

## ADHD

[JECT.](#) 2005 Jun;21(2):88-95.

### **Transcranial magnetic stimulation in persons younger than the age of 18.**

[Quintana H.](#)

Department of Psychiatry, Division of Child and Adolescent Psychiatry, Louisiana State University Health Science Center, School of Medicine, New Orleans, Louisiana 70112-2822, USA. [Hquint@lsuhsc.edu](mailto:Hquint@lsuhsc.edu)

**OBJECTIVES:** To review the use of transcranial magnetic stimulation (single-pulse TMS, paired TMS, and repetitive TMS [rTMS]) in persons younger than the age of 18 years. I discuss the technical differences, as well as the diagnostic, therapeutic, and psychiatric uses of TMS/rTMS in this age group. **METHODS:** I evaluated English-language studies from 1993 to August 2004 on nonconvulsive single-pulse, paired, and rTMS that supported a possible role for the use of TMS in persons younger than 18. Articles reviewed were retrieved from the MEDLINE database and Clinical Scientific index. **RESULTS:** The 48 studies reviewed involved a total of 1034 children ages 2 weeks to 18 years; 35 of the studies used single-pulse TMS (980 children), 3 studies used paired TMS (20 children), and 7 studies used rTMS (34 children). Three studies used both single and rTMS. However, the number of subjects involved was not reported. **CONCLUSIONS:** Single-pulse TMS, paired TMS, and rTMS in persons younger than 18 has been used to examine the maturation/activity of the neurons of various central nervous system tracts, plasticity of neurons in epilepsy, other aspects of epilepsy, multiple sclerosis, myoclonus, transcallosal inhibition, and motor cortex functioning with no reported seizure risk. rTMS has been applied to psychiatric disorders such as ADHD, ADHD with Tourette's, and depression. Adult studies support an antidepressant effect from repetitive TMS, but there is only one study that has been reported on 7 patients that used rTMS to the left dorsal prefrontal cortex on children/adolescents with depression (5 of the 7 subjects treated responded). Although there are limited studies using rTMS (in 34 children), these studies did not report significant adverse effects or seizures. Repetitive TMS safety, ethical, and neurotoxicity concerns also are discussed.

[Biol Psychiatry.](#) 2005 Jun 15;57(12):1597-600.

### **Transcranial magnetic stimulation-evoked cortical inhibition: a consistent marker of attention-deficit/hyperactivity disorder scores in tourette syndrome.**

[Gilbert DL](#), [Sallee FR](#), [Zhang J](#), [Lipps TD](#), [Wassermann EM](#).

Division of Neurology, Cincinnati Children's Hospital Medical Center and University of Cincinnati, OH 45229-3039, USA. [d.gilbert@cchmc.org](mailto:d.gilbert@cchmc.org)

**BACKGROUND:** Prior case-control studies using Transcranial Magnetic Stimulation (TMS) to probe the neural inhibitory circuitry of Attention Deficit Hyperactivity Disorder (ADHD), Tourette Syndrome (TS), and Obsessive Compulsive Disorder (OCD), have yielded conflicting results. Using regression analysis in TS patients with tics, ADHD, and/or OCD symptoms, all ranging from none to severe, we previously found that TMS-evoked short interval intracortical inhibition (SICI) correlated inversely with ADHD scores. We sought to validate this observation. **METHODS:** We used regression to estimate the consistency of the association between ADHD symptom scores and TMS-evoked SICI at two separate visits in 28 children and adults with TS. **RESULTS:** ADHD scores correlated significantly and consistently with SICI, particularly in patients not taking dopamine receptor blockers ( $r=.60$  and  $r=.58$ ). Hyperactivity, not inattention, scores accounted for ADHD-related variance in SICI. **CONCLUSIONS:** SICI reliably reflects the severity of hyperactivity in children and adults with TS.

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### **Emerging brain-based interventions for children and adolescents: overview and clinical perspective.**

[Hirshberg LM](#), [Chiu S](#), [Frazier JA](#).

The NeuroDevelopment Center, 260 West Exchange Street, Suite 302, Providence, RI 02903, USA. [lhirshberg@neruodevelopmentcenter.com](mailto:lhirshberg@neruodevelopmentcenter.com)

Electroencephalogram biofeedback (EBF), repetitive transcranial magnetic stimulation (rTMS), and vagal nerve stimulation (VNS) are emerging interventions that attempt to directly impact brain function through neurostimulation and neurofeedback mechanisms. This article provides a brief overview of each of these techniques, summarizes the relevant research findings, and examines the implications of this research for practice standards based on the guidelines for recommending evidence based treatments as developed by the American Academy of Child and Adolescent Psychiatry for attention deficit hyperactivity disorder (ADHD). EBF meets the "Clinical Guidelines" standard for ADHD, seizure disorders, anxiety, depression, and traumatic brain injury. VNS meets this same standard for treatment of refractory epilepsy and meets the lower "Options" standard for several other disorders. rTMS meets the standard for "Clinical Guidelines" for bipolar disorder, unipolar disorder, and schizophrenia. Several conditions are discussed regarding the use of evidence based thinking related to these emerging interventions and future directions.

[Curr Med Res Opin](#). 2003;19(2):125-30.

## **Repetitive transcranial magnetic stimulation (rTMS): new tool, new therapy and new hope for ADHD.**

[Acosta MT](#), [Leon-Sarmiento FE](#).

Department of Neurology, Children's National Medical Center, Washington, DC, USA.

Attention-deficit hyperactivity disorder (ADHD) is the most common developmental disorder that is associated with environmental and genetic factors. Neurobiological evidence suggests that fronto-striatum-cerebellum circuit abnormalities, mainly in the right hemisphere, are responsible for most of the disturbed sensorimotor integration; dopamine seems to be the main neurochemical alteration underlying these morphological abnormalities. Different conventional treatments have been employed on ADHD; however, repetitive transcranial magnetic stimulation (rTMS), a new and useful option for the clinical/research investigation of several neuropsychiatric disorders involving dopamine circuits, has yet to be considered as a therapeutic tool and possible drug-free option for ADHD. Here the authors explore the available evidence that makes this tool a rational therapeutic possibility for patients with ADHD, calling attention to safety issues, while highlighting the potentials of such an approach and the new hope it may bring for patients, parents, researchers and clinicians. The authors advocate carefully conducted clinical trials to investigate efficacy, safety, cost-effectiveness and clinical utility of rTMS for ADHD patients - in comparison to both placebo and standard treatments.

[Clin Neurophysiol](#). 2003 Nov;114(11):2036-42.

## **Disturbed transcallosally mediated motor inhibition in children with attention deficit hyperactivity disorder (ADHD).**

[Buchmann J](#), [Wolters A](#), [Haessler F](#), [Bohne S](#), [Nordbeck R](#), [Kunesch E](#).

Department of Child and Adolescence Neuropsychiatry, Centre of Nerve Disease, University of Rostock, Gehlsdorfer Strasse 20, 18147 Rostock, Germany.

**OBJECTIVE:** The aim of this study was to investigate mechanisms of motor-cortical excitability and inhibition which may contribute to motor hyperactivity in children with attention deficit hyperactivity disorder (ADHD). **METHODS:** Using transcranial magnetic stimulation (TMS), involvement of the motor cortex and the corpus callosum was analysed in 13 children with ADHD and 13 sex- and age-matched controls. Contralateral silent period (cSP) and transcallosally mediated ipsilateral silent period (iSP) were investigated. **RESULTS:** Resting motor threshold (RMT), amplitudes of motor evoked potentials (MEP) and cSP were similar in both groups whereas iSP-latencies were significantly longer ( $p < 0.05$ ) and their duration shorter ( $p < 0.01$ ) in the ADHD group. For the ADHD group iSP duration tended to increase and iSP latency to decrease with age (n.s.). Conners-Scores did neither correlate with iSP-latencies and -

duration nor with children's age. CONCLUSIONS: The shortened duration of iSP in ADHD children could be explained by an imbalance of inhibitory and excitatory drive on the neuronal network between cortex layer III-the projection site of transcallosal motor-cortical fibers-and layer V, the origin of the pyramidal tract. The longer iSP-latencies might be the result of defective myelination of fast conducting transcallosal fibers in ADHD. iSP may be a useful supplementary diagnostic tool to discriminate between ADHD and normal children.

[J Child Neurol](#). 2001 Dec;16(12):891-4.

### **Subjective reactions of children to single-pulse transcranial magnetic stimulation.**

[Garvey MA](#), [Kaczynski KJ](#), [Becker DA](#), [Bartko JJ](#).

Pediatric Movement Disorders Unit, Pediatrics and Developmental Neuropsychiatry Branch, National Institute of Mental Health, National Institutes of Health, Bethesda, MD 20892-1255, USA. [garvey@intra.nimh.nih.gov](mailto:garvey@intra.nimh.nih.gov)

Single-pulse transcranial magnetic stimulation is a useful tool to investigate cortical function in childhood neuropsychiatric disorders. Magnetic stimulation is associated with a shock-like sensation that is considered painless in adults. Little is known about how children perceive the procedure. We used a self-report questionnaire to assess children's subjective experience with transcranial magnetic stimulation. Normal children and children with attention-deficit hyperactivity disorder (ADHD) underwent transcranial magnetic stimulation in a study of cortical function in ADHD. Subjects were asked to rate transcranial magnetic stimulation on a 1 to 10 scale (most disagreeable = 1, most enjoyable = 10) and to rank it among common childhood events. Thirty-eight subjects completed transcranial magnetic stimulation; 34 said that they would repeat it. The overall rating for transcranial magnetic stimulation was 6.13, and transcranial magnetic stimulation was ranked fourth highest among the common childhood events. These results suggest that although a few children find transcranial magnetic stimulation uncomfortable, most consider transcranial magnetic stimulation painless. Further studies are necessary to confirm these findings.