Figure 1

montage	wave IV A/Fz	A/Cz′	Erb_{axil}/Fz	Erb_{axil}/Cz′	wave V A/Fz	A/Cz′	Erb_{axil}/Fz	Erb_{axil}/Cz′
mean [μV]	0.38	0.42	0.61	0.63	0.54	0.64	0.91	0.96
stddeviation	0.16	0.19	0.25	0.28	0.21	0.25	0.32	0.35

were averaged and analyzed for normal distribution and statistical significance ($p < 0.01$, Wilcoxon test or paired *t*-test).

Results: Data of 30 patients (47 ± 19 years/ 17 f), normal hearing or slight presbyacusis undergoing infratentorial surgeries (15 tumors, 14 microvascular decompression) were analyzed. Latencies and amplitudes neither differed between the right and left side nor between all latencies and amplitudes of waves I, II and III (Erb/Fz). Wave III (only Erb/Fz) as well as wave IV and V amplitudes were significantly larger ($p < 0.001$):

Discussion: Waves I – V were reliably recorded over Erb's point with the same derivation and latencies compared to the standard recording from preauricular. This montage resulting in significant larger amplitudes of waves IV and V might be of advantage in case of low amplitude signal and high noise. Thus, a multichannel recording can be recommended.

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FV 9

Therapeutic effect of Infra-Low-Frequency (ILF-) Neurofeedback training on Children and Adolescents with Attention Deficit (Hyperkinetic) Disorder—H. Schneider[a,*], A. Alfred[b], B. Wandernoth[a], A. Blunck[c] ([a] BEE Medic GmbH, Singen, Germany, [b] Praxis Dr. med. Adam Alfred, München, Germany, [c] Praxis für Psychiatrie und Psychotherapie, Rapperswil, Switzerland)

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Introduction: According to actual estimates, approximately five percent of children of school age suffer from hyperkinetic disorder/AD(H) S (Polanczyk et al., 2007; Banaschewski et al., 2017), so that innovative and effective treatment methods that show long-lasting efficacy without the use of psychotropic drugs are of great relevance.

Compared to AD(H) S therapies with pharmacological substances such as methylphenidate, neurofeedback (NFB) can achieve similar effects (Fuchs et al., 2003; Monastra et al., 2002; Rossiter and La Vaque, 2004). A modern and evidence-based variant of this procedure is the so-called ILF neurofeedback, which differs from the "classical" NFB in the following points, among others:

(1) In addition to the "conventional" EEG signals in the frequency range 1–40 Hz, brain activity is also processed in the so-called "infra-low" frequency range below 0.1 Hz.
(2) To convert the measured ILF signals of the EEG into visual, auditory and tactile feedback signals, the therapist sets an individual coupling factor for each patient.
(3) The EEG measurement is performed in a bipolar montage, where the placement of the electrodes on the skull is chosen according to the symptoms of over- or under arousal of the patient.

Currently, there are only a few studies using ILF neurofeedback as a treatment for AD(H) S (Sasu and Othmer, 2015). The present study is therefore intended to clarify the question of whether ILF neurofeedback is an effective therapy for children and adolescents with AD(H) disorders. To evaluate the results, a continuous performance test (CPT) was performed before and after the ILF neurofeedback treatment for various parameters of attention and impulse control.

Methods: In total, 251 patients in childhood and adolescence (7–21 years) with clinically validated diagnosis of AD(H) disorder participated in the data collection and received therapy in the form of 30 ILF neurofeedback treatments over a period of roughly 15 weeks, which corresponds to about two sessions per week.

A continuous performance test (CPT) was performed by each participant of the study before (T0) and after (T1) NFB treatment to assess clinically relevant parameters of attention and impulse control. In addition, a symptom analysis and a Copeland symptom listing were performed at these times (Copeland, 1989). In this study only data were collected from 196 participants who were able to complete the complete NFB treatment and CPT tests as well as the pre- and post-operative examinations. All these interventions were carried out by specialist therapists who had qualified in a certified ILF neurofeedback training course lasting several days.

To perform ILF neurofeedback EEG NeuroAmp® amplifiers and Cygnet® software (Corscience GmbH & Co. KG, Erlangen) were used. The ILF neurofeedback treatment protocol applied corresponds to the Othmer method, which measures parameters of slow cortical potentials in the low frequency range (<0.1 Hz) and processes them for the feedback process. The protocol also inhibits steep amplitude increases of EEG activity in certain bands of the entire frequency spectrum between 0–40 Hz (Othmer, 2017). This approach is evidence-based and is individually adapted to the patient. The EEG was recorded via sintered silver/silver chloride electrodes in a bipolar montage. The positioning of the electrodes was determined individually for each patient based on symptoms.

The CPT was performed using the "QIK-Test" device (BEE Medic GmbH, Singen). Each test had a duration of 21-min, during which the patient had to press a button on the device to respond to each target signal and had not to press a button for each non-target signal that was displayed. During this GO/NOGO test, the device recorded various parameters of attention and impulsivity, such as the response time (RT), the average RT, the variability of the response time (VAR) as well as omission errors (OM) and commission errors

(CO). Average RT is the mean of all correct reaction times to a target. VAR is the standard deviation of correct response times. OM occur when the subject does not respond correctly to a target CO occur when the subject responds incorrectly to a non-target. While omission errors (and outliners) are considered to determine sustained attention, commission errors (and anticipatory errors) are considered to determine impulse control.

The data evaluation was carried out using "Xlstat", a tool of the "Excel" software (Microsoft Corporation, Redmond, USA).

Results: Data from 196 participants whose average age was 12.1 years could be included in the study (SD: 2.8, interval: 7.3–21.5). The gender distribution was 21% female and 79% male.

In the CPTs performed at times T0 and T1, changes in the following four variables of attention and impulse control were analyzed: average response time (RT), variability of response time (VAR), omission error (OM), and commission error (CO). The averaged RT of the patients improved during the 30 sessions of ILF-Neurofeedback by about 21 ms (from 457 ms (SD = 88 ms) at T0 to 436 ms (SD = 85 ms) at T1). In parallel, VAR improved too by about 18 ms (from 122 ms (SD = 30 ms) at T0 to 104 ms (SD = 30 ms) at T1).

From the test parameters that determine impulse control, OM improved from an average of 9.6 errors (SD = 15.1 errors) at T0 to 5.0 errors (SD = 9.3 errors) at T1 and CO improved from an average of 19.1 errors (SD = 17.3 errors) at T0 to 9.0 errors (SD = 9.0 errors) at T1.

The values of RT and VAR were compared using independent t-tests because a normal distribution with equal variances was given. Both variables showed statistically significant improvements (RT: $t = 5.788$, $p < 0.0001$, two-tail; VAR: $t = 13.7$, $p < 0.0001$, two-tail) after treatment of 30 sessions ILF neurofeedback.

OM and CO did not follow a normal distribution, so a non-parametric Wilcoxon signed-rank test was performed. In both variables there were statistically significant improvements in values (OM: $Z = 83.5$, $p < 0.0001$; CO: $Z = 90.5$, $p < 0.0001$) after ILF neurofeedback treatment.

Discussion: The "QIK Test" CPT is a computerized visual continuous performance test developed for assessing attention and impulse control. While omission errors (and outliners) are considered to determine sustained attention, commission errors (and anticipatory errors) are considered to determine impulse control. The analysis of the CPT data show a significant improvement of all parameters of sustained attention and impulse control after 30 sessions of ILF-Neurofeedback training.

Although this study could not be substantiated by the addition of a control group, the results obtained suggest that ILF neurofeedback-assisted therapy in AD(H) S patients leads to a significant improvement in important parameters of attention and impulse control.

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FV 10

Adult ADHD is associated with reduced noradrenaline transporter availability in prefrontal/ parietal/thalamic regions: A [^{11}C] MRB-PET/MRI study—C. Ulke[a,*,1], M. Rullmann[b,1], J. Huang[a], J. Luthardt[b], G.A. Becker[b], M. Patt[b], P.M. Meyer[b], S. Tiepolt[b], S. Hesse[b], O. Sabri[b], M. Strauß[a] ([a] Leipzig University, Dept. of Psychiatry and Psychotherapy, Leipzig, Germany, [b] Leipzig University, Dept. of Nuclear Medicine, Leipzig, Germany)

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Aim: The dysregulation of the central noradrenergic (NA) system has been implicated in the pathophysiology of attention-deficit/hyperactivity disorder (ADHD). Specifically, the NA transporters (NAT) seem to play a key role modulating arousal and cognitive processes, known to be altered in adult ADHD patients. Further, NA transporters are treatment targets for prescribed drugs such as methylphenidate and atomoxetine in ADHD. Sofar, changes of NAT availability have not been described in adults with ADHD. In the present study, we tested the hypothesis that NA availability is altered in unmedicated adult patients with ADHD compared to healthy control subjects matched for gender and age.

Methods: To explore differences in NAT availability, PET and NAT-selective (S,S)-[11C]-O-methylreboxetine (MRB) were applied (mMR biograph, Siemens) in 18 unmedicated adult patients with ADHD (7 females, age 33.4 ± 8.5 years, 487.9 ± 8.3 MBq injected activity) and in 18 age- and sex-matched healthy controls (7 females, age 33.4 ± 7.4 years,468.6 ± 75 MBq). The regional distribution volume ratios (DVR) were calculated (VOI analysis) based on the individual PET-MRI data coregistration and a multi-linear reference tissue model with 2 contraints (MRTM2) and the occipital cortex serving as the reference region. DSM-IV subscales (total T-score) of the Connors adult ADHD rating scales (CAARS) were used to measure ADHD symptom severity.

Results: We found significant differences in DVR between patients with ADHD and healthy controls in several regions of interest (ROI), including prefrontal brain regions (e.g., the right dorsolateral prefrontal cortex 1.07 ± 0.03 and 1.04 ± 0.04, $p = .01$), the right thalamus (1.39 ± 0.09 and 1.32 ± 0.09, $p = .02$) and the right precuneus (1.09 ± 0.03 and 1.06 ± 0.04, $p = .02$) while most of the other investigated brain regions showed a tendency towards lower values in patients compared with healthy controls. We found significant negative correlations between NAT availability in these regions and ADHD symptom severity ($.01 \leqslant p \leqslant .03$).

Conclusion: These initial findings suggest decreased NAT availability in adult ADHD patients in relevant ROIs. It is an ongoing study for further exploring of how NA/NAT modulates resting-state activity (simultaneously measured by means of echo planar MR sequences) and appropriate behavior as assessed by thorough neuropsychological testing.

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