Neurofeedback Can be a Valuable Tool for Occupational Therapists working with Children with ADHD

Nicole Kuhl
Pacific University

Follow this and additional works at: http://commons.pacificu.edu/otpeds

Part of the Occupational Therapy Commons, and the Pediatrics Commons

Notice to Readers

This work is not a peer-reviewed publication. Though the author of this work has provided a summary of the best available evidence at the time of writing, readers are encouraged to use this CAT as a starting point for further reading and investigation, rather than as a definitive answer to the clinical question posed or as a substitute for clinical decision-making.

Select copyrighted material from published articles may be included in this CAT for the purpose of providing a context for an informed critical appraisal. Readers are strongly encouraged to seek out the published articles included here for additional information and to further examine the findings in their original presentation. Copyrighted materials from articles included in this CAT should not be re-used without the copyright holder’s permission.

Recommended Citation

http://commons.pacificu.edu/otpeds/8

This Critically Appraised Topic is brought to you for free and open access by the OT Critically Appraised Topics at CommonKnowledge. It has been accepted for inclusion in Pediatrics CATs by an authorized administrator of CommonKnowledge. For more information, please contact CommonKnowledge@pacificu.edu.
Neurofeedback Can be a Valuable Tool for Occupational Therapists working with Children with ADHD

**Disciplines**
Occupational Therapy | Pediatrics

**Rights**
Terms of use for work posted in CommonKnowledge.

This critically appraised topic is available at CommonKnowledge: http://commons.pacificu.edu/otpeds/8
Neurofeedback Can be a Valuable Tool for Occupational Therapists working with Children with ADHD.

Prepared by: Nicole Kuhl (kuhl5161@pacificu.edu)

Date: 11/30/2010

Review date: 11/30/2012

CLINICAL SCENARIO:
The Centers for Disease Control and Prevention (CDC website) estimates that 3 to 7% of children suffer from ADHD in the United States. The main treatment for ADHD is currently pharmaceutical using stimulants that can help children improve their ability to concentrate; however medications do not appear to help with reading skills, social skills and academic achievements, and can have such side effects as weight loss, loss of appetite, interrupted sleep patterns and in some cases slowed growth (Case-Smith, 2005). Also, not all children respond positively to pharmaceutical treatments and only 56% of the children diagnosed with ADHD are treated with medications (CDC website). Occupational therapists are already working with this population, helping with environmental modification, social training or using techniques to help children with sensory modulation (Case-Smith, 2005). Some promising results came out of several Neurofeedback therapy (Nf) studies (McCormack, Pauley, Douglas and Sinquefield, 2010, Monastra, Monastra and George, 2002, Gevensleben et al., 2009, Fuchs, Birbaumer, Lutzenberger, Gruzelier and Kaiser, 2003), indicating that this therapy could be an additional tool occupational therapists could use when working with children diagnosed with ADHD.

FOCUSED CLINICAL QUESTION:
What is the evidence supporting the use of Neurofeedback as a treatment for children with ADHD?

SUMMARY of Search, ‘Best’ Evidence appraised, and Key Findings:
- Five articles written since 2000 were selected to address the clinical question.
- A cohort study by Monastra, Monastra and George was chosen as the best evidence to answer the clinical question. This study looked at the effect of adding Neurofeedback.
therapy to a Comprehensive Clinical Care (CCC) program including the use of Ritalin, parent counselling and school intervention for a group consisting of 51 children (age 6 to 19) diagnosed with ADHD. A control group of 49 children received only the CCC program. The study showed that the group receiving Neurofeedback was the only one able to maintain their scores in attention assessment (TOVA) and behavioural scales (ADDES) when Ritalin was stopped. Also, EEG showed that the children who received Neurofeedback therapy were able to modify their brain activity to achieve the same EEG pattern as typical children (for the theta/beta ratio).

- A Meta-Analysis by Arns, de Ridder, Strehl, Breteler and Coenen (2009) looking at 15 studies investigating the effectiveness of Neurofeedback therapy found that Neurofeedback is an “efficacious and specific” treatment (Level 5 according to the guidelines for evaluation of clinical efficacy of psychological interventions) for ADHD core symptoms.

- A randomized controlled trial (RCT) comparing Neurofeedback with a computerized attention skill training (AST) program (Gevensleben et al. 2009), concluded that both parents and teachers reported a greater decrease in ADHD symptoms with Neurofeedback training (ES vary between .38 and .6 depending on the outcomes measured). However, this study reported that 52% of the children did not respond the Neurofeedback therapy.

- A cross sectional study done by Clarke, Barry, McCarthy and Seikowitz (2001) compared Electroencephalography (EEG) of children with ADHD with those of typical children. They found that children with ADHD, as a whole have some similarities in their EEGs, but they found 3 distinct sub-categories in this population. Cluster 1 and 2 have increased theta/beta ratio, but the third cluster has a decreased theta/beta ratio compared to typical children. These differences could account for the variation in response to Neurofeedback therapy found in some studies.

- A follow up study by Molina et al. (2009) looked at children eight years after they underwent therapy for ADHD. The study looked at pharmacotherapy, behavioural therapy and a combo therapy using both stimulants and behavioural therapy. The study concluded that the improvements seen after therapy did not maintain over time (independent of the therapy used) and that compared to a typical group of children from the same cohort, children with ADHD still presented a level of functioning at least 1 SD bellow, even when controlling for IQ. The authors emphasized the need for alternative therapies to help children with ADHD and their families.
CLINICAL BOTTOM LINE:
Neurofeedback was found efficacious in the treatment of ADHD in several studies; showing improvements not only in the behavioural symptoms experienced by the children with ADHD, but also in the underlying electrophysiological brain activity of these children. Even though these results are encouraging, some of these studies lack in clinical rigor (especially randomization) and some report large percentage of children not responding to treatment; indicating that additional research is needed, especially to identify different therapy protocols for children with different brain wave activity patterns. These future studies need to include randomization, the use of valid control groups and blind study strategies to increase the validity of their results.

Limitation of this CAT: The critically appraised paper has been individually prepared by a master’s of occupational therapy student as part of a university project and reviewed by a faculty member, but has not been externally peer-reviewed.

SEARCH STRATEGY:

Terms used to guide Search Strategy:

- Patient/Client Group: Children diagnosed with ADHD
- Intervention (or Assessment): Neurofeedback
- Comparison: Null
- Outcome(s): Reduction in the behavioural symptoms of ADHD (inattention, hyperactivity and impulsivity)
### Databases and sites searched

<table>
<thead>
<tr>
<th>Databases and sites searched</th>
<th>Search Terms</th>
<th>Limits used</th>
</tr>
</thead>
<tbody>
<tr>
<td>• MEDLINE (10/2010)</td>
<td>Search “neurofeedback”, map to “biofeedback, psychology” or “neurofeedback” Search “ADHD” map to “attention Deficit Disorder with Hyperactivity”</td>
<td>English language A total of 79 articles were found.</td>
</tr>
<tr>
<td>• OT Seeker (10/2010)</td>
<td>Search “neurofeedback” AND “ADHD”</td>
<td>A total of 2 articles were found</td>
</tr>
<tr>
<td>• Articles references (10/2010)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### INCLUSION and EXCLUSION CRITERIA

- **Inclusion:**
  - Study of children (<19 years old) with ADHD
  - Study of the effectiveness of Neurofeedback
  - Study that describes the neurophysiological component of ADHD
  - English language

- **Exclusion:**
  - Study done on adults
  - 2000 to present

### RESULTS OF SEARCH

3 relevant studies were chosen and categorised as shown in Table 1. Two additional studies that did not meet these criteria were added. One because it described the current evidence on the standard treatment used (Medication and behavioural therapy), the other because it describes the founding of EEG abnormalities in children with ADHD.
Table 1: Summary of Study Designs of Articles retrieved, based on the McMaster’s levels of Evidence (Law and MacDermid, 2008).

<table>
<thead>
<tr>
<th>Study Design/ Methodology of Articles Retrieved</th>
<th>Level</th>
<th>Number Located</th>
<th>Author (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-Analysis</td>
<td>1</td>
<td>1</td>
<td>Arns, de Ridder, Strehl, Breteler and Coenen (2009)</td>
</tr>
<tr>
<td>Randomized Controlled Trial</td>
<td>1</td>
<td>1</td>
<td>Grevensleben, Holl, Albrecht, Vogel, Schlamp, Kratz, Studer, Rothenberger, Moll, and Heinrich (2009)</td>
</tr>
<tr>
<td>Cohort study</td>
<td>2</td>
<td>1</td>
<td>Monasta, Monasta and George (2002)</td>
</tr>
</tbody>
</table>

BEST EVIDENCE
The following study/paper was identified as the ‘best’ evidence and selected for critical appraisal.

Reasons for selecting this study were:

- This study looked at both behavioural symptoms, and the electrophysiological abnormalities that can be found in some of the children with ADHD.
- It studies the efficacy of Neurofeedback in conjunction with the “gold standard” treatment (use of stimulants, parents’ counselling and school intervention) for ADHD which increases the ecological validity of the results.
The behavioural symptoms of ADHD were measured not only with parents and teachers questionnaires (which can be subjective) but also using an objective test measuring the child actual ability to concentrate (TOVA).

**SUMMARY OF BEST EVIDENCE**

Table 2: Description and appraisal of the cohort study by Monastra, Monastra and George (2002).

<table>
<thead>
<tr>
<th>Aim/Objective of the Study/Systematic Review:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The purpose of this study was to look at the effects of Ritalin, parenting style and neurofeedback (Nf) on the main behavioural symptoms of ADHD (inattention, impulsivity and hyperactivity), as well as on the physiological abnormalities found in some children with ADHD; such as reduced Sensorimotor EEG rhythm (SMR: 12-14 Hz) and beta (16-20Hz), and increased theta (4-8 Hz) waves.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>This cohort study used a control group to monitor the efficacy of Neurofeedback, but is not a randomized study as children were assigned to the intervention group or control group according to the parents’ choice. Only the teachers did not know what kind of interventions the children were receiving.</td>
</tr>
<tr>
<td>The independent variables were: Ritalin use, Nf use and parenting style.</td>
</tr>
<tr>
<td>The dependent variables were: results of the Attention Deficit Disorders Evaluation Scales (ADDES school and home) and the test of Variables of Attention (TOVA) assessments (see outcome section for more details), as well as Quantitative Electroencephalogram (QEEG).</td>
</tr>
<tr>
<td>The outcomes were measured before the study started, then once more one year after treatment started. Then again one week later after the participant flushed Ritalin out of their system (no medication for one week).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The study was conducted in The Family Psychology Institute, a private outpatient clinic in Upstate NY.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The participants were children age 6 to 19. 83 were male and 17 were female. 24 were diagnosed with ADHD/inattentive, and 76 were diagnosed with ADHD/combined.</td>
</tr>
</tbody>
</table>
Health professionals located near the clinical setting of the study referred the families to the study (not random sample).

49 children were assigned to the Comprehensive Clinical Care (CCC) control group, and 51 were assigned to the CCC+Neurofeedback.

The gender ratio, age, diagnosis, intelligence quotient (IQ) as well as family socioeconomic status (SES) were equivalent in the two groups.

All children received an electroencephalographic (EEG) to make sure that they had equivalent brain activities in the type of waves studied (beta, Theta and SMR).

All children had scores below 7 for inattention, impulsivity and hyperactivity on ADDES.

**Intervention Investigated**

Both groups received:

- Stimulant therapy: Children were given Ritalin for a year. The range was between 15 and 45 mg/day depending on the child’s need (measured by administration of the TOVA and a questionnaire on side effects given every week until results of TOVA were within 1 S.D of results found in healthy population of the same age).

- Parent counselling: parents received 10 parenting class including instruction on ADHD, the role of positive parenthood and the use of systematic reinforcements as well as nutrition.

- School consultation, the researchers helped the parents and school create appropriate IEPs for each of the children.

The intervention group also received EEG biofeedback (also called neurofeedback). The child received one 30 to 40 min “attention training” session every week. Children were playing computer games that rewarded them when they increased their frontal lobe arousal (monitored looking at beta, SMR and Theta waves). Also every 3 or 4 sessions, if they had reached a certain level of control over their brain activity they would get $15 cash reward. The training would continue until the child’s brain activity was within 1 S.D of that of typical children. All the participants reached that goal (average of 43 sessions).

**Outcome Measures**

3 categories of outcome measures were identified:

- Behavioural symptoms measures:
  * Home version of the Attention Deficit Disorders Evaluation Scale (ADDS)
  * School version of the Attention Deficit Disorders Evaluation Scale (ADDS)
For both of these questionnaires, a score below 7 is considered characteristic of ADHD diagnosis.

- Assessment of ability to stay focused on a task:
  * Test of Variables of Attention (TOVA)

For the TOVA the cut off score for typical children is below 80

- Recording of specific brain activity
  * Electroencephalography

**Main Findings:**
The authors report that the ADDES scores for children who received CCC+Neurofeedback showed significantly better improvement in attention (p<.001) and in hyperactivity/impulsivity (p<.001) than children in the CCC group. These same results were found for both the home and school ADDES.

The TOVA scores showed that children in both groups performed at the same level while using Ritalin; however, after Ritalin was stopped, only children who received Neurofeedback were able to maintain scores above the 80 cut off value for inattention, impulsivity and response time (p<.001).

Finally, when looking at the EEG the researchers studied the theta/beta ratio, as anticipated, only the group who received Neurofeedback therapy registered a change in this ratio (p<.001). After intervention, this ratio (called in this study, attentional indices) had values within the typical range (2.99).

**Original Authors’ Conclusions**
The study concludes that even though both CCC and CCC+B programs were efficacious at treating the symptoms of ADHD using a functional test such as TOVA, the CCC+ Neurofeedback group showed better improvement in behavioural scales such as ADDES. Also, parenting style is not relevant when treatment does not involves Nf; however, when using Nf, a “systematic” parenting style is a contributing factor to improve ADDES score (only for the Home version).

Another finding of this study is that the children who received Nf were able to retain the improvements they had made (ADDES and TOVA) after Ritalin was stopped, which was not the case for the control group. These results can be explained by the change in QEEG that was found in the CCC+B group when the medicine was flushed out of their system.
Critical Appraisal and Conclusion:

This study is very valuable because it looks at Neurofeedback in conjunction with ADHD “golden standard” treatment. It not only looks at behavioural symptoms but also at the actual change in brain activity that can be seen after Neurofeedback training. The use of the TOVA, which added an objective measurement of the improvement of attention and impulsivity symptoms, was a very clever addition. It would have been valuable to also add a concrete measurement of the child functioning such as grade point average.

The statistical analysis was thorough; using an ANOVA to look at main effects and interactions between the different variables. A post hoc analysis was also conducted for the most significant main effects and interactions using Tukey’s Honest Significant Difference Test.

As other researchers have found (Clarke, Barry, McCarthy and Selikowitz, 2001), brain activity of children with ADHD are not all similar, but can be categorized in 3 sub-groups. This current study intentionally chose children who all presented with the same electrophysiological abnormalities, creating a sampling bias, which reduces the generalisability of this study.

The results about parenting styles are interesting but would need further research. Because ADDES is a form completed by parents, there is a possibility that bias influenced the results. Parenting style was seen as significant only in the CCC+B group; as the parents chose which treatment their children received, it is possible that they had different expectations about the treatment, which led them to see the action of their children in a different way. It is likely that parenting style is a factor, but a more unbiased method should be used to measure its effect. The use of randomization of the participants and having them blind as to which treatment they were receiving would have also help with the validity of the study.

The fact that the control group did not receive any placebo treatment while the intervention group received Neurofeedback training is a cause for concern as the interaction and training the child received from the therapist during Neurofeedback therapy could be considered as a co-intervention. The use of a placebo treatment (attention skills training) could have helped reduce this bias.
### CONCLUSIONS OF OTHER STUDIES

<table>
<thead>
<tr>
<th>Study</th>
<th>Summary of the Research Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arns, M., de Ridder, S., Strehl, U., Breteler, M., Coenen, A. (2009). Efficacy of neurofeedback treatment in ADHD: the effects on inattention, impulsivity and hyperactivity: a meta-analysis. <em>Clinical EEG and Neuroscience, 40</em>(3), 180-189</td>
<td>- A Meta-Analysis by Arns, de Ridder, Strehl, Breteler and Coenen (2009) looking at 15 studies found that Neurofeedback is an “efficacious and specific” treatment (Level 5 according to the guidelines for evaluation of clinical efficacy of psychological interventions) for ADHD core symptoms; inattention, impulsivity, and to a lesser extent hyperactivity. This study highlights some additional research that needs to be done (e.g. the need to study the efficacy of different Neurofeedback protocols, as well as the need to create studies with more rigorous scientific methods).</td>
</tr>
<tr>
<td>Clarke, A. R., Barry, R.J., McCarthy, R., Selikowitz, M. (2001). EEG-defined subtypes of children with attention-deficit/hyperactivity disorder. <em>Clinical Neurology, 112</em>, 2098-2105.</td>
<td>A cross sectional study done by Clarke, Barry, McCarthy and Seikowitz (2001) compared Electroencephalography (EEG) of 184 children with ADHD with those of 40 typical children age 8 to 12. They found that children with ADHD, as a whole have some similarities in their EEGs (reduced theta, increased delta, decreased alpha and beta and increased theta/beta ratio), but they found 3 distinct sub-categories in this population. Cluster 1 is associated with cortical hypoarousal. Cluster 2 is somewhat similar to cluster 1 (increased theta/beta ratio) but the EEG profiles show some characteristics linked to “maturational lag”. Cluster 3 is different because these children exhibit decreased theta/beta ratio compared to typical...</td>
</tr>
</tbody>
</table>
children and cortical hyperarousal (and more temper tantrums). These differences could account for the variation in response found in some studies.


- This cleverly designed randomized controlled trial (RCT) compared a group of 59 children receiving Neurofeedback treatment with a group of 35 children receiving computerized attention skill training (AST) program. All children were diagnosed with ADHD and were between the age of 8 and 12. The study concluded that both parents and teachers reported a greater decrease in ADHD symptoms with Neurofeedback training (ES .57 for inattention, .6 for hyperactivity, and .37 for oppositional behaviour). This study reports that 52% of the children who received the Neurofeedback therapy did not respond to the therapy. The researchers indicated that future research to better understand what psychological or neurological factors influence a child’s chance to respond favourably to Nf treatment is needed.


A follow up study by Molina et al. (2009) looked at 579 children eight years after they underwent therapy for ADHD. The study looked at pharmacotherapy, behavioral therapy and a combo therapy using both stimulants and behavioral therapy. The study concluded that the improvements seen after therapy did not maintain over time (independent of the kind of therapy used) and that compared to a typical group of 261
children from the same cohort, children with ADHD still presented a level of functioning at least 1 SD below, even when controlling for IQ. This study highlights the critical need for alternative therapies to treat ADHD and its symptoms.

**IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH**

As highlighted in the AOTA position paper on physical agent modality (McPhee, Bracciano and Winthrop Rose, 2008), biofeedback (and by extension, Neurofeedback) is an acceptable therapy to be used by trained occupational therapists as long as it is used as a preparatory method to achieve functional goals. Research by the faculty of the OT program at the University of Missouri-Columbia showed that the state of concentration that children learned during Neurofeedback training was generalized to their daily activities, helping improve their behavioral symptoms (McCormack, Pauley, Douglas and Sinquefield, 2010).

A web search done on November 9th 2010 indicated that 11 professionals in Oregon and 7 in the Portland area used Neurofeedback to treat children and adults with ADHD. Some of these health professionals were nurse practitioners and naturopaths; others did not appear to have any qualifications other than Certified Neurofeedback Therapist; however none were occupational therapists.

Neurofeedback therapy is unlikely to be the answer for all children diagnosed with ADHD, not only because studies identified that some children do not respond to this therapy, but also because it is a long and costly process that can require over 40 sessions to achieve good results. A survey of the therapists using this tool in the Portland area indicated that the total cost can reach up to $4000, making it inaccessible for a lot of families.

However, it seems important that occupational therapists investigate further this therapy as it may help some of their clients and their families; as a mother mentioned “What I noticed in my son [after he completed his Neurofeedback therapy program] was not necessarily that he'd stop losing things at school or do his homework better. The improvement I saw was that he was easier to live with” (Hamilton, 2010). This kind of relief for both client and their families is what will enable them to engage successfully in life.
Neurofeedback therapy cannot be practiced by entry level occupational therapists; however the Biofeedback Certification International Alliance website describes the Masters of occupational therapy as one of the acceptable degree to be certified as a Board Certified in Neurofeedback (BCN). This certification requires 36 didactic hours (that can be taken online), 25 contact hours with a mentor certified in Neurofeedback, 100 client sessions and a case conference presentation, as well as a written examination. Application for the certification and courses cost around $1000 and the certification is valid for four years and can be renewed with proof that the therapist has taken at least 80 hours of continuing education over the past four years.

Even if the current research may indicate that Neurofeedback is a promising therapy for ADHD, further research is needed to assert the efficacy of this therapy. Future studies including the use of randomization, valid control groups and blind study strategies would increase the validity of the results. Also more research needs to be done to evaluate the efficacy of Neurofeedback on children presenting with different EEG characteristics. These data would allow the health professionals involved in the treatment of children diagnosed with ADHD to advocate for this therapy to be reimbursed by major health insurances rendering it more accessible to clients and their families.

REFERENCES


