyon, D., & Bourguignon, C. (2010). Pilot feasibility study of binaural auditory beats for reducing symptoms of inattention in children and adolescents with attention-deficit/hyperactivity disorder. *Journal of Pediatric Nursing*, *25*(1), 3–11.
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.

Kim, B.-N., Cho, S.-C., Kim, Y., Shin, M.-S., Yoo, H.-J., Kim, J.-W., … Hong, Y.-C. (2009). Phthalates Exposure and Attention-Deficit/Hyperactivity Disorder in School-Age Children. *Biological Psychiatry, 66*(10), 958–963.
Very few studies have examined the association between attention-deficit/hyperactivity disorder (ADHD) and phthalate exposure in humans. The aim of this study was to investigate the impact of phthalates on symptoms of ADHD in school-age children. Methods: A cross-sectional examination of urine phthalate concentrations was performed, and scores on measures of ADHD symptoms and neuropsychological dysfunction with regard to attention and impulsivity were obtained from 261 Korean children, age 8 –11 years. Results: Mono-2-ethylheylphthalate(MEHP)andmono-2-ethyl 5-oxohexylphthalate(MEOP)formetabolitesofDi-2-ethylhexylphthalate (DEHP) and mono-n-butyl phthalate (MNBP) for metabolites of dibutyl phthalate (DBP) were measured in urine samples. The mean concentrations of MEHP, MEOP, and MNBP were 34.0 g/dL (SD 36.3; range: 2.1–386.7), 23.4 g/dL (SD 23.0; range: .75–244.8), and 46.7 g/L (SD 21.4; range: 13.2–159.3), respectively. After adjustment for covariates, teacher-rated ADHD scores were significantly associated with DEHP metabolites but not with DBP metabolites. We also found significant relationships between the urine concentrations of metabolites for DBP and the number of omission and commission errors in continuous performance tests (CPT) after adjustment for covariates. Conclusion: The present study showed a strong positive association between phthalate metabolites in urine and symptoms of ADHD among school-age children.

Kim, S.-T., & Kim, J.-H. (1996). Child, Dyslexia, Attention Deficit/Hyperactivity Disorder. *Korean Academy of Child and Adolescent Psychiatry, 7*, 224–232.
There is no abstract available for this item.

King, A., Herron, S., Mckinstry, R., Bacak, S., Armstrong, M., White, D., & Debaun, M. (2006). A Multidisciplinary Health Care Team's Efforts to Improve Educational Attainment in Children With Sickle-Cell Anemia and Cerebral Infarcts. *J Sch Health, 76*(1), 33–37.
ABSTRACT: The primary objective of this study was to improve the educational success of children with sickle-cell disease (SCD) and cerebral infarcts. A prospective intervention trial was conducted; a multidisciplinary team was created to maximize educational resources for children with SCD and cerebral infarcts. Students were evaluated systematically before and after the intervention. A baseline evaluation was completed assessing the presence of an Individualized Education Plan (IEP), grade retention in school, and days absent from school in the year preceding the intervention. A postintervention assessment occurred 2 years later for these same measurements. At baseline, 74% (17 of 23) of the students were receiving IEPs. Two years later, 87% (20 of 23) students received IEPs (p 1⁄4 .34). Despite the intervention, the rate of children retained in their school grade increased from 0.6 per 100 years in school at baseline to 1.7 per 100 years, 95% CI (ÿ3.86, 1.49). The school absenteeism rate did not significantly change after the intervention; the average days absent per student rose from 15.5 to 22.5, (p 1⁄4 .05). The multidisciplinary team effort alone was insufficient to decrease grade retention and absenteeism rate. Further support, from either the parents or school administration, is needed to increase education attainment of students with cerebral infarcts.

Koch, K. S. (2003). Is the Effect of Neurotherapy on Attentional Ability of Children with ADHD Maintained Over Time? *Unisa Psychologia, 29*, 5–20.
This study explored whether improvements in attentional ability, as resulted during neurotherapy electroencephalogram (EEG) biofeedback treatment, were maintained over time in children with Attention Deficit / Hyperactivity Disorder (ADHD). A computerised continuous performance test, the test of variables of attention (TOVA), was used to test the attentional ability of 28 clients (23 male and 5 female, aged 7 to 16 years, average age = 12 years) of the Behavioural Neurotherapy Clinic in Melbourne, Australia. Measurements were taken prior to the start of treatment (point 0), at the point where treatment finished (point 1) and at an average of 19 months since

the completion of treatment (point 2). Where a participant had three valid test results (n=12), the raw scores were compared. It showed that the improvement in attentional ability for these candidates had remained stable since treatment finished. To account for children who had one or more sets of invalid scores, the number of invalid quarters for the entire group (N=28) was compared at the three points. This metric indicates that there was convincing evidence that when neurotherapy offered results, there is lasting improvement. However, attentional ability did not necessarily remain at the same level as at the completion of treatment. This study offers guarded support for neurotherapy as a safe and possibly long-lasting treatment for attention deficit. Somewhat contradictory evidence was found about the longevity of treatment results based on different measurement metrics. The results should also be interpreted in the light of reservations about bias in the sample and possible concerns about usage of the TOVA as a repeat measurement tool. This article also offers suggestions for further research in this area, such as the significance of other treatments and the effect of comorbidity.

Kropotov, Jury D., Vera A. Grin-Yatsenko, Valery A. Ponomarev, Leonid S. Chutko, Elena A. Yakovenko, and Inna S. Nikishena. (2005). ERPs Correlates of EEG Relative Beta Training in ADHD Children. *International Journal of Psychophysiology, 55*(10), 23–34.

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.

Kuhn, K., & Cambron, J. (2013). Chiropractic Management Using a Brain-Based Model of Care for a 15-year-old Adolescent Boy with Migraine Headaches and Behavioral and Learning Difficulties: A Case Report. *Journal of Chiropractic Medicine, 12*(4), 274.

The purpose of this report is to describe chiropractic management, using a brain-based model of care, of a teen who had migraine headaches and several social and learning difficulties.

Lacey, Daniel J., Adrienne Stolfi, and Louis E. Pilati. (2012). Effects of Hyperbaric Oxygen on Motor Function in Children with Cerebral Palsy. *An Neur*, *72*(5), 695–703.

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.

Leark, R. A., Dixon, D., Hoffman, T., & Huynh, D. (2002). Fake bad test response bias effects on the test of variables of attention. *Archives of Clinical Neuropsychology*, *17*(4), 335–342.

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.

Leark, R. A., Wallace, D. R., & Fitzgerald, R. (2004). Test-retest reliability and standard error of measurement for the test of variables of attention (T.O.V.A.) with healthy school-age children. *Assessment*, *11*(4), 285–289.
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.

Lee, K. T., Mattson, S. N., & Riley, E. P. (2004). Classifying children with heavy prenatal alcohol exposure using measures of attention. *Journal of the International Neuropsychological Society: JINS*, *10*(2), 271–7.
Deficits in attention are a hallmark of the effects of heavy prenatal alcohol exposure but although such deficits have been described in the literature, no attempt to use measures of attention to classify children with such exposure has been described. Thus, the current study attempted to classify children with heavy prenatal alcohol exposure (ALC) and non-exposed controls (CON), using four measures of attentional functioning: the Freedom from Distractibility index from the Wechsler Intelligence Scale for Children–Third Edition (WISC–III), the Attention Problems scale from the Child Behavior Checklist (CBCL), and omission and commission error scores from the Test of Variables of Attention (TOVA). Data from two groups of children were analyzed: children with heavy prenatal alcohol exposure and non-exposed controls. Children in the alcohol-exposed group included both children with or without fetal alcohol syndrome. Groups were matched on age, sex, ethnicity, and social class. Data were analyzed using backward logistic regression. The final model included the Freedom from Distractibility index from the WISC–III and the Attention Problems scale from the CBCL. The TOVA variables were not retained in the final model. Classification accuracy was 91.7% overall. Specifically, 93.3% of the alcohol-exposed children and 90% of the control children were accurately classified. These data indicate that children with heavy prenatal alcohol exposure can be distinguished from non-exposed controls with a high degree of accuracy using 2 commonly used measures of attention.

Lee, S., Lee, H., Ko, R., & Shin, Y. (2000). T.O.V.A. Profiles of Clinically Referred Children With Symptoms of Inattention. Journal of the Korean Academy of Child and Adolescent Psychiatry, 11(2), 290–296.
Objective: This study aims to investigate the cognitive characteristics of clinically referred children with symptoms of inattention, cach as having ADHD, tic disorder, and emotional disorder. Methods: 65 boys(38 with ADHD, 17 with Tic disorder, and 10 with Emotional disorder) were individually assessed using the KEDI-WISC(FIQ, VIQ, PIQ) and T.O.V.A.(errors of omission, errors of commission, reaction time, variability, anticipatory response, multiple response), and the results of those tests were analyzed. Results: There was significant difference among three diagnostic groups of the VIQ of KEDIWISC and the reaction time of T.O.V.A. after the correction of the effect of age difference. Conclusions: The findings suggest that the reaction time of T.O.V.A. might be the useful variable to differentiate the ADHD from other psychiatric disorders and the effect of age and IQ difference should be considered carefully to diagnose in clinical setting.

Levine, L. E., Waite, B. M., & Bowman, L. L. (2013). Use of Instant Messaging Predicts Self-Report but Not Performance Measures of Inattention, Impulsiveness, and Distractibility. *Cyberpsychology, Behavior, and Social Networking, 16*(12), 898–903.
We examined how young adults' use of instant messaging, text messaging, and traditional reading related to their self-reported experience of distractibility and impulsiveness and to their performance on computerized tasks designed to assess inattention and impulsive responses to visual stimuli. Participants reported their media use and completed self-report measures of impulsiveness (i.e., the Barratt Impulsiveness Scale) and distractibility for academic reading. They also completed performance based measures of inattention and impulsiveness using the Tests of Variables of Attention (T.O.V.A.(®)). Results demonstrated that instant message use was significantly related to higher levels of attentional impulsiveness and distractibility on the self-report measures, while traditional reading consistently predicted lower levels of impulsiveness and distractibility. However, media use was not significantly related to the performance measures of inattention and behavioral impulsiveness.

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's 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 θ waves, β waves, α waves, SMR waves, α/SMR power ratio, θ/β power ratio. Before and after intervention, Chinese-Binet intelligence scale(CBIS) and the test of variables of attention (TOVA) were tested. Result: Observation group: After 3 month-EEGBF treatment, the children's θ waves reduced markedly (P<0.05), β waves increased significantly (P<0.05), θ/β power ratio decreased obviously (P<0.05); α waves decreased obviously (P<0.05), SMR wave increased significantly (P<0.05), α/SMR power ratio decreased obviously (P<0.05). Control group: comparing with those waves before treatment, θ waves decreased obviously (P<0.05), β waves, θ/β power ratio, α waves, SMR waves and α/SMR power ratio showed no significant difference (P>0.05). After treatment, in observation group the intelligential 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.

Lin, H. Y., Hsieh, H. C., Lee, P., Hong, F. Y., Chang, W. D., & Liu, K. C. (2014). Auditory and Visual Attention Performance in Children With ADHD: The Attentional Deficiency of ADHD Is Modality Specific. *Journal of Attention Disorders*. DOI:
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.

Llorente, A. M., Amado, A. J., Voigt, R. G., Berretta, M. C., Fraley, J. K., Jensen, C. L., & Heird, W. C. (2001). Internal consistency, temporal stability, and reproducibility of individual index scores of the Test of Variables of Attention in children with attention-deficit/hyperactivity disorder. *Archives of Clinical Neuropsychology: The Official Journal of the National Academy of Neuropsychologists*, *16*(6), 535–46.
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.

Llorente, A. M., Voigt, R., Jensen, C. L., Fraley, J. K., Heird, W. C., & Rennie, K. M. (2008). The Test of Variables of Attention (TOVA): internal consistency (Q(1) vs. Q(2) and Q(3) vs. Q(4)) in children with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence*, *14*(4), 314–322.
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.

Llorente, A. M., Voigt, R. G., Jensen, C. L., Berretta, M. C., Kennard Fraley, J., & Heird, W. C. (2006). Performance on a visual sustained attention and discrimination task is associated with urinary excretion of norepinephrine metabolite in children with attention-deficit/hyperactivity disorder (AD/HD). *The Clinical Neuropsychologist*, *20*(1), 133–144.
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.

Lockwood, K. A., Bell, T. S., & Colegrove, R. W. (1999). Long-Term Effects of Cranial Radiation Therapy on Attention Functioning in Survivors of Childhood Leukemia. *Journal of Pediatric Psychology, 24*(1), 55–66.
Objective: To retrospectively examine the long-term effects of cranial radiation therapy (CRT) on attention functioning. Methods: Fifty-six survivors of childhood leukemia who had been randomly assigned to a treatment regimen of chemotherapy with or without 1,800 cGy CRT were administered a neuropsychological test battery. Results: Significant differences were found between the irradiated and nonirradiated groups on three of four attentional components. An interaction between treatment type and age at diagnosis was significant on one attentional component. Further, the mean scores of participants irradiated in early childhood were significantly low

relative to published norms for age-standard scores on the majority of task variables, while the other groups showed rare deviations from average scores. Conclusions: Findings from this study indicate that early irradiation was associated with significant impairment in attentional filtering, focusing, and automatic shifting.

Lorberboym, M., Watemberg, N., Nissenkorn, A., Nir, B., & Lerman-Sagie, T. (2004). Technetium 99m ethylcysteinate dimer single-photon emission computed tomography (SPECT) during intellectual stress test in children and adolescents with pure versus comorbid attention-deficit hyperactivity disorder (ADHD). *Journal of Child Neurology*, *19*(2), 91–96.

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.

Lou, H. C., Rosa, P., Pryds, O., Karrebaek, H., Lunding, J., Cumming, P., & Gjedde, A. (2004). ADHD: increased dopamine receptor availability linked to attention deficit and low neonatal cerebral blood flow. *Developmental Medicine and Child Neurology*, *46*(3), 179–183.

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

Lubar, J. F., Noland White, J., Swartwood, M. O., & Swartwood, J. N. (1999). Methylphenidate Effects on Global and Complex Measures of EEG. *Pediatr Neurol, 21*, 633–637.

Methylphenidate (MPH) effects on global and complex measures of electroencephalography were examined in boys with attention-deficit–hyperactivity disorder between the ages of 9 and 11 years. Electroencephalogram (EEG) data were collected separately from the administration of a continuous performance task and were evaluated for changes in overall frequency, coherence, phase, and asymmetry and against a referential database. MPH did not produce a clear change in EEG frequency measures compared with the task condition, although it did induce regional changes in the EEG and produced an improvement in task performance. In comparison against the referential database, MPH appeared to lessen the impact of abnormalities in EEG coherence, EEG phase, and EEG asymmetry on performance measures.

Lubar, J. F., Swartwood, M. O., Swartwood, J. N., & O'Donnell, P. H. (1995). Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by changes in T.O.V.A. scores, behavioral ratings, and WISC-R performance. *Biofeedback and Self-Regulation*, *20*(1), 83–99.

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.

Lufi, D., & Fichman, N. (2012). Development and Use of a Computerized Test, MATH-CPT, to Assess Attention. *Perceptual and Motor Skills*, *114*(1), 59–74.

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

Manor, I., Ben-Hayun, R., Aharon-Peretz, J., Salomy, D., Weizman, A., Daniely, Y., Megiddo, D., Newcorn, J., Biederman, J., and Adler, L. A. (2012). A Randomized, Double-blind, Placebo-controlled, Multicenter Study Evaluating the Efficacy, Safety, and Tolerability of Extended-release Metadoxine in Adults with Attention-Deficit/Hyperactivity Disorder. *The Journal of Clinical Psychiatry*, *73*(12), 1517–1523.

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.

Manor, I., Gutnik, I., Ben-Dor, D. H., Apter, A., Sever, J., Tyano, S., … Zalsman, G. (2010). Possible association between attention deficit hyperactivity disorder and attempted suicide in adolescents - a pilot study. *European Psychiatry: The Journal of the Association of European Psychiatrists*, *25*(3), 146–150.

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.

Manor, I., Tyano, S., Mel, E., Eisenberg, J., Bachner-Melman, R., Kotler, M., & Ebstein, R. P. (2002). Family-based and association studies of monoamine oxidase A and attention deficit hyperactivity disorder (ADHD): preferential transmission of the long promoter-region repeat and its association with impaired performance on a continuous performance test (TOVA). *Molecular Psychiatry*, *7*(6), 626–32.

Monoamine oxidase A (MAO A) is located on the X chromosome and metabolizes biogenic amines including dopamine, norepinephrine and serotonin. A functional promoter-region polymorphism of this gene has been described that has been studied in a number of mental illnesses but not in attention deficit hyperactivity disorder (ADHD). In the current study, we examined the MAO A promoter-region polymorphism initially in 133 triads and observed preferential transmission of the long alleles from 74 heterozygote mothers to ADHD probands (chi(2) = 4.37, P = 0.036, df = 1). We also examined the role of this polymorphism in a computerized continuous performance test, the TOVA. Significant differences were observed on errors of commission (chi(2) = 7.021, P = 0.008) and patients carrying the long MAO A allele made significantly more such errors. Errors of commission are a measure of impulsivity. However, following Ritalin (methylphenidate) administration the association between this polymorphism and errors of commission was markedly attenuated and no longer significant at the P < 0.05 level. We also analyzed the provisional association by the case-control design. A significant difference in allele frequency was observed between 110 male probands vs 202 male controls (Pearson chi(2) = 7.94, P = 0.047). Similarly results were obtained when 19 female probands were compared to female controls (genotype chi(2) = 21.28; P = 0.0032, 3 df and allele chi(2) = 30.88, P= 0.0007, 2 df). All three complementary approaches employed (family-based, case-control and quantitative trait design) suggest a role for the MAO A promoter-region polymorphism in conferring risk for ADHD in our patient population.

Manor, I., Corbex, M., Eisenberg, J., Gritsenkso, I., Bachner-Melman, R., Tyano, S., & Ebstein, R. P. (2004). Association of the dopamine D5 receptor with attention deficit hyperactivity disorder (ADHD) and scores on a continuous performance test (TOVA). *American Journal of Medical Genetics. Part B, Neuropsychiatric Genetics: The Official Publication of the International Society of Psychiatric Genetics, 127B*, S364.

Towards further clarifying the role of dopamine D5 receptor (DRD5) microsatellite polymorphism in the etiology of ADHD, we used a robust family based strategy to test for association between DRD5 and this disorder. Additionally, a neuropsychological mechanism by which this allele may confer risk was explored by examining the relationship between DRD5 genotype and scores on a continuous performance test. DNA was obtained from 164 probands and their parents. Additionally, the majority of these probands were administered a computerized continuous performance test, the Test Of Variables of Attention (TOVA). We first confirmed preferential transmission (TDT ?2?=?7.02, P?=?0.008) of the 148 base pair allele in 155 informative transmissions (94 transmitted and 61 non-transmitted 148 bp allele). Additionally, we used a family-based association test (FBAT) and observed significant multivariate association using FBAT between TOVA scores before methylphenidate administration and the DRD5 microsatellite polymorphism across all four TOVA variables: multi-allelic, multivariate test ?2?=?16.32, P?=?0.037 when the 148 bp allele was compared to all others (collapsed genotype) that was also significant (?2?=?59.20, P?=?0.025) when all 14 alleles (full genotype) were analyzed. Following methylphenidate, no significant association was observed (?2?=?12.08, P?=?0.147 for 148 bp versus all others) and, similarly, for all 14 alleles (?2?=?47.18, P?=?0.343). In summary, the main finding of this report is that the DRD5 repeat polymorphism

confers a small but significant risk for ADHD consistent with previous reports. Provisional results in this single investigation suggest that the DRD5 microsatellite also affects performance scores on the TOVA.

Manor, I., Ebstein, R., Weizman, A., & Tyano, S. (2003). Efficacy of single low-dose methylphenidate administration in adult ADHD patients according to psychometric assessment. *Dyn. Psychiatr.*, *36*(1-2), 75–88.
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 ($p\leq0.001$). Commission score, which correlates to impulsivity, showed the least improvement under MPH treatment, and was aggravated at higher doses (T= -0.16, p=0.88). Conclusions: Low doses of MPH seem to be efficient in adults according to the improvement in T.O.V.A., while higher dosages may correlate with side effects.

Manor, I., Laiba, E., Eisenberg, J., Meidad, S., Lerer, E., Israel, S., … Ebstein, R. P. (2008). Association between tryptophan hydroxylase 2, performance on a continuance performance test and response to methylphenidate in ADHD participants. *American Journal of Medical Genetics. Part B, Neuropsychiatric Genetics: The Official Publication of the International Society of Psychiatric Genetics*, *147B*(8), 1501–1508.
The main objective of this study was to examine neuropsychological mechanisms mediating the association between tryptophan hydroxylase 2 (TPH2) and attention deficit hyperactivity disorder (ADHD). A continuous performance test (T.O.V.A.) was administered to 344 participants diagnosed with DSM IV ADHD who were also genotyped for eight TPH2 intronic SNPs. Association between TPH2 (single SNPs and haplotypes), ADHD, and performance on the T.O.V.A. were tested using robust family-based association tests as implemented in two statistical genetic programs: UNPHASED and PBAT. Association was only observed between an eight locus haplotype and ADHD DSM IV combined type III (global P = 0.036). Robust association was observed between TPH2 single SNPs (and haplotypes) and performance on the T.O.V.A., especially Errors of Omission (eight locus haplotypes, global P = 0.038). Significant associations were also observed between TPH2 and improvement (before-after scores) in T.O.V.A. Total Response Variability scores following acute methylphenidate challenge (eight locus haplotypes, global P = 0.009). Using the MFBAT program, significant multivariate association was observed between single SNPs and haplotypes [eight locus haplotypes and all four T.O.V.A. variables (PBAT-GEE P = 0.013)]. The two most common TPH2 eight locus haplotypes were in a Yin Yang configuration and the Yang haplotype was the risk haplotype for both DSM IV ADHD and deficits in neuropsychological performance. The current investigation shows that risk for ADHD conferred by TPH2 variants is partially mediated by serotonergic mechanisms impacting some facets of executive function. Importantly, improvement in T.O.V.A. performance, especially on Response Time Variability, following methylphenidate was also associated with TPH2.

Manor, I., Meidad, S., Zalsman, G., Zemishlany, Z., Tyano, S., & Weizman, A. (2008). Objective versus subjective assessment of methylphenidate response. *Child Psychiatry and Human Development*, *39*(3), 273–282.
Subjective improvement-assessment in attention deficit/hyperactivity disorder (ADHD), following a single dose of methylphenidate (MPH) was compared to performance on the Test-of-Variables-of-Attention (TOVA). Self-perception was assessed with the clinical-global-impression-of-change (CGI-C). Participants included 165 ADHD subjects (M:F ratio 67%:33%) aged 5-18 (11.09 +/- 3.43) years. TOVA was administered before and after MPH challenge (0.3 mg/kg). Self-perception CGI-C scores were compared to the TOVA scores. An inverse correlation was found only between CGI-C and the TOVA-Commission-scores ($r = -0.326$, $p < 0.001$). We thus conclude that subjective reports are too unreliable to be used in order to assess MPH benefit in ADHD pediatric populations.

Manor, I., Newcorn, J. H., Faraone, S. V., & Adler, L. A. (2013). Efficacy of Metadoxine Extended Release in Patients with Predominantly Inattentive Subtype Attention-Deficit/Hyperactivity Disorder. *Postgraduate Medicine, 125*(4).
Objectives: To compare the effects of metadoxine extended release (ER) with those of placebo on inattentive (IA) versus hyperactive-impulsive (H-I) symptoms and predominantly inattentive (PI) versus combined type (CT) subtype

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

Manor, I., Rozen, S., Zemishlani, Z., Weizman, A., & Zalsman, G. (2011). When Does It End? Attention-Deficit/Hyperactivity Disorder in the Middle Aged and Older Populations. *Clinical Neuropharmacology*, *34*(4), 148–154.
Background: Attention-deficit/hyperactivity disorder (ADHD) is estimated to affect 4% to 6% of the adult population. In recent years, more and more middle-aged and older adults (955 years) turn to the ADHD unit at Geha Mental Health Center suspecting ADHD. Yet, a literature search resulted in very few relevant studies. Methods and Results: This study, approved by the Geha Mental Health Center ethics committee, presents 11 patients, 55 years or older, diagnosed and treated by the unit. The patients underwent complete clinical evaluation for ADHD according to Diagnostic and Statistical Manual of Mental Disorder, Fourth Edition. The data-collection phase included demographic and clinical data; Test of Variables of Attention scores used as indicators of methylphenidate (MPH) response; Clinical Global Impression scores of both severity and improvement were used. Because the sample is very small, allowing only limited statistical analyses, nonparametric statistics were used. Eleven patients, aged 61.64 T 3.87 years (male-female ratio, 9:2), were assessed. The follow-up was conducted for more than 2 months. Fifty-five percent had ADHD, predominantly inattentive, and 45% had ADHD combined type. All patients indicated suffering (Clinical Global-Impression Severity score range: mild = 27.3%, moderate = 45.4%, severe = 27.3%). Fifty-four per- cent showed at least 1 psychiatric comorbidity. Test of Variables of Attention scores showed significant improvement in 90% (8/9 patients) with MPH dosages similar to those used in younger adults. All patients attended the follow-up visits. Ninety-one percent (10/11) continued with the medication. Clinical Global Impression-Improvement scores showed significant improvement in 73%. No adverse effects were reported. Conclusions: This pilot study described 11 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.

Manor, I., Rubin, J., Daniely, Y., & Adler, L. A. (2014). Attention Benefits After a Single Dose of Metadoxine Extended Release in Adults with Predominantly Inattentive ADHD. *Postgraduate Medicine*, *126*(5), 7–16.
OBJECTIVE: To assess the first-dose effectiveness and tolerability of metadoxine extended release (MDX) in adults with predominantly inattentive attention-deficit/hyperactivity disorder (ADHD-PI). METHODS: In this double-blind, placebo-controlled, crossover study, adults with ADHD-PI were randomized 1:1:1 to receive a single dose of MDX 1400 mg, MDX 700 mg, and placebo (ClinicalTrials.gov identifier: NCT01685281). The primary efficacy end point was the mean change in the Test of Variables of Attention (TOVA) ADHD score from baseline to 3 to 5 hours after drug administration. Secondary assessments included TOVA subscores, TOVA response rates (defined as an increase of 0.8 points in the TOVA ADHD score), and the Cambridge Neuropsychological Automated Test Battery. Safety assessments included adverse events and vital signs. RESULTS: The intention-to-treat population included 36 patients (52.8% men; mean age, 32 years). The efficacy of MDX 1400 mg was demonstrated by a statistically significant difference in the mean (+/- SD) change in the TOVA ADHD score at baseline to 3 to 5 hours after drug administration compared with placebo (2.0 [4.2]; P = 0.009). The TOVA response time variability subscore was significantly different between MDX 1400 mg and placebo (mean difference, 7.9 [19.2] points; P = 0.022). Significantly more adults responded to single-dose MDX 1400 mg versus placebo (97.1% vs 71.4%, P = 0.006). There

were no statistically significant differences between MDX 700 mg and placebo on any measures. Exploratory analyses of the Cambridge Neuropsychological Automated Test Battery did not yield significant findings. Fatigue and headache were the 2 most frequently reported adverse events. There were no clinically significant abnormalities in laboratory values, vital signs measurements, Columbia-Suicide Severity Rating Scale scores, or electrocardiographic parameters. CONCLUSIONS: Single-dose MDX 1400 mg significantly improved sustained and selective attention in adults with ADHD-PI as measured by the TOVA ADHD score 3 to 5 hours after drug administration. Single doses of MDX 700 and 1400 mg were well tolerated.

Manor, I., Sever, Y., & Weizman, A. (1999). Computerized test as a diagnostic auxiliary–TOVA–another tool in the diagnosis of attention deficit disorders (ADHD). *Harefuah, 136*(10), 812–815.
There is no abstract available for this item.

Manor, I., Tyano, S., Eisenberg, J., Bachner-Melman, R., Kotler, M., & Ebstein, R. P. (2002). The short DRD4 repeats confer risk to attention deficit hyperactivity disorder in a family-based design and impair performance on a continuous performance test (TOVA). *Molecular Psychiatry*, *7*(7), 790–794.
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.

Mansfield, L., Mendoza, C., Flores, J., & Meeves, S. G. (2003). Effects of fexofenadine, diphenhydramine, and placebo on performance of the test of variables of attention (TOVA). *Annals of Allergy, Asthma & Immunology: Official Publication of the American College of Allergy, Asthma, & Immunology*, *90*(5), 554–559.
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.

Marshall, P., Schroeder, R., O'Brien, J., Fischer, R., Ries, A., Blesi, B., & Barker, J. (2010). Effectiveness of symptom validity measures in identifying cognitive and behavioral symptom exaggeration in adult attention deficit hyperactivity disorder. *The Clinical Neuropsychologist*, *24*(7), 1204–1237.
This study examines the effectiveness of symptom validity measures to detect suspect effort in cognitive testing and invalid completion of ADHD behavior rating scales in 268 adults referred for ADHD assessment. Patients were

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

Mautner, V.-F., Kluwe, L., Thakker, S. D., & Leark, R. A. (2002). Treatment of ADHD in neurofibromatosis type 1. *Developmental Medicine and Child Neurology*, *44*(3), 164–170.
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.

Memória, C. M., Muela, H. C. S., Moraes, N. C., Costa-Hong, V. A., Machado, M. F., Nitrini, R., … Yassuda, M. S. (2018). Applicability of the Test of Variables of Attention – T.O.V.A in Brazilian adults. *Dementia & Neuropsychologia, 12*(4), 394–401.
The functioning of attention is complex, a primordial function in several cognitive processes and of great interest to neuropsychology. The Test of Variables of Attention (T.O.V.A) is a continuous computerized performance test that evaluates some attention components such as response time to a stimulus and errors due to inattention and impulsivity. Objective: 1) To evaluate the applicability of T.O.V.A in Brazilian adults; 2) To analyze the differences in performance between genders, age ranges, and levels of education; 3) To examine the association between T.O.V.A variables and other attention and cognitive screening tests. Methods: The T.O.V.A was applied to 63 healthy adults (24 to 78 years of age) who also underwent the Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Digit Span and Digit Symbol (Wechsler Intelligence Scale for Adults - WAIS-III) and the Trail Making Test. Results: the T.O.V.A was little influenced by age or education, but was influenced by gender. The correlations between some T.O.V.A variables and the Digit Symbol and Trail Making test were weak (r-values between 0.2 and 0.4), but significant ($p<0.05$). There was no correlation with the Digit Span test. Conclusion: The T.O.V.A showed good applicability and proved adequate for evaluating attentional processes in adults.

Mishra, J., Sagar, R., Joseph, A. A., Gazzaley, A., & Merzenich, M. M. (2016). Training sensory signal-to-noise resolution in children with ADHD in a global mental health setting. *Translational Psychiatry, 6*(4), e781–e781.
Children with attention deficit/hyperactivity disorder (ADHD) have impaired focus on goal-relevant signals and fail to suppress goal-irrelevant distractions. To address both these issues, we developed a novel neuroplasticity-based training program that adaptively trains the resolution of challenging sensory signals and the suppression of progressively more challenging distractions. We evaluated this sensory signal-to-noise resolution training in a small sample, global mental health study in Indian children with ADHD. The children trained for 30 h over 6 months in a double-blind, randomized controlled trial. Training completers showed steady and significant improvements in ADHD-associated behaviors from baseline to post training relative to controls, and benefits sustained in a 6-month follow-up. Post-training cognitive assessments showed significant positive results for response inhibition and Stroop interference tests in training completers vs controls, while measures of sustained attention and short-term memory showed nonsignificant improvement trends. Further, training-driven improvements in distractor suppression correlated with the improved ADHD symptoms. This initial study suggests utility of signal-to-noise

resolution training for children with ADHD; it emphasizes the need for further research on this intervention and substantially informs the design of a larger trial.

Monastra, V. J., Lubar, J. F., & Linden, M. (2001). The Development of a Quantitative Electroencephalographic Scanning Process for Attention Deficit–Hyperactivity Disorder: Reliability and Validity Studies. *Neuropsychology, 15*(1), 136-144.

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

Monastra, V. J., Monastra, D. M., & George, S. (2002). The effects of stimulant therapy, EEG biofeedback, and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback, 27*(4), 231-249.

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.

Murray, D.W., Childress, A., Giblin, J., Williamson, D., Armstrong, R., and Starr, H.L. (2011). Effects of OROS Methylphenidate on Academic, Behavioral, and Cognitive Tasks in Children 9 to 12 Years of Age with Attention-Deficit/Hyperactivity Disorder. *Clinical Pediatrics, 50*(4), 308–320.

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.

Noh, J., Kim, J., Jung, Y., & Hong, S. (1997). A Study on the Diagnostic Efficacy of the T.O.V.A. and the GDS for Attention Deficit Hyperactivity Disorder. *Korean Journal of Clinical Psychology, 16*(2), 355–364.

Attention deficit hyperactivity disorder is a childhood disorder characterized by severe inattention, hyperactivity, and impulsivity, which can lead to dysfunction in academic, occupational, and social performance during adolescence and adulthood. ADHD is diagnosed through developmental history taking, interview, behavioral rating scales by teachers and parents, and individual psychological assessment. Psychological assessment includes intelligence tests, neuropsychological tests, and continuous performance tasks. The T.O.V.A. and the GDS are among

the most commonly used computerized CPTs. The purpose of this study was to determine the effectiveness of the T.O.V.A. & the GDS in assessing ADHD in groups. The subjects consisted of 19 children with ADHD and 21 without ADHD (40 boys and girls, ages 7 to 14, and above 80 in IQ). The ANOVA showed significant difference between ADHD and non-ADHD subjects in terms of reaction time in the first and second halves and on the whole, the first half's variability in RT, and the first half's d'. The discriminant analysis had an accuracy of 75%, showing that they effectively differentiate the two groups. RT variability and the anticipatory responses were the biggest factors for the T.O.V.A. and the Vigilance Task was the most influential for the GDS.

Norris, S. L., Lee, C., Burshteyn, D., & CeaAravena, J. (2001). The effects of performance enhancement training on hypertension, human attention, stress, and brain wave patterns: A case study. *Journal of Neurotherapy, 4*(3), 29-44.
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.

Norris, S. L., Lee, C., Cea, J., & Burshteyn, D. (1998). Performance enhancement training effects on attention: A case study. *Journal of Neurotherapy, 3*(1), 19-25.
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.

Nydén, A., Niklasson, L., Stahlberg, O., Anckarsater, H., Wentz, E., Rastam, M., & Gillberg, C. (2010). Adults with autism spectrum disorders and ADHD neuropsychological aspects. *Research in Developmental Disabilities, 31*(6), 1659–1668.
The purpose of the present study was to assess which types of neuropsychological deficits appear to be most commonly associated with autism spectrum disorders (ASD) and attention-deficit/hyperactivity disorder (ADHD) in adults. The effect of the combination of ASD with ADHD (ASD/ADHD) was also studied. One hundred and sixty-one adult individuals (!18 years of age) were included in the study. None had full scale IQ less than 71. The neuropsychological investigations included measures of intellectual ability, learning and memory, attention/executive function and theory of mind. The three diagnostic groups showed reduced performance in most cognitive domains. However, within these domains differentiating distinct features could be seen. The dysfunctions of the ASD/ADHD group cannot be seen as a summary of the dysfunctions found in the ASD and ADHD groups. The ADHD seemed to have the most severe neuropsychological impairments of the three groups. No domain-specific deficit typical of any of the diagnostic groups was found.

O'Mahony, N., Florentino-Liano, B., Carballo, J. J., Baca-García, E., & Rodríguez, A. A. (2014). Objective diagnosis of ADHD using IMUs. *Medical Engineering & Physics, 36*(7), 922–926.
This work proposes the use of miniature wireless inertial sensors as an objective tool for the diagnosis of ADHD. The sensors, consisting of both accelerometers and gyroscopes to measure linear and rotational movement, respectively, are used to characterize the motion of subjects in the setting of a psychiatric consultancy. A support vector machine is used to classify a group of subjects as either ADHD or non- ADHD and a classification accuracy of greater than 95% has been achieved. Separate analyses of the motion data recorded during various activities throughout the visit to the psychiatric consultancy show that motion recorded during a continuous performance

test (a forced concentration task) provides a better classification performance than that recorded during “free time”.

Oh, K.-S., Shin, D.-W., Oh, G.-T., & Noh, K.-S. (2003). Dopamine Transporter Genotype Influences the Attention Deficit in Korean Boys with ADHD. *Yonsei Medical Journal, 44*(5), 787-792.
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- base pair variable number of tandem repeats (VNTR) polymorphism in the 3' untranslated region was amplified. The attention deficits were measured by the test of variables of attention (T.O.V.A.). Between the 10/10 genotype and 10/* genotype, standard scores of the T.O.V.A were compared using a Mann-Whiney test. A comparison with the 10/10 genotype and 10/* genotype showed that those patients with the 10/10 genotype made less omission errors in the first quarter of the test ($p < 0.05$, by Mann-Whiney test). No significant differences were observed in the errors of commission, response time, variability. This study found that the 10/10 genotype made less omission errors on the T.O.V.A. This suggests that the dopamine transporter genotype influences the attention deficits measured by T.O.V.A.

Oh, S.-Y., & Kim, Y.-K. (2017). Association of Norepinephrine Transporter Gene Polymorphisms in Attention-Deficit/Hyperactivity Disorder in Korean Population. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 73*, 56–63. doi:10.1016/j.pnpbp.2016.10.006.
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 (KEDI-WISC) and the Continuous Performance Test (CPT) in a drug-naive state. The $\chi 2$ test and 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 com- mon 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.

Ossmann, J. M., & Mulligan, N. W. (2003). Inhibition and Attention Deficit Hyperactivity Disorder in Adults. *American Journal of Psychology, 116*(1), 35-50.

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.

Ozan, E., Deveci, E., Oral, M., Karahan, U., Oral, E., Aydin, N., & Kirpinar, I. (2010). Neurocognitive Functioning in a Group of Offspring Genetically at High-Risk for Schizophrenia in Eastern Turkey. *Brain Research Bulletin*, *82*(3-4), 218–223.

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

Parasnis, I., Samar, V. J., & Berent, G. P. (2003). Deaf Adults Without Attention Deficit Hyperactivity Disorder Display Reduced Perceptual Sensitivity and Elevated Impulsivity on the Test of Variables of Attention (T.O.V.A.). *Journal of Speech Language & Hearing Research, 46*(5), 1166-1183.

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.

Parletta, N., Niyonsenga, T., & Duff, J. (2016). Omega-3 and Omega-6 Polyunsaturated Fatty Acid Levels and Correlations with Symptoms in Children with Attention Deficit Hyperactivity Disorder, Autistic Spectrum Disorder and Typically Developing Controls. *PLoS ONE, 11*(5), 1–16.
Background: There is evidence that children with Attention Deficit Hyperactivity Disorder (ADHD) and Autistic Spectrum Disorder (ASD) have lower omega-3 polyunsaturated fatty acid (n-3 PUFA) levels compared with controls and conflicting evidence regarding omega-6 (n-6) PUFA levels. Objectives: This study investigated whether erythrocyte n-3 PUFAs eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were lower and n-6 PUFA arachidonic acid (AA) higher in children with ADHD, ASD and controls, and whether lower n-3 and higher n-6 PUFAs corre- lated with poorer scores on the Australian Twin Behaviour Rating Scale (ATBRS; ADHD symptoms) and Test of Variable Attention (TOVA) in children with ADHD, and Childhood Autism Rating Scale (CARS) in children with ASD. Methods: Assessments and blood samples of 565 children aged 3–17 years with ADHD (n = 401), ASD (n = 85) or controls (n = 79) were analysed. One-way ANOVAs with Tukey's post-hoc analysis investigated differences in PUFA levels between groups and Pearson's correla- tions investigated correlations between PUFA levels and ATBRS, TOVA and CARS scores. Results: Children with ADHD and ASD had lower DHA, EPA and AA, higher AA/EPA ratio and lower n-3/n-6 than controls (P<0.001 except AA between ADHD and controls: P = 0.047). Children with ASD had lower DHA, EPA and AA than children with ADHD (P<0.001 for all compari- sons). ATBRS scores correlated negatively with EPA (r = -.294, P<0.001), DHA (r = -.424, P<0.001), n-3/n-6 (r = -.477, P<0.001) and positively with AA/EPA (r = .222, P <.01). TOVA scores correlated positively with DHA (r = .610, P<0.001), EPA (r = .418, P<0.001) AA (r = .199, P<0.001), and n-3/n-6 (r = .509, P<0.001) and negatively with AA/EPA (r = -.243, P<0.001). CARS scores correlated significantly with DHA (r = .328, P = 0.002), EPA (r = -.225, P = 0.038) and AA (r = .251, P = 0.021). Conclusions: Children with ADHD and ASD had low levels of EPA, DHA and AA and high ratio of n-6/n-3 PUFAs and these correlated significantly with symptoms. Future research should further investigate abnormal fatty acid metabolism in these disorders.

Patrick, G. J. (1996). Improved Neuronal Regulation in ADHD: An Application of 15 Sessions of Photic-Driven EEG Neurotherapy. *Journal of Neurotherapy, 1*(4), 27-36.
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.

Paz, Y., Friedwald, K., Levkovitz, Y., Zangen, A., Alyagon, U., Nitzan, U., … Bloch, Y. (2017). Randomized Sham-Controlled Study of High-Frequency Bilateral Deep Transcranial Magnetic Stimulation (dTMS) to Treat Adult Attention Hyperactive Disorder (ADHD) - Negative Results. *The World Journal of Biological Psychiatry,* 1–14.
Background: Recent studies support the possible effectiveness of rTMS as a treatment for ADHD. Objectives: To evaluate the safety and possible efficacy of bilateral prefrontal deep rTMS for the treatment of adult ADHD. Methods: Twenty-six adult ADHD patients were randomized blindly to sham or actual deep TMS. Twenty daily sessions were conducted using the bilateral H5 deep TMS coil (Brainsway, IL) in order to stimulate the prefrontal

cortex at 120% of the motor threshold at high frequency. For assessment, the Conners' Adult ADHD Rating Scale (CAARS) questionnaire and a computerized continuous performance test, Test of Variables of Attention (T.O.V.A.), were used. Results: No differences in clinical outcomes were detected between the actual dTMS and sham groups. Conclusions: The presented evidence does not support the utility of bilateral prefrontal stimulation to treat adult ADHD. Due to the small sample size, caution must be exercised in interpreting our preliminary findings.

Peskin, M., Sommerfeld, E., Basford, Y., Rozen, S., Zalsman, G., Weizman, A., & Manor, I. (2016). Continuous Performance Test Is Sensitive to a Single Methylphenidate Challenge in Preschool Children With ADHD. *Journal of Attention Disorders,* 1–9.
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 and after a single MPH challenge (0.3 or 0.5 mg/kg). Baseline TOVA performance was correlated with Conners' Rating Scales (CRS) and 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.

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., Shalev, 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.

Porumb, M. (2007). Using TOVA for the assessment of ADHD: a case study. *Cogn Brain Behav, 11*(3), 571–84.
The number of children diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and the general public awareness of ADHD has increased dramatically in the past decades.. Unfortunately, the assessment and diagnostic procedures for determining the presence of ADHD remains relatively uncertain and inconsistent among

professionals such as psychologists, psychiatrists, neurologists, and pediatricians who make such diagnoses (National Institute of Health, 1998). Continuous performance tests, particularly Test of Variables of Attention (T.O.V.A.) are widely used in the assessment and study of ADHD. Although T.O.V.A. has reliably revealed differences between children with ADHD and normal controls, discrimination between children with clinical ADHD and children with sub-clinical levels of ADHD is problematic. Furthermore, most studies use convenience samples
from clinical care settings that may not represent the ADHD population as a whole. Our study presents a summary of the research about the clinical utility of T.O.V.A. in discriminating between children with ADHD and those with other clinical disorders, or normal children. By presenting a case study we show how the results of T.O.V.A. are confirmed by the evaluation of Attention/Executive Functions using NEPSY. We also illustrate the added-value of T.O.V.A. in diagnosing the subtypes of ADHD.

Preston, A., Fennell, E. B., & Bussing, R. (2005). Utility of a CPT in Diagnosing ADHD among a Representative Sample of High-Risk Children: A Cautionary Study. *Child Neuropsychology, 11*(5), 459–469.
Continuous performance tests (CPTs) are widely used in the assessment and study of attention deficit hyperactivity disorder (ADHD). Although CPTs have reliably found differences between children with ADHD and normal controls, discriminating between children with ADHD and children with subclinical levels of behavioral or cognitive problems is a more clinically relevant and difficult endeavor. Additionally, most studies use convenience samples from clinical care settings that may not represent the ADHD population as a whole. The current study assessed the utility of a clinically used CPT, the Test of Variables of Attention (TOVA), in distinguishing between children with ADHD and children with subclinical levels of attention/behavior problems. Participants constituted a representative sample of elementary school students at high risk for ADHD, including 116 children with ADHD and 51 subclinical controls. Results found no significant differences between the ADHD and subclinical group on CPT variables, and CPT performance did not reliably predict group membership. Implications of the findings are discussed.

Putman, J. A., Othmer, S. F., Othmer, S., & Pollock, 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.

Reader, M. J., Harris, E. L., Schuerholz, L. J., & Denckla, M. B. (1994). Attention Deficit Hyperactivity Disorder and Executive Dysfunction. *Developmental Neuropsychology, 10*(4), 493–512.
To evaluate the relationship between attention deficit hyperactivity disorder (ADHD) and executive functioning (EF) a sample of ADHD children (N = 48) with above average IQs (median = 117.5) was administered a battery of standardized norm-referenced tests sensitive to EF. Below average performance was found on the Wisconsin Card Sorting Test and continuous performance test (Test of Variables of Attention, TOVA) but not on Word Fluency or the Rey Complex Figure. Significant intraindividual discrepancies were found for a selected pair of content-matched tests that differed in EF task demands. Pennington, Groisser, and Welsh's (1993) “double dissociation” of ADHD and

reading disability (RD) was tested by examining the EF performance of ADHD with and without RD. No significant differences between ADHD/No-RD and ADHD/RD were found on any of the EF measures.

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.

Riccio, C. A., Garland, B. H., & Cohen, M. J. (2007). Relations Between the Test of Variables of Attention (TOVA) and the Children's Memory Scale (CMS). *Journal of Attention Disorders, 11*(2), 167–171.
Objective: There is considerable overlap in the constructs of attention and memory. The objective of this study was to examine the relationship between the Test of Variables of Attention (TOVA), a measure of attention, to components of memory and learning as measured by the Children's Memory Scale (CMS). Method: Participants (N = 105) were consecutive referrals to an out-patient facility, generally for learning or behavior problems, who were administered both the TOVA and the CMS. Results: Significant correlations were found between the omissions score on the TOVA and subscales of the CMS. TOVA variability and TOVA reaction time correlated significantly with subscales of the CMS as well. TOVA commission errors did not correlate significantly with any CMS Index. Conclusion: Although significant, the correlation coefficients indicate that the CMS and TOVA are measuring either different constructs or similar constructs but in different ways. As such, both measures may be useful in distinguishing memory from attention problems.

Robinson, E. V., & Rogers, R. (2017). Detection of Feigned ADHD across Two Domains: The MMPI-2-RF and CAARS for Faked Symptoms and TOVA for Simulated Attention Deficits. *Journal of Psychopathology and Behavioral Assessment.*
Psychological assessments of Attention Deficit/Hyperactivity Disorder (ADHD) must consider possible feigning of ADHD symptoms and simulated deficits on attentional measures. Studies have consistently found that motivated examinees can easily feign ADHD with little research focused on its detection. Via a between-subjects simulation design, the current study investigated the MMPI-2-RF and the Conners Infrequency Index (CII) in a university sample by comparing four groups: feigned ADHD, feigned mental disorders, genuine ADHD, and non-ADHD controls. Encouragingly, the CII evidenced moderate discriminability between feigned ADHD and (a) genuine ADHD (d = 0.97) as well as (b) feigned mental disorders (d = 0.96). Because the MMPI- 2-RF F-family scores did not differentiate ADHD feigners from other feigners or genuine ADHD, a Dissimulation (Ds) ADHD (Ds-ADHD) scale was developed by utilizing erroneous stereotypes as the detection strategy. While requiring cross-validation, the initial data demonstrated good discriminant validity in distinguishing feigned ADHD from both genuine ADHD and general feigning. As noted in the Discussion, ADHD assessments must systematically take into account examinees' level of effort and actively evaluate the possibility of feigned ADHD.

Rodríguez, C., Gonzalez-Castro, P., Cueli, M., Areces, D., & Gonzalez-Pienda, J. (2016). Attention Deficit/Hyperactivity Disorder (ADHD) Diagnosis: An Activation-Executive Model. *Frontiers in Psychology, 7*.
Attention deficit with, or without, hyperactivity and impulsivity (ADHD) is categorized as neuro-developmental disorder. ADHD is a common disorder in childhood and one of the most frequent conditions affecting school ages. This disorder is characterized by a persistent behavioral pattern associated with inattention, over-activity (or hyperactivity), and difficulty in controlling impulses. Current research suggests the existence of certain patterns of cortical activation and executive control, which could more objectively identify ADHD. Through the use of a risk and resilience model, this research aimed to analyze the interaction between brain activation variables (nirHEG and

Q-EEG) and executive variables (Continuous performance test -CPT-) in subjects with ADHD. The study involved 499 children, 175 females (35.1%) and 324 males (64.91%); aged from 6 to 16 years (M = 11.22, SD = 1.43). Two hundred and fifty six of the children had been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and 243 were without ADHD. For the analysis of this objective, a causal model was designed to include the following different measures of task-execution: CPT TOVA (omissions, commissions, response time, variability, D prime and the ADHD Index); electrical activity (using Q-EEG); and blood-flow oxygenation activity (using nirHEG). The causal model was tested by means of structural equation modeling (SEM). The model that had been constructed was based upon three general assumptions: (1) There are different causal models for children with ADHD and those without ADHD; (2) The activation measures influence students' executive performance; and (3) There are measurable structural differences between the ADHD and control group models (executive and activation). In general, the results showed that: (a) activation measures influence executive patterns differently, (b) the relationship between activation variables (nirHEG and Q-EEG) depends on the brain zone being studied, (c) both groups showed important differences in variables correlation, with a good fit in each model (with and without ADHD). Lastly, the results were analyzed with a view to the diagnosis procedure. Therefore, we discuss the implications for future research.

Rodríguez, C., González-Castro, P., García, T., Núñez, J. C., & Alvarez, L. (2014). Attentional functions and trait anxiety in children with ADHD. *Learning and Individual Differences, 35*, 147–152.

The present study examined the effects of Trait Anxiety on attentional task performance in children with and without attention deficit hyperactivity disorder (ADHD). 220 students between 8 and 12 years performed two neuropsychological tasks related to selective and sustained attention. They were classified into four groups: ADHD + ANX, students with ADHD and Trait Anxiety (n = 73); ADHD (n = 53); ANX, a group with Trait Anxiety (n = 15); and a non-clinical control group (n = 41). Results offer evidence in both attentional tasks that the ADHD group performed worse than the non-clinical control and ANX groups, and the ANX group achieved similar results to the control group. Finally, the trait anxiety factor did not contribute to the performance of the different attentional tasks in the ADHD + ANX group. These results suggest important differences in ADHD symptomatology and comorbidity, indicating implications of these measures for differential diagnosis and treatment.

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.

Rosa-Neto, P., Lou, H. C., Cumming, P., Pryds, O., Karrebaek, H., Lunding, J., & Gjedde, A. (2005). Methylphenidate-evoked changes in striatal dopamine correlate with inattention and impulsivity in adolescents with attention deficit hyperactivity disorder. *NeuroImage, 25*(3), 868–876.

Abnormal central dopamine (DA) neurotransmission has been implicated in the impulsivity, inattention, and hyperactivity of attention deficit hyperactivity disorder (ADHD). We hypothesized that a pharmacological challenge with methylphenidate (MP) at a therapeutic dose increases extracellular DA concentrations in proportion to the severity of these specific ADHD symptoms. To test this hypothesis, we measured by PET the effect of acute challenge with MP on the availability of striatal binding sites for [11C]raclopride (pB), an index of altered interstitial DA concentration, in nine unmedicated adolescents (1 female, 8 males; age 13.7 F 1.8 years) with a current diagnosis of ADHD. We estimated the pB of [11C]raclopride for brain dopamine D2/3 receptors first in a baseline resting condition, and again after an acute challenge with MP (0.3 mg/kg, p.o.), and calculated the percentage change in (%DpB) in left and right striatum. On another day, measurements of impulsivity and inattention were performed using a computerized continuous performance test. There was a significant correlation between the

magnitude of %DpB in the right striatum and the severity of inattention and impulsivity. MP-evoked %DpB correlated with standard scores for impulse control (r = 0.68; P = 0.02), attention (r = 0.81; P = 0.005), information processing (r = 0.66; P = 0.02), and consistency of attention, or variability (r = 0.60; P = 0.04). In conclusion, the results link inattention and impulsivity with sensitivity of brain DA receptor availability to an MP challenge, corroborating the hypothesis that MP serves to potentiate decreased DA neurotransmissionin ADHD.

Ross, J. L., Feuillan, P., Kushner, H., Roeltgen, D., & Cutler, G. B. (1997). Absence of Growth Hormone Effects on Cognitive Function in Girls with Turner Syndrome. *The Journal of Clinical Endocrinology and Metabolism, 82*(6), 1814–7.
Turner syndrome (TS) is a genetic disorder characterized by short stature, gonadal dysgenesis, and a particular neurocognitive profile of normally developed language abilities (particularly verbal IQ) and impaired visual-spatial and/or visual-perceptual abilities. We have followed a large sample of girls with Turner syndrome who were enrolled in a long-term, double-blind, placebo-controlled trial of the effects of growth hormone (GH) treatment on final adult height. This study provides a unique opportunity to prospectively evaluate the effects of GH treatment on neurocognitive function in this population of girls with Turner syndrome. The GH- and placebo-treated Turner syndrome subjects were well matched for age, treatment duration, race, karyotype, and socioeconomic status. Treatment (GH or placebo) durations ranged from 1-7 yr. Whether GH deficiency and/or treatment in childhood and adolescence influences cognitive outcome in short children or GH-children is controversial. The major result of this study was the absence of GH treatment effects on cognitive function in girls with Turner syndrome. Our findings are in agreement with most of the previous studies that found no apparent growth hormone treatment effects on cognitive function in growth-hormone deficient children. We conclude that this study does not support a role for growth hormone in influencing childhood brain development in girls with Turner syndrome. Their characteristic nonverbal neurocognitive deficits were not altered with GH treatment into early adolescence.

Ross, J. L., Stefanatos, G. A., Kushner, H., Zinn, A., Bondy, C., & Roeltgen, D. (2002). Persistent cognitive deficits in adult women with Turner syndrome. *Neurology, 58*(2), 218–225.
BACKGROUND: Turner syndrome (TS) has a characteristic neurocognitive profile. Verbal abilities are, in general, normal; however, women with TS, as a group, have specific deficits in visual-spatial abilities, visual-perceptual abilities, motor function, nonverbal memory, executive function, and attentional abilities. Observed deficits could be caused by genetic or endocrine factors. OBJECTIVE: To evaluate the specific cognitive deficits that appear to persist in adulthood, are not estrogen-responsive, and may be genetically determined. METHODS: The cognitive performance of adult women with TS (n = 71) who were estrogen repleted was compared with verbal IQ- and socioeconomic status-matched female controls (n = 50). Sixty-one women with TS had ovarian failure and received estrogen replacement and 10 had preserved endogenous ovarian function and were not receiving estrogen replacement at the time of evaluation. RESULTS: Similar to children and adolescents with TS, adults with TS have normal verbal IQ but have relative difficulty on measures of spatial/perceptual skills, visual-motor integration, affect recognition, visual memory, attention, and executive function despite estrogen replacement. These deficits are apparent in women with TS despite apparently adequate estrogen effect, either endogenous or by hormone replacement. CONCLUSION: The cognitive phenotypes of adults with TS, with or without ovarian failure, are similar, indicating that estrogen replacement does not have a major impact on the cognitive deficits of adults with TS.

Ross, J., Stefanatos, G. A., Roeltgen, D., Kushner, H., & Cutler, G. (1995). Ullrich-Turner syndrome: neurodevelopmental changes from childhood through adolescence. *American Journal of Medical Genetics, 31*(58), 74–82.
Our objective was to investigate whether the previously-described neurocognitive pattern in girls with Ullrich-Turner syndrome is found in childhood and adolescence; we used a prospective, controlled study of neurocognitive development in girls with Ullrich-Turner syndrome. The patients included 56 girls with Ullrich-Turner syndrome, and 100 normal age- and verbal IQ-matched female control subjects, whose ages ranged from 6-14 years. All girls with Ullrich-Turner syndrome and the normal control girls received a battery of neurocognitive tests designed to evaluate the following domains: general cognition, memory, academic achievement, language, visual-spatial/perceptual skills, visual-motor skills, attention, and affect recognition. Our results demonstrated consistent findings in Ullrich-Turner syndrome girls across the age range studied. In general, the Ullrich-Turner girls resembled control subjects in terms of verbal and language abilities. We found relatively depressed performance IQ and a significant verbal IQ-performance IQ difference. Significant differences were observed on examination of nonverbal abilities. The Ullrich-Turner girls performed more poorly than control girls on 1) tests of visual-motor skills including the Beery Test of Visual-Motor Integration, the Perceptual Organization

Factor, and the Rey-Osterrieth Figures; 2) tests of visual-spatial skills, including the Motor-Free Visual Perception Test; 3) tests of attention, including the Freedom From Distractibility Factor; and 4) the Affective Prosody Affect Recognition Test. Ullrich-Turner subjects showed evidence of multifocal or diffuse right cerebral dysfunction and deficits generally involving nonverbal skills that may be due to X chromosome monosomy, gonadal dysgenesis, or both. Future studies will examine the role of estrogen replacement on cognitive function in Ullrich-Turner syndrome individuals.

Rossiter, T. R., & La Vaque, T. J. (1995). A comparison of EEG biofeedback and psychostimulants in treating attention deficit/hyperactivity disorders. *Journal of Neurotherapy, 1*(1), 48-59.
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.

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 ADIHD 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. R. (1998). Patient-directed neurofeedback for AD/HD. *Journal of Neurotherapy, 2*(4), 54-63.
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.

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.

Rotem, A., Danieli, Y., Ben-Sheetrit, J., Bashari, A., Golubchik, P., Ben-Hayun, R., … Manor, I. (2019). Apparent lack of practice effects in the Test of Variables of Attention (TOVA) in adult ADHD. *ADHD Attention Deficit and Hyperactivity Disorders, 11*(1), 73–81.

The test of variables of attention (TOVA) is a continuous performance test commonly used as an aid for diagnosis of ADHD and assessment of treatment response. It has been studied and standardized in both children and adults. As a repetitive measurement of treatment efficacy, used both in research and in the clinic, it's important to disprove a practice effect. A retrospective cohort analysis was done, using only the placebo-arm participants from two different randomized, multicenter, double-blind clinical trials on the efficacy of a non-stimulant (metadoxine-XR). In order to reveal the practice effects, only the participants that showed no placebo effect (< 25% improvement), in the Conners' Adult ADHD Rating Scale–investigator rated (CAARS-Inv), the gold standard, were included. Demographic data, CAARS-Inv baseline and TOVA results during each visit were recorded and analyzed. Ninety-one participants from two studies were pooled (2014 n = 24, 2016 n = 67). They did not differ significantly in any demographic parameter, most side effect frequencies, and CAARS-Inv baseline scores. The baseline TOVA performances demonstrated similarity in the degree of inattention, variability, impulsivity, and response time. The TOVA scores were not altered significantly between visits, as assessed by repeated-measures analysis of variance. No significant differences were detected between the TOVA baseline-to-endpoint scores as assessed by paired t test. No practice effects were detected, in both clinical trials, suggesting that the results of the TOVA are likely to represent genuine changes in attentional performance. Further studies are needed to replicate these findings.

Ruel, T. D., Boivin, M. J., Boal, H. E., Bangirana, P., Charlebois, E., Havlir, D. V., … Wong, J. K. (2012). Neurocognitive and Motor Deficits in HIV-Infected Ugandan Children With High CD4 Cell Counts. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America, 54*(7), 1001–1009.

BACKGROUND: Human immunodeficiency virus (HIV) infection causes neurocognitive or motor function deficits in children with advanced disease, but it is unclear whether children with CD4 cell measures above the World Health Organization (WHO) thresholds for antiretroviral therapy (ART) initiation suffer significant impairment. METHODS: The neurocognitive and motor functions of HIV-infected ART-naive Ugandan children aged 6-12 years with CD4 cell counts of >350 cells/muL and CD4 cell percentage of >15% were compared with those of HIV-uninfected children, using the Test of Variables of Attention (TOVA), the Kaufman Assessment Battery for Children, second edition (KABC-2), and the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT-2). RESULTS: Ninety-three HIV-infected children (median CD4 cell count, 655 cells/muL; plasma HIV RNA level, 4.7 log(10) copies/mL) were compared to 106 HIV-uninfected children. HIV-infected children performed worse on TOVA visual reaction times (multivariate analysis of covariance; P = .006); KABC-2 sequential processing (P = .005), simultaneous processing (P = .039), planning/reasoning (P = .023), and global performance (P = .024); and BOT-2 total motor proficiency (P = .003). High plasma HIV RNA level was associated with worse performance in 10 cognitive measures and 3 motor measures. In analysis of only WHO clinical stage 1 or 2 HIV-infected children (n = 68), significant differences between the HIV-infected and HIV-uninfected groups (P 15%. Study of whether early initiation of ART could prevent or reverse such deficits is needed.

Rugino, T. A., & Copley, T. C. (2001). Effects of Modafinil in children with attention-deficit/hyperactivity disorder: An open-label study. *Journal of the American Academy of Child & Adolescent Psychiatry, 40*(2), 230-235.

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.

Rugino, T. A., & Samsock, T. C. (2003). Modafinil in Children with Attention-Deficit Hyperactivity Disorder. *Pediatric Neurology, 29*(2), 136-142.
Previous clinical evidence suggested that modafinil may improve clinical features of children with attention-deficit hyperactivity disorder. To test this hypothesis, a randomized, double-blind, placebo-controlled study design was used. Of 24 children initially randomized into the study, 11 control subjects and 11 treatment patients completed the study, with evaluation before medication and after 5 to 6 weeks. The average Test of Variables of Attention attention-deficit hyperactivity disorder z score improved by 2.53 S.D.s for the modafinil group compared with a decline of 1.02 for control patients (P < or = 0.02). Conners Rating Scales ADHD total t scores for the modafinil group improved from 76.6 to 68.2 compared with improvement from 77.7 to 76.0 for control subjects (P = 0.04). Ten of 11 treatment patients were reported as "significantly" improved, whereas eight of 11 control subjects were reported as manifesting "no" or "slight" improvement (P < 0.001). Adverse effects were few and manageable, with no anorexia. Modafinil may be a useful treatment for children with ADHD, particularly when anorexia limits use of stimulants.

Sanchez-Lopez, J., Fernandez, T., Silva-Pereyra, J., & Mesa, J. A. M. (2013). Differences between Judo, Taekwondo and Kung-fu Athletes in Sustained Attention and Impulse Control. *Psychology, 4*(7), 607–612.
Attention processes are essential in athletic performance. Competition in combat sports requires high levels of attention, concentration and self-control. The aim of this study was to determine the differences in attention test performance among three groups of athletes from different disciplines of martial arts (judo, taekwondo and kung-fu). Twenty athletes with at least one year of experience in their respective sport were included in the study. The Test of Variables of Attention (TOVA) was performed, and data for the standard and Z scores of the quarters, halves and totals of each variable were analysed. The kung-fu athletes showed better inhibition response than the judo and taekwondo athletes. Minor performance deterioration during the impulsivity test was identified in kung-fu athletes compared with taekwondo and judo athletes. Judo athletes showed higher variability in reaction times than kung-fu athletes. Our study suggests that kung-fu training improved attention skills more than the other two disciplines. This effect can be explained by the athletes' dedication to kung-fu training and the sport's promotion of discipline, self-control and meditation.

Sanchez-Lopez, J., Fernandez, T., Silva-Pereyra, J., Martinez - Mesa, J. A., & Moreno - Aguirre, A. J. (2013). Measuring Attention in Martial Arts Athletes. Experts Versus Novices. *Revista de Psicología del Deporte, 22*(2), 3210–3329.
ABSTRACT: The aim of this study was determine differences in the performance of attention task regarding expertise in martial arts. Participated 12 martial arts athletes experts and 13 novices. They performed the Test of Variables of Attention (Greenberg, 1996) and, with a permutations non-parametric statistical method, data for each variable, condition and segment of the test, were analyzed. Comparisons between groups showed a trend of higher global Attention Deficit Hyperactivity Disorder (ADHD) score for expert than novice subjects. With the purpose to know the performance of each group trough the test, a statistical within-analysis for each group was performed; results revealed, in general, a more consistency in correct responses and reaction time performances of experts than novice athletes. Results suggest that the physical and mental training of the martial arts may produce an improvement in attention process in athletes.

Sanchez-Lopez, Javier, Thalia Fernandez, Juan Silva-Pereyra, Juan A. Martinez Mesa, and Francesco Di Russo. (2014). Differences in Visuo-Motor Control in Skilled vs. Novice Martial Arts Athletes during Sustained and Transient Attention Tasks: A Motor-Related Cortical Potential Study. Edited by Bart Rypma. *PLoS ONE, 9*(3), e91112.
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 athletes showed better cue facilitation, which permitted a major economy of resources and ‘‘automatic’’ or less controlled responses to relevant stimuli. In conclusion, the present data suggest that motor expertise enhances neural flexibility and allows better adaptation of cognitive control to the requested task.

Sanou, A. S., Diallo, A. H., Holding, P., Nankabirwa, V., Engebretsen, I. M. S., Ndeezi, G., … Kashala-Abotnes, E. (2018). Effects of schooling on aspects of attention in rural Burkina Faso, West Africa. *PloS One, 13*(9), e0203436.
BACKGROUND: We aimed to study the effects of schooling on aspects of attention using the Test of Variables of Attention (TOVA) among children in rural Burkina Faso. METHODS: We re-enrolled children of a previously community-based cluster randomized exclusive breastfeeding trial in rural Burkina Faso. A total of 534 children (280 boys and 254 girls) aged 6 to 8 years were assessed using the TOVA. We examined the effect size difference using Cohen's d, ANOVA and conducted regression analyses. RESULTS: Forty nine percent of the children were in school. Children not in school performed poorly with a small effect size difference for 'Response Time', 'Errors of omission', and 'Errors of commission' compared to children in school. The effect size difference was moderate for 'Response Time Variability', and 'D prime score'. CONCLUSION: Schooling affects different aspects of attention in rural Burkina Faso. In settings where literacy and schooling rate is low, public sensitizations of the benefits of schooling need to be reinforced and advice on sending children to school need to be provided continuously.

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 Automatized Naming test. Girls with ADHD only were

faster than boys on both tasks. When data for girls only were analyzed, girls with Tourette syndrome with ADHD had the greatest variability of reaction time on the Test of Variables of Attention, and were slowest on Letter Word Fluency. Girls with TS only were slower than girls in the other three groups on Letter Word Fluency. Poor Letter Word Fluency is explained as a linguistic executive dysfunction involving speed and efficiency of memory search in this bright group of girls with Tourette syndrome, not otherwise at risk for linguistic difficulties.

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.

Semrud-Clikeman, M., & Wical, B. (1999). Components of attention in children with complex partial seizures with and without ADHD. *Epilepsia, 40*(2), 211–215.
PURPOSE: To evaluate attentional difficulties in children with complex partial seizures, we reviewed the records of 12 children with complex partial seizures with attention deficient hyperactivity disorder (CPS/ADHD); 21 children with CPS without ADHD (CPS); 22 children with ADHD; and 15 control children. METHODS: Each child completed a computerized performance test (CPT), which evaluated sustained attention, inhibition of response, response time, and consistency of response. The ADHD groups also completed the CPT after a dose of methylphenidate. RESULTS: The results found poorest performance on the CPT by the CPS/ADHD group. Particular difficulty in attention was found for children with epilepsy regardless of the ADHD diagnosis. When methylphenidate was administered to the ADHD groups, both groups improved in performance on the CPT. CONCLUSIONS: Epilepsy may predispose children to attention problems that can significantly interfere with learning. Similar improvement for children with CPS/ADHD was found with methylphenidate compared with baseline as for children with ADHD but without CPS.

Seung-tae, K., & Ji-hae, K. (1996). Cognitive Characteristics of Children with Dyslexia and Children with ADHD. *Korean Academy of Child and Adolescent Psychiatry, 7*, 224–232.
There is no abstract available for this item.

Severtson, S. G., Hedden, S. L., Martins, S. S., & Latimer, W. W. (2012). Patterns of Cognitive Impairments Among Heroin and Cocaine Users: The Association With Self-Reported Learning Disabilities and Infectious Disease. *Journal of Learning Disabilities, 45*(2), 139–150.
This study used data from six neuropsychological measures of executive function (EF) and general intellectual functioning (GIF) administered to 303 regular users of heroin and/or cocaine as indicators in a latent profile analysis (LPA). Results indicated the presence of three profiles: impaired GIF and EF profile (30.8%), intact GIF and EF profile (58.8%), and high GIF/intact EF profile (10.4%). Using a multinomial logistic regression, it was determined that individuals who reported being diagnosed with either a learning disability (LD) and/or attention-deficit/hyperactivity disorder (ADHD) were more likely to be in the impaired GIF and EF profile than other profiles. Results from a logistic regression indicated that the impaired GIF and EF profile was associated with a greater prevalence of past hepatitis B and/or C infection. Implication for harm reduction and treatment programs and the need to take into account individuals with LD and ADHD are discussed.

Severtson, S. G., & Latimer, W. W. (2008). Factors related to correctional facility incarceration among active injection drug users in Baltimore, MD. *Drug and Alcohol Dependence, 94*(1–3), 73–81.

Aim—We investigated the moderating effect of impulse control on the association between drug use and incarceration among active injection drug users (IDU). Methods—The study sample consisted of 282 IDUs aged 15 to 50 years from the Baltimore metropolitan region who reported injection drug use within the past 6 months and indicated that heroin or speedball was their drug of choice. Impulse control was measured using commission error standardized scores from the Test of Variables of Attention (TOVA). Incarceration was obtained using self-reported lifetime history of incarceration in correctional facilities. Results—Findings indicated that impulse control moderated the association between years of injection drug use and incarceration in correctional facilities adjusting for ethnicity, gender, estimated pre-morbid intelligence, and age of first injection use. Specifically, among individuals that were intact in impulse control, four or more years of injection drug use was associated with incarceration (AOR=4.97, 95% CI: 2.02–12.23). This finding was not observed among individuals with impaired impulse control (AOR=0.57, 95% CI: 0.10–3.23). Furthermore, impulse control moderated the association between regular cocaine use and incarceration. Among individuals that had a history of cocaine use, individuals with low impulse control but not impaired were more likely to have reported time in a correctional facility (AOR=6.28, 95% CI: 1.68–23.60). There was no association among individuals with impaired or intact impulse control. Conclusion—Results highlight the importance of considering cognitive measures of impulse control in addressing negative outcomes associated with drug use.

Shaffer, R. J., Jacokes, 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.

Shalev, L., Gross-Tsur, V., & Pollak, Y. (2012). Single Dose Methylphenidate Does Not Impact on Attention and Decision Making in Healthy Medical Students. *Journal of Neurology Research, 2*(6), 227–234.

Background: Methylphenidate (MPH) is effective for the treatment of Attention Deficit Hyperactivity Disorder (ADHD) and used illicitly by healthy adults, even though evidence concerning its efficacy is inconsistent and equivocal. We studied the effect of MPH on two cognitive tasks (attention/inhibition and decision making), a subjective rating scale and heart rate and blood pressure. Methods: Forty five medical students, ages 20 - 30, who denied past or present ADHD symptoms, participated in this double-blind, randomized, placebo controlled cross-over experiment. Data col- lection was conducted in two sessions, each 2.5 hours, two weeks apart. At the beginning of each session, the subjects completed a Visual Analogue Scale (VAS) quantifying their feelings regarding present mental and emotional state and then administered either placebo or MPH (0.3 mg/kg). Ninety minutes later, they again completed the VAS and were administered two cognitive tasks: Test of Variables of Attention (TOVA) and the modified Cambridge Gam- bling Test (mCGT). We found no differences with or without MPH for reaction time, response time variability, number of commissions and omissions in the TOVA or for quality, sum of gamble and reaction time for the mCGT. Results: No differences were observed between sessions with or without methylphenidate for reaction time, response time variability, number of commissions and omissions in the TOVA or for quality, sum of gamble and reaction time for the mCGT. Furthermore, no differences were observed in subjective rating on the VAS. Small, non-significant increases in blood pressure were documented. A practice effect was noted for the two consecutive sessions regardless of intervention.

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.
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.

Shen, T. W., Liu, F. C., Chen, S. J., & Chen, S. T. (2013). Changes in heart rate variability during TOVA testing in patients with major depressive disorder. *Psychiatry and Clinical Neurosciences, 67*(1), 35–40.
AIM: The aim of this study was to identify major depressive disorder (MDD) based on heart rate variability (HRV) during tests of variables of attention (TOVA). METHOD: Forty-five MDD patients without cardiovascular disease and 45 controls matched by age and gender participated in this study. RESULTS: Compared to the controls, the MDD group had lower resting HRV parameters, more omissions and variability and longer response times on TOVA, and failure of attention employment to decrease HRV. CONCLUSIONS: The resting HRV parameters may provide easily measured, clinically useful ways to identify patients with MDD and to monitor their progress in treatment.

Sichel, A. G., Fehmi, L. G., & Goldstein, D. M. (1995). Positive outcome with neurofeedback treatment in a case of mild autism. *Journal of Neurotherapy, 1*(1), 60-64.
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).

Slomine, B. S., Salorio, C. F., Grados, M. A., Vasa, R. A., Christensen, J. R. & Gerring, J. P. (2005). Differences in Attention, Executive Functioning, and Memory in Children with and without ADHD after Severe Traumatic Brain Injury. *Journal of the International Neuropsychological Society: JINS*, *11*(5), 645–53.
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.

Smith, P. N., & Sams, M. W. (2005). Neurofeedback with juvenile offenders: A pilot study in the use of QEEG-based and analog-based remedial neurofeedback training. *Journal of Neurotherapy, 9*(3), 87-99.
Introduction. Atypical EEG and neuropsychological indicators have been observed among offenders. Dangerous offenders treated with a combined program that included neurofeedback (EEG biofeedback) and galvanic skin response (GSR) biofeedback demonstrated reduction in recidivism (Quirk, 1995). This study was designed to further evaluate the EEG findings of youth offenders and to provide an initial report on the effectiveness of a task oriented analog/ QEEG-based remedial neurofeedback training approach. Method. Five offenders with significant psychopathology were referred for treatment. The group was evaluated with attentional testing and analog/QEEG assessment prior to and following neurotherapy. Treatment consisted of 20 or 40 sessions of a task-activated, analog/QEEG- based approach. Another group of thirteen offenders were assessed with attentional testing and provided with neurotherapy following QEEG assessment. Results. For all of the youth trained, in the analog/QEEG group, prevs. post-audio and visual attention testing demonstrated significant improvement within 20 remedial sessions. Three of the five youth showed rapid advancement in a residential grading system. Staff observational ratings suggested behavioral improvement in the QEEG group who in general were in training for a longer period of time. Conclusion. EEG abnormalities and deficits in neuropsychological testing were found among offenders. Neurotherapy as an adjunctive treatment appears to hold promise for improvement in cognitive performance as well as recidivism. It is anticipated that different neurofeedback protocols may enhance outcomes.

Sohn, C.-H., Shin, M.-S., Hong, K.-E., & Jeong, D.-U. (1996). A Case of Childhood Obstructive Sleep Apnea Syndrome with Co-morbid Attention Deficit Hyperactivity Disorder Treated with Continuous Positive Airway Pressure Treatment. *3*(1), 85–95.
Obstructive sleep apnea syndrome(OSAS) in childhood is unique and different n-om that in adulthood in several aspects, including pathophysiology, clinical features, diagnostic criteria, complications, management, and prognosis. Characteristic features of childhood OSAS in comparison with the adult form are the variety of severe complications such as developmental delay, more prominent behavioral and cognitive impairments, vivid cardiovascular symptoms, and increased death risk, warranting a special attention to the possible diagnosis of OSAS in children who snore. However, the childhood OSAS is often neglected and unrecognized. We, therefore, report a case of very severe OSAS in a 5-year-old boy who was sucessfully treated with continuous positive airway pressure(CPAP) treatment. Interestingly, the patient was comor-bid with the attention deficit hyperactivity disorder. Prior to the initial visit to us, adenotonsillectomy had been done at the age of 4 with no significant improvement of apneic symptoms and heavy snoring. On the initial diagnostic procedures, marked degree of snoring was audible even in the daytime wake state and the patient was observed to be very hyperactive. Increased pulmonary vascularity with borderline cardiomegaly was noted on chest X-ray. The baseline polysomnography revealed that the patient was very sleep-apneic and snored very heavily, with the respiratory disturbance index(RDI) of 46.9 per hour of sleep, the mean SaO2 of 78.8%, and the lowest SaO2 of 40.0%(the lowest detectable oxygen level by the applied oxymeter). The second night polysomnography was done for CPAP titration and the optimal pressure turned out to be. The applied CPAP treatment was well tolerated by the patient and was found to be very effective in alleviating heavy snoring and severe repetitive sleep apneas. After 18 months of the CPAP treatment, the patient was followed up with nocturnal polysomnography(baseline and CPAP nights) and clinical examination. Sleep apneas were still present without CPAP on the baseline night. However, the severity of OSAS was significantly decreased(RDI of 15.7, mean SaO2 of 96.2%, and the lowest SaO2 of 83.0%), compared to the initial polysomnographic findings before initiation of long-term CPAP treatment. Wechsler intelligence tests done before and after the CPAP treatment were compared with each other and surprising improvement of intelligence(total 9 points, performance 16 points) was noted. Clinically he was found to be markedly improved in his attention deficit hyperactive behavior after CPAP treatment, but with minimal change of TOVA(test of variables of attention) scores except conversion of reaction time score into normal range. On the chest X-ray taken after 18 months of CPAP application, the initial cardiopulmonary abnormalities were not found at all. We found that the CPAP treatment in a young child is very effective, safe, and well-tolerated and also improves the co-morbid attention deficit hyperactive symptoms. Overall, the growth and development of the child has been facilitated with the long-term use of CPAP. Cardiovascular complications induced by OSAS have been also normalized with CPAP treatment. We suggest that

early diagnosis and active treatment intervention of OSAS in children are crucial in preventing and ameliorating possible serious complications caused by repetitive sleep apneas and consequent hypoxic damage during sleep.

Song, D. H., Jhung, K., Song, J., & Cheon, K. A. (2011). The 1287 G/A polymorphism of the norepinephrine transporter gene (NET) is involved in commission errors in Korean children with attention deficit hyperactivity disorder. *Behavioral and Brain Functions: BBF, 7*, 12–9081–7–12.
BACKGROUND: Previous evidence supports the role of noradrenergic systems in ADHD, and norepinephrine transporter (NET) is critical in regulating the noradrenergic system. The present study aimed to investigate the association between NET gene polymorphism and the performance measures of the Continuous Performance Test (CPT) in Korean ADHD children. METHODS: Eighty-seven children (mean age = 9.23 +/- 1.99 years) with ADHD were recruited from a university hospital. Genotypes of G1287A of the NET gene (SLC6A2) were analyzed. All participants completed the CPT, with performance measures of omission errors, commission errors, reaction time and reaction standardization computed. The relationship between G1287A polymorphisms and CPT performance measures was examined. RESULTS: There were 46 subjects with the G/G genotype, 35 subjects with the G/A genotype and 6 subjects with the A/A genotype. Among the three groups, there were no significant differences in the performance of CPTs. When dichotomized according to whether the subjects have the rare allele or not, subjects with the homozygous G/G genotype showed significantly lower commission errors compared to those without G/G genotypes (by independent T-test, t = -2.18, p = 0.026). DISCUSSION: Our study found a significant association between commission errors of the CPT and the G1287A genotype of the NET gene in Korean ADHD children. These findings suggest a protective role of the G/G genotype of the NET polymorphisms in the deficits of response inhibition in ADHD children.

Song, D. H., Shin, D. W., Yook, K. H., Jon, D. I., Kim, K.-H., & Min, S.-K. (1998). Effect of Methylphenidate on Functional Cerebral Localization During Attentional Tasks in Boys with ADHD. *Korean J Child & Adol Psychiatr, 9*, 218–226.
This study aims at investigating the effects of psychostimulant on functional cerebral localization during the attentional tasks in ADHD. Inclusional subjects were 13 boy between 6-12 years old who met the DSM-IV criteria for ADHD. In each patient, there was a drugfree period(without methyphenidate) and a drug-loaded period(with oral methylphenidate administration), and within each period there was a resting state and a stimulated state with TOVA. Comparisons were made by measuring the amplitudes of four bands(, , ,) of quantitative EEG to see if there were any differences between the drug-free period(resting and stimulated) and the drug-loaded period(resting and stimulated). In the resting state, there was no difference between the drug-free and drug-loaded periods. In the stimulated state with TOVA, the presence of methylphenidate induced significant changes in the theta to beta ratio() in the right frontal, right parieto-occipital, and left temporal-parietal areas in contrast to the drugf-ree period. These data suggest that methylphenidate shows electrophysiological influences on cerebral topographical activities during the attentional tasks in ADHD.

Song, D. H., Shin, D. W., Jon, D. I., & Ha, E. H. (2005). Effects of methylphenidate on quantitative EEG of boys with attention-deficit hyperactivity disorder in continuous performance test. *Yonsei Medical Journal, 46*(1), 34–41.
The purpose of this study was to investigate the effects of methylphenidate, a psychostimulant, on quantitative electroencephalography (QEEG) during the continuous performance test (CPT) in boys with attention-deficit hyperactivity disorder (ADHD). The QEEG was obtained from 20 boys with ADHD. The amplitudes of 4 bands (alpha, beta, delta, and theta) in the QEEG, as well as the theta /beta ratio, before and after the administration of methylphenidate were compared during both the resting and CPT states. Methylphenidate induced a significant increase of alpha activities in both the right and left frontal and occipital areas, an increase of beta activities in almost all areas except for the temporal region, a decrease of theta activities in both the occipital and right temporo-parietal areas, a mild decrease of delta activities in the occipito-parietal areas, and an increase of the theta/beta ratio in the right frontal and parieto-occipital, and left temporal areas during the CPT state. No significant QEEG changes were induced by the administration of methylphenidate in the resting state. These data suggest that methylphenidate has greater electrophysiological influences on the cerebral topographical activities during the performance of attentional tasks, as compared to the resting state, in boys with ADHD.

Stein, M. A., Blondis, T. A., Schnitzler, E. R., O'Brien, T., Fishkin, J., Blackwell, B., Szumowski, E., & Roizen, N. J. (1996). Methylphenidate Dosing: Twice Daily Versus Three Times Daily. *Pediatrics, 98*(4), Part 1, 748–56.

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 similar 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.

Stein, M. A., Sarampote, C. S., Waldman, I. D., Robb, A. S., Conlon, C., Pearl, P. L., … Newcorn, J. H. (2003). A Dose-Response Study of OROS Methylphenidate in Children With Attention-Deficit/Hyperactivity Disorder. *PEDIATRICS, 112*(5), e404–e404.

Results. Parent ratings were more sensitive to treat- ment effects than teacher ratings. ADHD symptoms and Clinical Global Impressions Severity Index ratings at each dose condition differed significantly from placebo and baseline ratings, which did not differ from one an- other. For those with ADHD-CT, there was a clear linear dose-response relationship, with clinically significant re- ductions in ADHD Rating Scale-IV scores occurring in two thirds to three fourths of the subjects during either 36- or 54-mg dose conditions. Children with ADHD-PI, conversely, were more likely to respond optimally to lower doses and derived less benefit from higher doses, with 60% displaying significant improvement on the ADHD Rating Scale-IV at 36 mg or lower. Mild stimulant side effects were reported during placebo and at all dos- age levels. With the exception of insomnia and decreased appetite, which were more common at higher doses, par- ent report of side effects was not related to dose. In addition, younger and smaller children were more likely to display sleep difficulties and decreased appetite at the higher dose levels Although pulse rate increased slightly with increasing dose, there were no dose effects on blood pressure. Conclusions. In children with ADHD-CT, the most common subtype of ADHD, increasing doses of stimulant medication were associated with increased improvement of inattention and hyperactivity symptoms. In children with ADHD-PI, symptom improvement occurred at lower doses and less benefit was derived from higher doses. In both ADHD subtypes, higher doses were associated with parent ratings of increased insomnia and decreased appetite.

Stewart, G. A., Steffler, D. J., Lemoine, D. E., & Leps, J. D. (2001). Do Quantitative EEG Measures Differentiate Hyperactivity in Attention Deficit/Hyperactivity Disorder? *Child Study Journal, 31*(2), 103-121.

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

Surmeli, T., Ertem, A., Eralp, E., & Kos, I. H. (2012). Schizophrenia and the efficacy of qEEG-guided neurofeedback treatment: a clinical case series. *Clinical EEG and Neuroscience: Official Journal of the EEG and Clinical Neuroscience Society*, *43*(2), 133–144.

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.

Surmeli, T., Eralp, E., Mustafazade, I., Kos, I. H., Ozer, G. E., and Surmeli, O.H. (2016). Quantitative EEG Neurometric Analysis-Guided Neurofeedback Treatment in Postconcussion Syndrome (PCS): Forty Cases. How Is Neurometric Analysis Important for the Treatment of PCS and as a Biomarker? *Clinical EEG and Neuroscience*.

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.

Surmeli, T., and A. Ertem. (2009). QEEG Guided Neurofeedback Therapy in Personality Disorders: 13 Case Studies. *CLINICAL EEG and NEUROSCIENCE, 40*(1), 5–10.

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.

Surmeli, T., & Ertem, A. (2010). Post WISC-R and TOVA improvement with QEEG guided neurofeedback training in mentally retarded: a clinical case series of behavioral problems. *Clinical EEG and Neuroscience: Official Journal of the EEG and Clinical Neuroscience Society*, *41*(1), 32–41.

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

Swartwood, J. N., Swartwood, M. O., Lubar, J. F., & Timmermann, D. L. (2003). EEG differences in ADHD-combined type during baseline and cognitive tasks. *Pediatric Neurology*, *28*(3), 199–204.

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.

Swartwood, M. O., Swartwood, J. N., Lubar, J. F., Timmermann, D. L., Zimmerman, A. W., & Muenchen, R. A. (1998). Methylphenidate effects on EEG, behavior, and performance in boys with ADHD. *Pediatric Neurology*, *18*(3), 244–250.

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.

Teicher, M. H., Ito, Y., Glod, C. A., & Barber, N. I. (1996). Objective measurement of hyperactivity and attentional problems in ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry*, *35*(3), 334–342.

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.

Teicher, M. H., Polcari, A., & McGreenery, C. E. (2008). Utility of Objective Measures of Activity and Attention in the Assessment of Therapeutic Response to Stimulants in Children with Attention-Deficit/Hyperactivity Disorder. *Journal of Child and Adolescent Psychopharmacology, 18*(3), 265–270. Attention-deficit/hyperactivity disorder (ADHD) is a highly prevalent disorder that can respond dramatically to medication, if dose is appropriately titrated. Studies suggest that computer measures of attention cannot be used for titration as they show improvement on doses too low to produce clinical benefits. We assessed whether measures of motor activity and attention using the McLean Motion Attention Test (M-MAT™) could identify doses associated with optimal clinical response. Eleven boys (9.6 ± 1.8 years), receiving treatment with methylphenidate, and meeting DSM-IV criteria for ADHD, participated in this triple-blind (parent, child, rater), within-subject, efficacy study. Subjects received 1 week each of placebo, low (0.4 mg/kg), medium (0.8 mg/kg), and high (1.5 mg/kg) daily doses of methylphenidate. Parents rated response using an index of clinical global improvement. In 9/11 subjects, the dose that produced the best improvement on M-MAT™ measures was also the dose that produced the best clinical outcome ($p < 10^{-5}$). Parents rated response to this dose significantly better than response to previously prescribed treatment. Objective measures of primarily activity and secondarily attention responded to treatment in a manner concordant with clinical ratings, suggesting that these measures have ecological validity, and the potential to facilitate medication management and titration.

Thompson, L., & Thompson, M. (1998). Neurofeedback combined with training in metacognitive strategies: Effectiveness in students with ADD. *Applied Psychophysiology & Biofeedback, 23*(4), 243-263.

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.

Thompson, Lynda, Michael Thompson, and Andrea Reid. (2010). Neurofeedback Outcomes in Clients with Asperger's Syndrome. *Applied Psychophysiology and Biofeedback, 35*(1), 63–81.

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 electroncephalographic (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)(2)/(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.

Toomim, H., Mize, W., Kwong, P., Toomim, M., Marsh, R., Kozlowski, G., Kimball, M., and Rémond, A. (2005). Intentional Increase of Cerebral Blood Oxygenation Using Hemoencephalography (HEG): An Efficient Brain Exercise Therapy. *Journal of Neurotherapy*, *8*(3), 5–21. doi:10.1300/J184v08n03_02.
Intentional enhancement of regional cerebral blood oxygenation (rCBO2) in specific cerebral locations was studied as a brain exercise. A review of literature showed the effect of brain exercise on brain physiology. Hemoencephalography (HEG), a graphic analog of brain blood flow of oxygenated hemoglobin indicated by non-invasive infrared spectroscopy, was used to guide intentionally increasing rCBO2. A musical note and visual graphic keyed to changes in cortical blood ox- ygenation was provided to the participant. A primary aim of this study was to demonstrate the capacity of subjects with brain disorders to increase oxygenation of selected brain tissue using HEG and test the hypothesis that multiple repetitions of these brain exercises improved sustained attention measured with a continuous performance test. The impulsivity score for subjects in the exercise group was in the normal range after 10 sessions. In a small set of subjects, low arousal SPECT images showed increased vascularity after 30 half-hour sessions of intentional enhancement of local blood oxygenation.

Topitsch, D., Schober, E., Wurst, E., & Kryspin-Exner, I. (1998). Changes in attention with hypo- and hyperglycaemia in children with insulin dependent diabetes mellitus. *European Journal of Pediatrics, 157*(10), 802-805.
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/1 (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.

Trembach, A. B., Vitko, E. V., Volobueva, I. A., & Moskovchenko, E. V. (2008). Cortex Mechanism of Posture: Motor Coordinations and Mental Functions. *6*(83).
ABSTRACT: Children with attention deficit hyperactivity disorder (ADHD), having mental dysfunction (decreased attention, impulsivity, unmotivated aggression), found a violation of motor coordination, which is expressed in particular in reducing postural stability (Trembach AB et al., 2004). The problem of the relationship of motor and mental functions in humans with different pathologies of the central nervous was the subject of discussion at two international congresses (Gate & Mental Function, Madrid, 2006, Amsterdam, 2008). However, the neurophysiological mechanisms of this phenomenon are not well understood. The purpose of research - the study of motor and mental functions in children with ADHD 4-8 years and substantiation of their correction by improving motor coordination. 1 explore the electrophysiological correlates of central programs in the implementation of

voluntary movements in children with different levels of attention and impulsivity;: To solve the following tasks were set 2 -Explore stabilometric characteristics orthograde posture in children with different levels of attention and impulsivity; 3 - reveal the influence of motor learning, aimed at improving coordination abilities through biofeedback in children with ADHD, the level of postural stability and mental functions. Methodology The contingent participating in the study. With the written consent of their parents were examined 120 children of 4-8 years of both sexes. Research and sequence of their implementation of the Protocol. At the first stage to determine the level of attention, impulsivity, motor reaction time and its variability was used Test of Variables of Attention (T.O.V.A). On the basis of analysis T.O.V.A. Two groups of children were identified: Group 1 (Control) are children with normal levels of attention and impulsivity (34 boys and girls); Group 2 (experimental) are children with a reduced level of attention and increased impulsivity (34 boys and girls). The second stage was studied electrical activity of the brain in the computer electroencephalograph "Mizar" and a comparative analysis of topographic maps EEG power spectrum in children two selected groups of 14 people in the implementation of motor tasks of varying complexity.

Trembach, A. B., Belyaev, M. A., & Lysenko, V. V. (2004). Age-related changes in attention and impulsivity in young schoolchildren. *Human Physiology, 30*(5), 537-544.
Normative values of attention, impulsivity, response time, and response time variability were determined for seven- to ten-year-old children with the continuous performance Test of Variables of Attention (TOVA). An age-related increase in attention and a decrease in impulsivity, response time, and its variability were revealed. Differences in TOVA scores were studied for students of gymnasia and schools providing general education.

Trudeau, D. L., Anderson, J., Hansen, L. M., Shagalov, D. N., Schmoller, J., Nugent, S., & Barton, S. (1998). Findings of Mild Traumatic Brain Injury in Combat Veterans with PTSD and a History of Blast Concussion. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *10*(3), 308–313.
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.

Tumwine, J. K., Nankabirwa, V., Diallo, H. A., Engebretsen, I. M. S., Ndeezi, G., Bangirana, P., … Meda, N. (2018). Exclusive breastfeeding promotion and neuropsychological outcomes in 5-8 year old children from Uganda and Burkina Faso: Results from the PROMISE EBF cluster randomized trial. *PLOS ONE, 13*(2), e0191001.
Background: The beneficial effects from exclusive breastfeeding (EBF) have been widely acknowledged. We assessed the effect of exclusive breastfeeding promotion by peer counsellors in Uganda and Burkina Faso, on cognitive abilities, social emotional development, school performance and linear growth among 5–8 years old children. Methods: Children in the PROMISE EBF trial (2006–2008) were re-enrolled in the follow-up PROM- ISE Saving Brains (SB) study (2013–2015). Caretaker interviews captured sociodemo- graphic characteristics and social emotional development using the parent version of the Strengths and Difficulties Questionnaire (SDQ). Overall cognition and working memory were assessed using the Kaufman Assessment Battery for Children, second edition (KABC2), cognitive flexibility was measured with the Child Category Test (CCT), and atten- tion with the Test of Variables of Attention (T.O.V.A), while school performance wasmeasured by a standardized test on arithmetic and reading. Country-pooled, age adjusted z-scores from each of the above outcomes were entered into a linear regression model controlling for confounders. Results: The number of children re-enrolled in the intervention and control arms were: 274/396 (69.2%) and 256/369 (69.4%) in Uganda and 265/392 (67.6%) and 288/402 (71.6%) in Bur- kina Faso. Assessment of cognitive ability showed small and no significant differences, of which general cognition (z-scores, 95% CI) showed the largest mean difference: -0.17 (-0.40; 0.05). Social emotional symptoms were similar across arms. There were no differ- ences in school performance or linear growth for age detected. Conclusion: Peer promotion for exclusive breastfeeding in Burkina Faso and Uganda was not associ- ated with differences at 5–8 years of age in a range of measures of child development: cog- nitive abilities, emotion-behaviour-social symptoms or linear growth. This study from sub Saharan Africa did not reconfirm findings elsewhere that have shown an association between exclusive breastfeeding and cognitive performance.

This might be due to a num- ber of methodological limitations inherent in the current study. For example since the major- ity of the children were breastfed, the benefits of the intervention could have been diluted. Other factors such as the mental and HIV status of the mothers (which were not assessed in the current study) could have affected our results. Hence regarding the effect of exclusive breastfeeding on measures of child neurocognitive development in sub Saharan Africa, the jury is still out.

Tyton, T. N., Scott, H. M., & Horswill, C. A. (2018). Metabolic Rate during a Cognitive Vigilance Challenge at Alternative Workstations. *Journal of Occupational and Environmental Medicine, 1.*
Objective: Compare energy expenditure (EE, kcal/min) at three workstations during an attention-demanding cognitive function task (Test of Variables of Attention or TOVA). Workstations included the seated desk (SIT), standing desk (STAND), and seated workstation designed to promote spontaneous movement (SWING). Methods: Adult males (n = 11) and females (n = 13) were assessed for EE using VO2 and VCO2 per quarter of the 22-min TOVA. Results: Average EE were 1.39 ± 0.06 (SIT), 1.55 ± 0.08 (SWING), and 1.44 ± 0.08 (STAND). Main effects ($p < 0.05$) were seen for workstation (SWING, STAND > SIT), and quarter of TOVA (Q2 < Q1,Q3,Q4). TOVA errors and response times were not different for workstations but increased for Q3 and Q4. Conclusion: Spontaneous movement at an alternative workstation elevated EE 10-11% compared to sitting and could increase daily non-exercise activity thermogenesis without diminishing mental attention to desk work.

Vaisman, N., Kaysar, N., Zaruk-Adasha, Y., Pelled, D., Brichon, G., Zwingelstein, G., & Bodennec, J. (2008). Correlation between changes in blood fatty acid composition and visual sustained attention performance in children with inattention: effect of dietary n-3 fatty acids containing phospholipids. *The American Journal of Clinical Nutrition*, *87*(5), 1170–1180.
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.

van Wijngaarden, E., Thurston, S., Myers, G., Harrington, D., Cory-Slechta, D., Strain, J., and Watson, G., et al. (2016). Methyl Mercury Exposure and Neurodevelopmental Outcomes in the Seychelles Child Development Study Main Cohort at Age 22 and 24 years. *Neurotoxicology and Teratology*.
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 24years of age. Methods: Neurodevelopmental tests at 22years included the Boston Naming Test, Cambridge Neuropsychological Test Automated Battery (CANTAB), and the Profile of Mood States. At 24years, 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 prenatal 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 24years 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. *J Int'l Neuropsych. Society, 17*(3), 463–73.
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.

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 <.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.

Votruba, K. L., Persad, C., & Giordani, B. (2016). Cognitive Deficits in Healthy Elderly Population With "Normal" Scores on the Mini-Mental State Examination. *Journal of Geriatric Psychiatry and Neurology, 29(*3), 126–132. This study investigated whether healthy older adults with Mini-Mental State Examination (MMSE) scores above 23 exhibit cognitive impairment on neuropsychological tests. Participants completed the MMSE and a neuropsychological battery including tests of 10 domains. Results were compared to published normative data. On neuropsychological testing, participants performed well on measures of naming and recall but showed mild to moderate impairment in working memory and processing speed and marked impairment in inhibition, sustained attention, and executive functioning. Almost everyone (91%) scored at least 1 standard deviation (SD) below the mean in at least 1 domain. The median number of domains in which individuals scored below 1 SD was 3.0 of 10.0, whereas over 21% scored below 1 SD in 5 domains or more. With the strictest of definitions for impairment, 20% of this population scored below 2.0 SDs below the norm in at least 2 domains, a necessary condition for a diagnosis of dementia. The finding that cognitive impairment, particularly in attention and executive functioning, is found in healthy older persons

who perform well on the MMSE has clinical and research implications in terms of emphasizing normal variability in performance and early identification of possible impairment.

Wada, N., Yamashita, Y., Matsuishi, T., Ohtani, Y., & Kato, H. (2000). The Test of Variables of Attention (TOVA) is Useful in the Diagnosis of Japanese Male Children with Attention Deficit Hyperactivity Disorder. *Brain & Development, 22*(6), 378-382.

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.

Wallmark, S., Lundström, E., Wikström, J., & Ronne-Engström, E. (2015). Attention Deficits After Aneurysmal Subarachnoid Hemorrhage Measured Using the Test of Variables of Attention. *Stroke*, *46*(5), 1374–1376.

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-administrated 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.

Walters, A. S., Mandelbaum, D. E., Lewin, D. S., Kugler, S., England, S. J., & Miller, M. (2000). Dopaminergic therapy in children with restless legs/periodic limb movements in sleep and ADHD. Dopaminergic Therapy Study Group. *Pediatric Neurology*, *22*(3), 182–186.

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.

Wang, L.-J., Chen, C.-K., & Huang, Y.-S. (2015). Gender Differences in the Behavioral Symptoms and Neuropsychological Performance of Patients with Attention-Deficit/Hyperactivity Disorder Treated with Methylphenidate: A Two-Year Follow-up Study. *Journal of Child and Adolescent Psychopharmacology*, *25*(6), 501–508.

Objective: This study investigated the gender differences in behavioral symptoms, as rated by various informants, and in neuropsychological performance, among patients with attention-deficit/hyperactivity disorder (ADHD) treated with methylphenidate during 24 months in a clinical setting. Methods: Study participants comprised 128

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

Wang, L.-J., Chen, C.-K., & Huang, Y.-S. (2015). Neurocognitive performance and behavioral symptoms in patients with attention-deficit/hyperactivity disorder during twenty-four months of treatment with Methylphenidate. (Report). *JOURNAL OF CHILD AND ADOLESCENT PSYCHOPHARMACOLOGY*, *25*(3), 246.

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.

Weyandt, L. L., Hays, B., & Schepman, S. (2005). The Construct Validity of the Internal Restlessness Scale. *Assessment for Effective Intervention*, *30*(3), 53–63.

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.

Weyandt, L. L., Mitzlaff, L., & Thomas, L. (2002). The Relationship Between Intelligence and Performance on the Test of Variables of Attention (TOVA). *Journal of Learning Disabilities, 35*(2), 114-120.

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.

Weyandt, L. L., Rice, J. A., Linterman, L. M., & Emert, E. (1998). Neuropsychological Performance of a Sample of Adults With ADHD, Developmental Reading Disorder, and Controls. *Developmental Neuropsychology.*
In this study, we investigated the performance of adults with Attention Deficit Hyperactivity Disorder (ADHD), relative to adults with Developmental Reading Disorder (DRD), and controls on a battery of executive function tasks (Wisconsin Card Sorting Test [WCST], Test of Variables of Attention, Tower of Hanoi, and Ravens Progresive Matrices) and several self-report ADHD rating scales (Wender Utah Rating Scale, Patient Behavior Checklist, and Adult Rating Scale). Sixty-four participants took part in the study (21 with ADHD, 19 with DRD, and 24 controls). Kruskall-Wallis one-way analysis of variance results revealed a significant difference between groups, with the DRD group committing more WCST errors (total and preseveration) than the remaining groups. Group differences were also found on the ADHD ratings scales, with the ADHD group reporting higher ratings. Discriminant Function Analyses (using the rating scales and the neuropsychological tasks) correctly classified 67% and 44% of the cases, respectively. The psychometric properties of the ADHD rating scales were also explored.

Wigal, S. B., Wigal, T., Schuck, S., Brams, M., Williamson, D., Armstrong, R. B., & Starr, H. L. (2011). Academic, Behavioral, and Cognitive Effects of OROS® Methylphenidate on Older Children with Attention-Deficit/Hyperactivity Disorder. *Journal of Child and Adolescent Psychopharmacology*, *21*(2), 121–131.
Objective: To assess the effect of Osmotic-Release Oral System (OROS) methylphenidate (MPH) on a variety of measures evaluating academic performance, cognition, and social behavior in children with attention-deficit/hyperactivity disorder (ADHD). Methods: This double-blind, randomized, placebo-controlled, crossover laboratory school study enrolled 78 children aged 9–12 years with ADHD who responded to OROS MPH. After determining individualized OROS MPH dosing (18–54 mg/day), 71 subjects received blinded treatment (OROS MPH or placebo then vice versa) on each of 2 laboratory school days, separated by 1 week. Primary efficacy was measured by Permanent Product Measure of Performance at 4 hours after study drug administration. Results: Treatment with OROS MPH resulted in statistically significant improvement in Permanent Product Measure of Performance and Swanson, Kotkin, Agler, M-Flynn, and Pelham scores, measures of response time, and of working memory compared to placebo. Other measures did not meet all pre-established criteria for significance (maintenance of the overall type I error rate at 5%). Adverse events were consistent with previous reports of stimulant medications used in the management of ADHD. There were no discontinuations due to adverse events, and no serious adverse events or deaths. Conclusions: OROS MPH dosed to reduce core symptoms of ADHD to within the normal range also improved performance on a variety of academic tasks in school-aged children compared to placebo. Adverse effects reported were consistent with prior studies.

Williamson, D., Murray, D. W., Damaraju, C. V., Ascher, S., & Starr, H. L. (2014). Methylphenidate in Children with ADHD With or Without Learning Disability. *Journal of Attention Disorders*, *18*(2), 95–104.
Objective: To explore treatment response to Osmotic Release Oral System ® (OROS) methylphenidate in children with ADHD with and without comorbid learning disability (LD). Method: Data were analyzed from two 6-week, double-blind, randomized, placebo-controlled, crossover studies evaluating individually determined doses of OROS methylphenidate versus placebo in 135 children (ages 9 to 12 years) with ADHD with or without an LD in reading, math, or both. The sample was demographically diverse, with 31% females and more than 40% minority, predominantly African American and Hispanic. On two laboratory school days, participants received either OROS methylphenidate or placebo and were given a battery of cognitive and behavioral tests. Results: Treatment with OROS methylphenidate led to improvement in ADHD Rating Scale scores for participants with or without comorbid LD. Both groups performed better during treatment with OROS methylphenidate than placebo on measures of cognitive skills (i.e., Test of Variables of Attention, Finger Windows Backwards), academically related tasks (i.e., Dynamic Indicators of Basic Early Literacy Skills, Test of Handwriting Skills–Revised, Permanent Product Math Test), and observed classroom behavior (i.e., Swanson, Kotkin, Alger, M-Flynn, and Pelham Scale). Conclusion: In children

with ADHD with or without comorbid LD, behavior and performance improved during treatment with OROS methylphenidate.

Wu, Y., Huang, Y., Chen, Y., Chen, C., Chang, T., & Chao, C. (2007). Psychometric Study of the Test of Variables of Attention: Preliminary Findings on Taiwanese Children with Attention-Deficit/Hyperactivity Disorder. *Psychiatry and Clinical Neurosciences, 61*(3), 211-218.

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 31ADHD 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.

Xueni, L., & Yufeng, W. (2000). A Preliminary Application of the Test of Variables of Attention (T.O.V.A.) in China. *Chinese Mental Health Journal, 14*(3), 149–52.

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.

Yeates, K. O., Luria, J., Bartkowski, H., and Rusin, J. (1999). Postconcussive Symptoms in Children with Mild Closed Head Injuries. *Journal of Head Trauma Rehabilitation, 14*(4), 337–50.

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 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.

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.

Zelnik, N., Bennett-Back, O., Miari, W., Goez, H. R., & Fattal-Valevski, A. (2012). Is the Test of Variables of Attention Reliable for the Diagnosis of Attention-Deficit Hyperactivity Disorder (ADHD)? Journal of Child Neurology, 27(6), 703–707.
The diagnosis of attention-deficit hyperactivity disorder (ADHD) is occasionally biased by the subjectivity of symptoms and reports of parents and teachers. The advent of continuous performance tests raised expectations that the diagnosis of ADHD will be more standardized and accurate. In this study, the authors looked for the validity of the ADHD scores obtained by the Test of Variables of Attention in 230 children who were referred to their ADHD clinic between 2005 and 2007. Based on clinical evaluations, 179 children were diagnosed with affirmed or suspected ADHD. Among the 179 children with ADHD, the Test of Variables of Attention was suggestive of ADHD in 163 participants (91.1% sensitivity), but it was also suggestive for ADHD in 78.4% of the children without ADHD. With a low specificity of 21.6%, the authors feel that the Test of Variables of Attention is not reliable enough to serve as a screening diagnostic tool for ADHD.

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.