Neurofeedback/Biofeedback for Behavioral and Substance Use Disorders

Policy Number: BH727NFB062025
Annual Review Date: June 16, 2025
Interim Review Date: N/A

Table of Contents Page

Introduction & Instructions for Use

Introduction

Behavioral Clinical Policies are a set of objective and evidence-based behavioral health criteria used by medical necessity plans to standardize coverage determinations, promote evidence-based practices, and support members' recovery, resiliency, and wellbeing for behavioral health benefit plans that are managed by Optum®.

Instructions for Use

This guideline is used to make coverage determinations as well as to inform discussions about evidence-based practices and discharge planning for behavioral health benefit plans managed by Optum. When deciding coverage, the member's specific benefits must be referenced.

All reviewers must first identify member eligibility, the member-specific benefit plan coverage, and any federal or state regulatory requirements that supersede the member's benefits prior to using this guideline. In the event that the requested service or procedure is limited or excluded from the benefit, is defined differently or there is otherwise a conflict between this guideline and the member's specific benefit, the member's specific benefit supersedes this guideline. Other clinical criteria may

apply. Optum reserves the right, in its sole discretion, to modify its clinical criteria as necessary using the process described in Clinical Criteria. This guideline is provided for informational purposes. It does not constitute medical advice.

Optum may also use tools developed by third parties that are intended to be used in connection with the independent professional medical judgment of a qualified health care provider and do not constitute the practice of medicine or medical advice.

Optum may develop clinical criteria or adopt externally-developed clinical criteria that supersede this guideline when required to do so by contract or regulation.

Benefit Considerations

Before using this policy, please check the member-specific benefit plan document and any federal or state mandates, if applicable.

Description of Service

Neurofeedback/biofeedback therapy is a non-invasive technique that uses real-time physical sign monitors, such as electroencephalographs (EEGs), heart-rate variability/respiratory sinus arrhythmia (HRV/RSA), magnetic encephalography (MEG), and functional real-time functional magnetic resonance imaging (rtfMRI). These modalities provide feedback to individuals on how to control physiologic functions and mental states. The real-time feedback such as the individuals' EEG pattern and other physiological processes allows the individual to correct and enhance a mental and behavioral strategy for symptom improvement.

Coverage Rationale

Neurofeedback or biofeedback (with or without EEG guidance) is unproven and not medically necessary for treating individuals with any behavioral or substance use disorder, including but not limited to:

- Attention-deficit/hyperactivity disorder (ADHD)
- Depression
- Anxiety
- Obsessive-compulsive disorder
- Post-traumatic stress disorder
- Alcohol/drug abuse
- Autism spectrum disorder

The reviewed evidence, including randomized controlled trials and systematic reviews, does not clearly demonstrate the treatment effect of neurofeedback/biofeedback on behavioral or substance use disorders. Many of these reviewed studies contain a number of significant limitations. Additionally, there is a lack of well-designed clinical trials with sufficient sample sizes, randomization, and blinding demonstrating the effectiveness of neurofeedback/biofeedback in the treatment of behavioral and substance use disorders.

Clinical Evidence

Systematic Reviews and Meta-Analyses

Attention-Deficit/Hyperactivity Disorder (ADHD)

An UptoDate review by Chan (2025) states that high-quality randomized controlled trials regarding neurofeedback as a treatment for children diagnosed with ADHD have had varying results and are currently not proven efficacious.

An UptoDate review by Solanto (2025) found that although there have been several neurofeedback studies regarding adults diagnosed with ADHD, the results are varied. Further research is required to determine the rationale for these mixed results.

Peterson et al. (2024) completed a systematic review on effective ADHD treatments for children and adolescents. The review included randomized controlled trials (RCTs), controlled clinical trials, and prospective and retrospective observational studies comparing non-drug treatments. Participants ranged from birth to 17 years old with a diagnosis of ADHD. The review identified 21 neurofeedback (NF) studies, 19 of which used an RCT design. NF protocols varied in session duration, number of sessions, and target approach. Participant sizes ranged from 29 to 186. Approximately 75% of the NF studies included a passive control group, such as an attention-matched task, waitlist, or no intervention. Several studies compared NF to active interventions like methylphenidate or cognitive training. Outcomes varied, with some studies reporting improvements in individual cognitive tasks. However, further analysis found low strength of evidence that NF improved ADHD symptom scores compared to passive controls. Similarly, low strength of evidence was found between NF and cognitive training in the few studies that reported this comparison. Follow-up data ranged from 1.5 to 25 months post-treatment, with no durable statistical effects observed at or beyond 12 months. The authors concluded that medications have the strongest evidence for improving outcomes. However, further research is needed for alternative treatments due to the adverse effects that can be associated with medications.

Kuznetsova and colleagues (2023) assert that there is a lack of clarity regarding neurofeedback (NF) and efficacy for ADHD due to unresolved multiple controlled trials. This systematic review is seeking to compare learners versus non-learners and examine the technique of NF. The study inclusion criteria consisted of healthy individuals diagnosed with ADHD by DSM guidelines, ICD-10 diagnoses; and autism and other disorders, at least diagnosed by a psychiatrist using replicable methods. Studies with both children and adults diagnosed with ADHD were included. The interventions included task-based NF multi-session protocols as follows: TBR (theta-beta ratio); SMR (sensorimotor); SCP (slow cortical potential); and alpha. This systematic review comprises 17 studies. In 6 out of the 17 studies, the ability to self-regulate was measured only during pre- and post-intervention. Among the 4 studies focused on learning, each study utilized different statistical analysis methods rendering conclusions difficult. Although a majority of the studies utilized the standard two-group comparisons, they did not address within-group variability and individual differences. The overall results of this systematic review confirm a lack of studies on individual learning related to NF, with heterogenous protocols across the studies. Future research with a focus on the limitations is needed in addition to establishing positive and durable outcomes regarding NF and successful learning.

A systematic review of eighteen peer-reviewed studies was conducted by Saif and Sushkova (2023) regarding the clinical efficacy of neurofeedback (NF) protocols in treatment of attention deficit/hyperactivity disorder (ADHD). Studies included EEG-based neurofeedback intervention for the treatment of ADHD. Participant sample sizes ranged from 20 to 202, with ages from 6 – 17 years old. The types of NF used in the studies were theta/beta ratio (TBR), sensorimotor rhythm (SMR), or slow cortical potentials (SCP). NF intervention duration ranged from 3 weekly sessions over 10-12 months to 60 total sessions for 2-3 times weekly. The results indicate that various NF protocols are as effective as stimulant medications, however, there are numerous limitations contributing to inconclusive results. Some studies suggest NF intervention as a stand-alone treatment, while other studies recommend combining NF with medications or Vitamin D3. The differences in the types of ADHD (inattentive, hyperactive/impulsive, or combined) are not addressed and NF interventions may not be effective for all types of ADHD. The reviewed studies had too many heterogenous factors to complete a meta-analysis; different inclusion criteria, equipment use, duration of NF intervention, control group, assessment tools, and statistical analysis methods. The authors of this systematic review recommend further high-quality research design to determine a consensus of NF efficacy for ADHD treatment, in addition to standardized NF protocols.

Lin et al. (2022) conducted a systematic review and meta-analysis on the additive effects of EEG neurofeedback on medications for ADHD. The meta-analysis included five RCTs with 305 participants diagnosed with ADHD, ages 8–11 years old, the median number of neurofeedback treatment sessions was 30 (range: 16–40 weeks). All included trials that utilized theta/beta ratio EEG-NF protocols. There was a lack of blinding in the majority of included studies. The results for the combined approach were not superior to medication alone in the therapeutic effects on the symptoms of hyperactivity/impulsivity from parents' observation, (Hedges' g = 0.1714, 95% CI [− 0.0544 - 0.3971], p = 0.1368, I^2 =3.1%). Findings for combining EEG-NF with medications showed no additional therapeutic benefit compared to medication alone (Hedges' g = 0.1201, 95% CI [− 0.3531 - 0.5933], p = 0.6189, I^2 =58.6%). Durability results at the median follow-up of 12 weeks showed additive effects of EEG-NF on medications from parents' observations of ADHD symptoms of hyperactivity and impulsivity (Hedges' g = 0.2898, 95%CI [0.0238 - 0.5557]) and inattention symptoms (Hedges' g = 0.3274, 95%CI [0.0493 - 0.6055]). Results showed additive effects lacked durability at six months after EEG-NF intervention (Hedges' g = 0.4807, 95% CI [− 0.2430 - 1.2044], p = 0.1930, I^2 = 83.2%). These results support additive benefits of combining EEG-NF with medications compared to medication alone in treating global symptoms and symptoms of inattention in individuals diagnosed with ADHD. The authors note that future trials including participants of

diverse demographic backgrounds while using different NF protocols are required to clarify the efficacy of combining EEG-NF with medications in clinical practice.

Lambez et al. (2020) performed a meta-analysis on eighteen studies published between 1980 and 2017 regarding the neuropsychological effects of non-pharmacological interventions for ADHD. The interventions within the studies were categorized into four categories: neurofeedback, cognitive-behavioral therapy, cognitive training, and physical exercises. The findings revealed that all interventions demonstrated homogeneous and noteworthy results; neurofeedback showed a moderate effect size of 0.61 (df=5, 95% CIL= −3.77, 4.82). The authors report an overall positive effect of psychological interventions on ADHD cognitive symptomology; this analysis supports the inclusion of non-pharmacological interventions in combination with the pharmacological treatments. The authors acknowledge limitations of this meta-analysis as a small number of studies met the strict inclusion criteria; the majority of studies included mixed groups of participants who were taking stimulant medication during the intervention and testing period; the notable results found in this study are limited to laboratory tasks. There were numerous quality intervention studies that were not included in this analysis due to their lack of computerized or written neuropsychological tests. The authors conclude that further research should focus on comparing randomized clinical trials while differentiating between medicated and non-medicated participants.

The Emergency Care Research Institute (ECRI) published a health technology assessment (2020) on neurofeedback (NF) for treating ADHD in children and adolescents. The report examined evidence from 3 meta-analyses that were considered low quality and 3 additional randomized controlled trials; the results indicated that NF is less effective than pharmacotherapy and behavioral therapy in treating ADHD symptoms. Limitations among the studies include the use of different NF protocols, varied outcome assessment methods, and small patient groups with different ages. Clinical guidelines from the Canadian ADHD Resource Alliance (2020), the American Academy of Pediatrics (2019), and the Canadian Paediatric Society (2018) state that there is insufficient data to recommend NF for the treatment of ADHD. Future research is required with larger RCTs using standardized NF protocols to assess safety and effectiveness.

Van Doren et al. (2019) conducted a systematic review and meta-analysis to evaluate neurofeedback (NF) in children with ADHD. The review investigated effects of NF after treatment and during 2–12 months post-treatment follow-up period, in which no additional neurofeedback sessions or booster sessions were performed. A total of ten studies met inclusion criteria with 10 studies in the NF arm (n = 256) and 9 studies in the control arm (n = 250). The authors concluded that compared to non-active control treatments, NF has more durable treatment effects, for at least 6 months following treatment. The authors indicated that carefully designed RCTs with longer follow-up time periods are needed before definite treatment recommendations can be provided.

Razoki (2018) performed a systematic review aimed to evaluate the efficacy of neurofeedback (NF) compared to stimulant medication in treating children and adolescents with ADHD. The review examined eight randomized controlled trials that compared an NF condition, either alone or combined with medication. The age of participants ranged from 6-24 years across the eight studies. The number of NF (theta/beta or theta/SMR) sessions ranged from 20 to 40, and the duration per session ranged from 25 to 50 minutes across the studies. The sample sizes were from n=32 to n=130. Results revealed that when only trials are considered that include blinded ratings or those that are sham-NF or semi-active controlled, or those that utilize optimally titration procedures, the findings do not support theta/beta NF as a standalone treatment for children or adolescents with ADHD. Nevertheless, an additive treatment effect of NF was observed on top of stimulants and theta/beta NF was able to decrease medication dosages, and both results were maintained at 6-month follow-up. The authors concluded that the role of NF in treating children diagnosed with ADHD should be considered as complementary in a multimodal treatment approach, individualized to the child, and may be considered a viable option to stimulants for a specific group of patients. Future research should further explore the possibility of NF reducing medication dosages. In addition, future research should prioritize which particular group of patients that may benefit from NF treatment.

Other Behavioral Disorders

Barreiros et al. (2024) completed a systematic review of sixteen studies on fMRI neurofeedback interventions for individuals with depression, including those diagnosed with major depressive disorder (MDD), recurrent depression, or mild depression. Sample sizes ranged from 6 to 43 participants. In nine studies, participants were not taking antidepressants, six studies included participants on antidepressants, and one study did not report medication status. The studies employed various neurofeedback (NF) protocols, including different regulatory strategies, NF signals and targets, session durations, and the

number of sessions. Nine studies included control groups, while seven did not. Depression was assessed using tools such as the Hamilton Depression Rating Scale (HDRS), the Montgomery-Åsberg Depression Rating Scale (MADRS), and the Beck Depression Inventory (BDI). Overall, studies with sham NF control groups (n=9) reported significant outcome effects related to session and training, whereas studies without control groups showed varied results. A major limitation noted was the heterogeneity in NF methodologies, which prevented a meta-analysis. Other limitations included a lack of durability data, small sample sizes, and varied medication statuses among participants. The authors recommend more rigorous and robust research designs to improve the reliability of future studies. They acknowledge the need for reproducible neurofeedback protocols to enhance research comparability, generalizability, and to establish standardized clinical NF protocols.

Li et al. (2024) conducted a single-center, randomized, single-blind, sham-controlled parallel trial to investigate neurofeedback as a treatment for impulsive behavior in males diagnosed with schizophrenia. The study included eighty adult male participants with documented impulsive behavior and a schizophrenia diagnosis. Participants had been treated with standardized oral risperidone (3-6 mg/day) for at least one month, were in a stable (non-acute) phase, had never received MECT, and had not used mood stabilizers or sedative-hypnotics in the past month. The control group (n=40) received risperidone and sham neurofeedback, while the study group (n=40) received risperidone and active neurofeedback therapy. Neurofeedback (alpha wave) sessions were administered five times per week, for 20 minutes sessions, over six weeks. Clinical symptoms were assessed at baseline, three weeks, and six weeks using the Positive and Negative Syndrome Scale (PANSS), the Modified Overt Aggression Scale (MOAS), and the Rating Scale for Extrapyramidal Side Effects (RSESE). Baseline data comparison between the control and study groups revealed a statistically significant difference only in the number of hospitalizations (P=0.018). After three and six weeks of intervention, the study group showed significant improvements in MOAS scores ($P < 0.001$) and PANSS scores ($P < 0.001$), including the Excited, Positive, Cognitive, and Depressive/Anxiety components, with no significant changes in RSESE scores ($P = 0.745$). The trial's limitations include its focus on males only, excluding potential differences in impulsive behavior among females, the use of a single psychiatric assessment tool, and the exclusive monitoring of alpha waves in neurofeedback. The authors acknowledge that while the results are promising, future research should involve larger, multi-center trials that include both male and female patients, robust study designs, and durability data.

Patil et al. (2023) completed a 12-study systematic review on EEG-based neurofeedback to treat depression. The twelve studies were categorized into two groups based on the NF protocols most commonly used to treat depression symptoms: (1) alpha-asymmetry (ALAY) and (2) high-beta down-training NF protocols. Participants were adults (n=352) diagnosed with MDD or treatment-resistant depression. The overall findings suggest that individuals diagnosed with depression showed notable clinical, cognition, and neural improvements with EEG-NF training. Comparisons of the protocols among the studies revealed superior behavioral and clinical outcomes for high-beta down-training compared to the ALAY protocol. The number of sessions across the studies ranged from 8 – 30 sessions, with duration of sessions ranging from 5 – 12 weeks. Due to the low cost and negligible risk of adverse effects, the authors recommend exploring EEG-NF as an augmentation tool for individuals being treated with anti-depressants that remain symptomatic. Limitations include minimal studies that have compared participants diagnosed with depression to a healthy control group, variation of protocols, small sample sizes without blinding, and lack of follow-up data. The authors conclude that future research is needed with robust clinical design and larger sample sizes to establish efficacy of EEG-NF for the treatment of depression.

Blume et al. (2022) conducted a randomized-controlled pilot study to investigate the efficacy of two EEG neurofeedback (NF) protocols in decreasing episodes of binge eating, eating disorder and general psychopathology, executive functioning, and EEG activity. Adult participants were diagnosed per the DSM-5 with binge eating disorder (BED) and overweight (N = 39). Participants were randomly assigned according to BMI < 30 kg and BMI > 30 kg to either a food-specific EEG NF protocol (n=20), designed to reduce frontocentral beta activity and increasing theta activity after viewing highly palatable food pictures, or a general EEG NF protocol (n=19) training the regulation of slow cortical potentials. Participants completed assessments at baseline, pretreatment, posttreatment, and 3-month follow-up; each assessment included elements of the validated Eating Disorder Examination (EDE). The primary outcome was identified as the number of objective binge-eating episodes (OBEs) in the last 14 days. Both EEG NF protocols revealed positive outcomes with significantly reduced OBEs, global eating disorder psychopathology, and food craving. Results for the food-specific group showed a significant decrease in OBEs from pretreatment to posttreatment, $p < 0.01$, $\eta 2 = 0.33$. Results for the general EEG feedback group revealed a significant reduction in the number of OBEs at posttreatment compared to pretreatment with a large time effect size, $p < 0.01$, $\eta 2 = 0.38$. Approximately one third (31.6%) of participants reported abstinence from OBEs after treatment without any differences between treatments. These results showed durability at the 3-month follow-up. Among the six measured executive functions, only decision making improved at posttreatment in both groups 95% CI [2.79, 31.19], $p = 0.01$, $d = 0.50$. Cognitive flexibility was

significantly improved after food-specific neurofeedback only, posttreatment (M = 0.95, SD = 4.33) and at 3-month follow-up (M = 2.39, SD = 5.17). The researchers state that these outcomes highlight EEG neurofeedback as a promising treatment modality for individuals diagnosed with BED. Future studies with empirical design and larger participant samples are needed to establish NF efficacy and standard NF procedures regarding treatment of BED.

Hong and Park (2022) conducted a systematic review and meta-analysis of neurofeedback (NF) training for post-traumatic stress disorder (PTSD) symptoms to investigate the effects of real-time functional magnetic resonance imaging (fMRI-NFT) and electroencephalogram-based neuro-feedback training (EEG-NFT). Seven studies met the inclusion criteria for the systematic review and meta-analysis. Various NF protocols exist; 3 of the studies used fMRI-NFT and 4 used EEG-NFT; all studies included adult participants (n=114) diagnosed with PTSD. Symptoms were measured as the primary outcomes in all studies, utilizing the following assessment tools: Clinician-Administered PTSD Scale (CAPS), PTSD Checklist-Military Version (PCL-M), PTSD Diagnostic and Statistical Manual of Mental Disorders Checklist-5th edition (PCL-5), the Davidson Trauma Scale (DTS), the Montgomery–Asberg Depression Rating Scale (MADRS), Beck Depression Inventory (BDI), Hamilton Anxiety Scale (HAM-A), Hamilton Depression Rating Scale (HDRS), Beck Anxiety Inventory (BAI), Impact of the Event Scale-revised (IESR), and Inventory of Altered Self-Capacities (IASC). The findings revealed that EEG-based neuro-feedback training was more beneficial in training PTSD symptoms than fMRI-NFT. A significant result was obtained from EEG-NFT (4 studies, Hedges' g= -1.132, 95% CI: -2.061 to -0.203, $p < 0.05$). A non-significant result was found for fMRI-NFT (3 studies, Hedges' g = -0.368, 95% CI: -0.851 to 0.115, $p < 0.05$) showed low heterogeneity ($Q = 0.156$, $p = 0.925$, $I^2 = 0.000$), and the effect size was not significant for PTSD symptoms. Additionally, the methods were also shown to be valid for evaluating clinical PTSD diagnoses with significant results of Hedges' g = -0.658, 95% CI: -0.983 to -0.333, $p < 0.05$). The authors note that future research is needed to establish a gold standard protocol for the EEG-based neuro-feedback training (EEG-NFT) method for treating individuals with PTSD symptoms.

Alvarez et al. (2021) conducted a meta-analysis of twenty-two clinical studies regarding the efficacy of biofeedback/neurofeedback in the treatment of depression and depressive symptoms. Studies included either an established diagnosis of depression using a standardized diagnostic tool, or participants presented with increased depressive symptoms. In the first group of studies for participants with MDD, the between group analyses, comparing NF to control groups, produced an effect size of Hedges' g = 0.717 and p=0.0121, while the within group analysis of sole NF yielded an effect size of Hedges' g = 1.050 and p=0.001. In the second group of studies for participants with depressive symptoms, a small but significant effect between groups was found of Hedges' g = 0.303 and p=0.003 in support of bio- and neurofeedback versus control groups. Moderator analyses revealed that treatment efficacy was not moderated by any of the sociodemographic and clinical variables. The results revealed biofeedback and neurofeedback are a promising technique associated with a reduction in self-reported depression. The authors note limitations among the studies such as lack of robust clinical design, unclear risk of bias, small sample sizes, heterogeneity of NF protocols, and lack of follow-up assessments. Future rigorous randomized controlled trials are needed to establish clear efficacy and durability.

A systematic review conducted by Trambaiolli and colleagues (2021) examined neurofeedback training efficacy in major depressive disorder, in addition to study quality and reporting practices. Initially, 585 studies were screened for inclusion. Criteria for the twenty-four selected studies consisted of adults 18 years and older with a current, formal diagnosis of depression. Results among the EEG fMRI studies showed statistically and clinically within group (sole NF) improvements of clinical measures between 6% and 73%. The between group (NF vs. control groups) comparisons showed less significant changes ranging from -7% to 52%. While most of the reviewed studies show positive outcomes with NF compared to control group(s), data from RCTs regarding specific therapeutic effects of NF in depression remains small; future RCTs will require larger samples. The researchers stated that most of these studies did not adhere to stringent study quality or reporting practices in addition to being outdated in following the current best practice standards for study design and reporting. Some of the primary issues addressed by the researchers include heterogeneity of NF protocols, control conditions, lack of blinding, randomization, small sample sizes, and lack of follow-up. The authors acknowledge that these limitations are a barrier to determining clinical efficacy and conclude with recommendations for future research that will identify therapeutic efficacy of NF in depression treatment.

Steingrimsson et al. (2020) performed a systematic review and meta-analysis on electroencephalography-based neurofeedback (EEG-NF) as treatment for post-traumatic stress disorder (PTSD). Four studies were included with 123 adult participants at least 18 years old and diagnosed with PTSD. Outcomes examined were the EEG-NF intervention compared to sham EEG-NF, other treatments such as psychotherapy and medications, or no treatment. Among the four studies the number of total EEG-NF sessions ranged from 20-30 with varied frequency. A notable result was found in the EEG-NF versus no treatment category, 3

RCTs (n=92), the EEG-NF group reported a decrease in PTSD symptoms (Mean difference, -2.30; 95% CI, -4.27 to -0.24), p = 0.03. The authors discuss numerous limitations with the 3 RCTs such as small sample size, vague blinding and randomization techniques, and different scales used to measure PTSD symptoms. Follow-up was done in 1 study, 4 weeks after treatment completion with findings of a reduction of PTSD symptoms of 34% on the Davidson Trauma Scale after EEG-NF versus 8% in the control group (p < 0.001). Lack of durability measures is noted in three of the four studies. The authors conclude that future trials should include quality research design, larger sample sizes with less heterogeneity in treatment protocols.

Ferreira et al. (2019) conducted a systematic review and meta-analysis to assess the therapeutic efficacy of biofeedback in obsessive-compulsive and related disorders (OCD&RD) category (body dysmorphic, hoarding, trichotillomania, and excoriation disorders). Ten studies containing 102 OCD participants (three randomized controlled trials) mostly applying neurofeedback (one publication that used thermal biofeedback) were included in the review. Five neurofeedback studies were selected for meta-analysis (89 patients; two randomized controlled trials). The authors found a beneficial effect of neurofeedback for OCD symptoms, but also found critical limitations on methodology, high heterogeneity among studies, and a reporting bias. Future research following high-quality guidelines with well-designed methodology are needed to address the efficacy of biofeedback approaches for OCD&RD.

Imperatori et al. (2018) conducted a systematic review to evaluate the effectiveness of biofeedback and neurofeedback for eating disorders (EDs) and EDs-related symptoms. Thirteen studies were included in the review. Neurofeedback was represented and investigated in eight of the reviewed studies. The studies considered provide preliminary data of the usefulness of feedback-based techniques in the treatment of several dysfunctional eating behaviors (e.g., food craving, rumination). Due to the high heterogeneity of samples, outcome measures and feedback modalities, a meta-analysis in order to quantify the effectiveness of both biofeedback and neurofeedback was not performed. The results of this review suggest that feedback-based treatments may be useful in the treatment of several dysfunctional eating behaviors. The authors conclude that future well-designed studies with large clinical samples are needed in order to draw definitive conclusions.

Clinical Trials & Studies

The Neurofeedback Collaborative Group (2023) conducted a 25-month follow-up on the effects of theta-beta ratio (TBR) neurofeedback (NF) for attention-deficit/hyperactivity disorder (ADHD). Children aged 7 to 10 years old diagnosed with ADHD were randomized to 38 sessions of TBR NF (n = 84) or control treatment (n = 58) of NF identical appearance, intensity/frequency, and duration. The study used the method of parallel group double-blinding. Assessments were completed at baseline, mid-treatment, treatment end, and at 6, 13, and 25 months after baseline. Participants were instructed to discontinue stimulant meds 5 days before the scheduled assessments. The primary outcome was based on the parent rated items of inattention via the Connors-3 likert scale (Conners, 3rd edition); the predicted results at treatment end will be durable in addition to the difference from the control treatment will increase at 25 months. The results showed that the 25-month follow-up included 120 participants out of the initial 142 participants. The primary outcome of parent-rated inattention was not significantly different between treatments regardless of the large pre and post effect sizes (NF recipients, d = 1.63; controls, d = 1.42). The study found differences between the control group (57.1%) and the NF group (38.6%) requiring ADHD medication, p= 0.059. There were significant findings in both groups regarding Improvement from baseline to 25 months (NF group p < .0001, d= 1.63; control group p < .001, d = 1.42) without significant difference between the groups (p = .47). The researchers of this study report strong outcomes and also acknowledge limitations. The results cannot be generalized to other NF methods or diagnoses other than inattentive ADHD. Future replication of this high-quality study design is needed to determine standardized NF protocols and expand to additional types of ADHD.

Lam et al. (2022) performed a double-blind, sham-controlled randomized trial examining the efficacy of fMRI neurofeedback on clinical and cognitive measures in children diagnosed with ADHD. The participants were eighty-eight boys aged 10-18 years old diagnosed with ADHD. Participants prescribed stimulant medications were instructed to omit the medication 24 hours before each assessment and could remain on the medication throughout the study. Participants were block-randomized in a 1:1 ratio to an active (n=44) or sham (n=44) intervention group, stratified by medication status (nonmedicated or on stable ADHD medication) and by age group (under or over 14 years 6 months). Participants had seven visits available; visit 1 for screening and baseline assessment, visits 2-5 for fMRI-NF interventions, and visits 6 and 7 for post-treatment and 6-month follow-up assessments. The intervention comprised fifteen active fMRI-NF runs over 1 hour scan sessions; the sham intervention group experienced duplicate procedures but received sham neurofeedback. The primary outcome was measured via the parent-rated ADHD Rating Scale (ADHD-RS) at the posttreatment assessment. Results showed no significant effects for group-by-time interaction, or for group effect on ADHD-RS total scores, as primary posttreatment or secondary 6-month follow-up outcomes.

Time effect showed significantly increasing ADHD-RS scores from posttreatment assessment to follow-up assessment (F=8.44, df=1, 82.7, p=0.005). Within-group findings were significantly reduced scores for both groups, compared to baseline, at the posttreatment (p values <0.001) and follow-up (p values <0.009) assessments. Although there was no improvement in ADHD-RS total scores or other clinical and cognitive measures, the sham intervention group showed decreased irritable mood and improved motor inhibition at the posttreatment assessment. There were no side effects or adverse events reported. A limitation noted was that approximately 65% of participants were current medication users, which could taint neurofeedback-related clinical or cognitive effects; future research with replication in a medication-naive study would clarify this. In addition, the researchers state that future studies investigating if different fMRI target regions produce improved cognitive outcomes. Lastly, optimal and standardized protocols for fMRI-NF in ADHD are needed.

The Neurofeedback Collaborative Group (2021) performed a double-blind placebo-controlled randomized clinical trial of neurofeedback (NF) for attention-deficit/hyperactivity disorder (ADHD) with a 13-month follow-up. There were 142 participants, children aged 7-10 with a diagnosis of moderate/severe ADHD. The design was a 2-site, parallel-group, double-blind randomized comparison of active neurofeedback (NF) treatments to sham NF (control) treatments, for up to thirty-eight treatments in a 14-week period, with follow-up at 6, 13, and 25 months. The primary outcome findings for both groups showed significant improvement ($p < 0.001$, $d = 1.5$) in analysis of the of parent/teacher-rated inattention from baseline to end of treatment and at the 13-month follow-up. However, NF was not significantly effective when compared to control treatment at either time point on this primary outcome ($d = 0.01$, $p = 0.965$ at treatment end; $d = 0.23$, $p = 0.412$ at 13-month follow-up). Responders (Clinical Global Impression-Improvement [CGI-I]) received active NF were 61% and 54% received control treatment ($p = 0.36$). A 10-month end of treatment follow-up suggested a minor improved inattention score for active NF; an increase from 27.4% end of treatment to 39.7% at 10 months. The 13-month follow-up showed no significant improvement from treatment end for NF ($d = 0.1$), with mild deterioration for control treatment ($d = -0.07$). Active NF required significantly less medication at the 13-month follow-up ($p = 0.012$). The authors acknowledge there was no significant effect of active NF beyond the control treatment, and particularly a lack of durability beyond 13 months; participants plan for reassessment at 25 months. Limitations such as long-term durability and lack of generalizability due to using only theta/beta NF protocols are indicators that continued and future research is necessary.

Guidelines & Consensus Statements

- *American Academy of Child & Adolescent Psychiatry (AACAP)*
  - Clinical Practice Guideline for the Assessment and Treatment of Children and Adolescents With Major and Persistent Depressive Disorders (2022) finds the following regarding neurofeedback/biofeedback:
    - "There is insufficient information to draw conclusions about the benefits or harms of the treatment. As such, treatment statements for these domains are not offered. Research is urgently needed to support additional treatment statements in these domains for future guidelines."

- *American Academy of Pediatrics (AAP)*
  - In the AAP's Clinical Practice Guideline for the Diagnosis, Evaluation, and Treatment of ADHD in Children and Adolescents (2019), states that "Some nonmedication treatments for ADHD-related problems have either too little evidence to recommend them or have been found to have little or no benefit. These include mindfulness, cognitive training, diet modification, EEG biofeedback, and supportive counseling."

- *Department of Veterans Affairs and Department of Defense (VA/DoD)*
  - The VA/DoD Clinical Practice Guidelines for the Management of Major Depressive Disorder (2022) indicates the following for complementary and alternative treatments:
    - For individuals diagnosed with major depressive disorder (MDD), there is insufficient evidence to recommend for or against the addition of biofeedback.
  - The VA/DoD Clinical Practice Guidelines for the Management of Posttraumatic Stress Disorder and Acute Stress Disorder (2023) states the following for non-pharmacologic biologic interventions:
    - For individuals diagnosed with PTSD, there is inconclusive evidence for neurofeedback to recommend for or against it as an intervention for PTSD.

U.S. Food and Drug Administration

Neurofeedback/biofeedback devices are considered a medical device when registered with the FDA. They are considered Class II devices and are exempt from 510(K) premarket notification requirements.
See the following for more information:
FDA website: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=882.5050.

Centers for Medicare and Medicaid Services

Medicare does not have a National Coverage Determination (NCD) specifically for neurofeedback or biofeedback (with or without EEG guidance) used in treating individuals with behavioral or substance use disorders. Local Coverage Determinations (LCDs) exist for CPT codes 90875 and 90876. For behavioral health topics, refer to the LCDs for Outpatient Psychiatry and Psychology Services, Partial Hospitalization Programs and Psychiatry and Psychology Services.

Medicare has published NCD 30.1 Biofeedback Therapy and NCD 30.1.1 Biofeedback Therapy for the Treatment of Urinary Incontinence. Medicare states that biofeedback is covered only when it is reasonable and necessary for the individual patient for muscle re-education of specific muscle groups or for treating pathological muscle abnormalities of spasticity, incapacitating muscle spasm, or weakness, and more conventional treatments (heat, cold, massage, exercise, support) have not been successful. This therapy is not covered for treatment of ordinary muscle tension states or for psychosomatic conditions (www.cms.gov).

Applicable Codes

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member-specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other clinical criteria may apply.

Procedure Codes	Description
90875	Individual psychophysiological therapy incorporating biofeedback training by any modality (face-to-face with the patient), with psychotherapy (e.g., insight oriented, behavior modifying or supportive psychotherapy); 30 minutes
90876	Individual psychophysiological therapy incorporating biofeedback training by any modality (face-to-face with the patient), with psychotherapy (e.g., insight oriented, behavior modifying or supportive psychotherapy); 45 minutes
90901	Biofeedback training by any modality

References

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders*, (5th ed.), Text Revision. American Psychiatric Publishing.

American Academy of Pediatrics. (2019). Clinical practice guideline for the diagnosis, evaluation, and treatment of attention-deficit/hyperactivity disorder in children and adolescents. *Pediatrics*, 144(4), 1-27, e20192528.

Barreiros, A.R., Breukelaar, I.B., Harris, A.W., & Korgaonkar, M.S. (2024). fMRI neurofeedback for the modulation of the neural networks associated with depression. *Clinical Neurophysiology*, 168, 34-42.

Blume, M., Schmidt, R., Schmidt, J., Martin, A., & Hilbert, A. (2023). EEG neurofeedback in the treatment of adults with binge-eating disorder: A randomized controlled pilot study. *Neurotherapeutics*, 19(1), 352-365.

Chan, E. (2025). Attention deficit hyperactivity disorder in children and adolescents. UptoDate database. Uptodate.com.

Department of Veterans Affairs and Department of Defense (VA/DoD). (2022). Clinical Practice Guidelines for the Management of Major Depressive Disorder. U.S. Department of Veterans Affairs website: https://www.healthquality.va.gov/guidelines/MH/mdd/VADoDMDDCPGFinal508.pdf.

Emergency Care Research Institute (ECRI). (2020). Neurofeedback for treating attention deficit hyperactivity disorder in children and adolescents. *Health Technology Assessment*, 1-13.

Fernandez-Alvarez, J., Grassi, M., Colombo, D., Botella, C., Cipresso, P., Perna, G., & Riva, G. (2021). Efficacy of bio- and neurofeedback for depression: A meta-analysis. *Psychological Medicine*, 52, 201-216, https://doi.org/10.1017/S0033291721004396.

Ferreira, S., Pêgo, J.M., & Morgado, P. (2019). The efficacy of biofeedback approaches for obsessive-compulsive and related disorders: A systematic review and meta-analysis. *Psychiatry Research*, 272, 237-245.

Hong, J., & Park, J. H. (2022). Efficacy of neuro-feedback training for PTSD symptoms: A systematic review and meta-analysis. *International Journal Of Environmental Research and Public Health*, 19(13096), 1-13.

Imperatori, C., Mancini, M., Della Marca, G., Valenti, E.M., & Farina, B. (2018). Feedback-based treatments for eating disorders and related symptoms: A systematic review of the literature. *Nutrients*, 10(1806), 1-17.

Kuznetsova, E., Veilahti, A. V. P., Akhundzadeh, R., Radev, S., Konicar, L., & Cowley, B. U. (2023). Evaluation of neurofeedback learning in patients with ADHD: A systematic review. *Applied Psychophysiology and Biofeedback*, 48(1), 11-25.

Lam, S. L., Criaud, M., Lukito, S., Westwood, S. J., Agbedjro, D., Kowalczyk, O. S., Curran, S., Barret, N., Abbott, C., Liang, H., Simonoff, E., Barker, G.J., Giampietro, V., & Rubia, K. (2022). Double-blind, sham-controlled randomized trial testing the efficacy of fMRI neurofeedback on clinical and cognitive measures in children with ADHD. *American Journal of Psychiatry*, 179(12), 947-958.

Lambez, B., Harwood-Gross, A., Golumbic, E.Z., & Rassovsky, Y. (2020). Non-pharmacological interventions for cognitive difficulties in ADHD: A systematic review and meta-analysis. *Journal of Psychiatric Research*, 120, 40-55.

Li, Z., Ren, H., Tian, Y., Zhou, J., Chen, W., OuYang, G., Chen, Z., Yi, W., Song, H., Xie, P., Wang, X., Chen, X., Xiao, Q., & Liu, H. (2024). Neurofeedback technique for treating male schizophrenia patients with impulsive behavior: A randomized controlled study. *Frontiers in Psychiatry*, 15, 1472671.

Lin, F. L., Sun, C. K., Cheng, Y. S., Wang, M. Y., Chung, W., Tzang, R. F., Chiu, H.J., Cheng, Y.C., & Tu, K. Y. (2022). Additive effects of EEG neurofeedback on medications for ADHD: A systematic review and meta-analysis. *Scientific Reports*, 12(20401), 1-10.

Neurofeedback Collaborative Group. (2021). Double-blind placebo-controlled randomized clinical trial of neurofeedback for attention-deficit/hyperactivity disorder with 13-month follow-up. *Journal of the American Academy of Child & Adolescent Psychiatry*, 60(7), 841-855.

Neurofeedback Collaborative Group. (2023). Neurofeedback for attention-deficit/hyperactivity disorder: 25-month follow-up of a double-blind randomized controlled trial. *Journal of the American Academy of Child & Adolescent Psychiatry,* 62(4), 435-446.

Patil, A. U., Lin, C., Lee, S. H., Huang, H. W., Wu, S. C., Madathil, D., & Huang, C. M. (2023). Review of EEG-based neurofeedback as a therapeutic intervention to treat depression. *Psychiatry Research: Neuroimaging*, 329(111591), 1-11.

Peterson, B.S., Trampush, J., Maglione, M., Bolshakova, M., Rozelle, M., Miles, J., Pakdaman, S., Brown, M., Yagyu, S., Motala, A., & Hempel, S. (2024). Treatments for ADHD in children and adolescents: A systematic review. *Pediatrics*, 153(4), e2024065787.

Razoki, B. (2018). Neurofeedback versus psychostimulants in the treatment of children and adolescents with attention-deficit/hyperactivity disorder: A systematic review. *Neuropsychiatric Disease and Treatment*, 14, 2905-2913.

Saif, M.G.M. & Sushkova, L. (2023). Clinical efficacy of neurofeedback protocols in treatment of attention deficit/hyperactivity disorder (ADHD): A systematic review. *Psychiatry Research: Neuroimaging*, 111723.

Solanto, M.V. (2025). Attention deficit hyperactivity disorder in adults: Psychotherapy. UptoDate database. Uptodate.com.

Steingrimsson, S., Bilonic, G., Ekelund, A.-C., Larson, T., Stadig, I., Svensson, M., Vukovic, I.S., Wartenberg, C., Wrede, O., & Bernhardsson, S. (2020). Electroencephalography-based neurofeedback as treatment for posttraumatic stress disorder: A systematic review and meta-analysis. *European Psychiatry*, 63(1), e7, 1–12.

Trambaiolli, L.R., Kohl, S.H., Linden, D.E.J., & Mehler, D.M.A. (2021). Neurofeedback training in major depressive disorder: A systematic review of clinical efficacy, study quality and reporting practices. *Neuroscience & Biobehavioral Reviews*, 125, 33-56.

U.S. Food and Drug Administration. (2022). Code of Federal Regulations, Subchapter H – Medical Devices, Section 882.5050 Biofeedback device. FDA website: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=882.5050.

Van Doren, J., Arns, M., Heinrich, H., Vollebregt, M.A., Strehl, U., & Loo, S.K. (2019). Sustained effects of neurofeedback in ADHD: A systematic review and meta-analysis. *European Child & Adolescent Psychiatry*, 28, 293-305.

Revision History

Date	Summary of Changes
06/15/2020	Annual review: updates to references/sourcing.
06/21/2021	Annual review: updates to references/sourcing.
06/21/2022	Annual review: updates to references/sourcing.
07/18/2023	Annual review: updates to references/sourcing.
06/18/2024	Annual review: updates to references/sourcing.
06/16/2025	Annual review: Approved by Optum committees on 6/16/2025 and 07/22/2025 • Updated to references/sourcing

Appendix

Additional resources considered in support of this policy:

Begemann, M.J., Florisse, E.J., van Lutterveld, R., Kooyman, M., & Sommer, I.E. (2016). Efficacy of EEG neurofeedback in psychiatry: A comprehensive overview and meta-analysis. *Translational Brain Rhythmicity*, 1(1), 19-29.

Cortese, S., Ferrin, M., Brandeis, D., Holtmann, M., Aggensteiner, P., Daley, D., Santosh, P., Simonoff, E., Stevenson, J. Stringaris, A., Sonuga-Barke, E. on behalf of the European ADHD Guidelines Group. (2016). Neurofeedback for attention-

deficit/hyperactivity disorder: Meta-analysis of clinical and neuropsychological outcomes from randomized controlled trials. *Journal of the American Academy of Child and Adolescent Psychiatry*, 55(6), 444-455.

Fielenbach, S., Donkers, F.C., Spreen, M., & Bogaerts, S. (2018). Effects of a theta/sensorimotor rhythm neurofeedback training protocol on measures of impulsivity, drug craving, and substance abuse in forensic psychiatric patients with substance abuse: Randomized controlled trial. *JMIR Mental Health*, 5(4), e10845, 1-11.

Goessl, V.C., Curtiss, J.E., & Hofmann, S.G. (2017). The effect of heart rate variability biofeedback training on stress and anxiety: A meta-analysis. *Psychological Medicine*, 47(15), 2578-2586.

Janssen, T.W., Bink, M., Gelade, K., van Mourik, R., Maras, A., & Oosterlaan, J. (2016). A randomized controlled trial investigating the effects of neurofeedback, methylphenidate, and physical activity on event-related potentials in children with attention-deficit/hyperactivity disorder. *Journal of Child and Adolescent Psychopharmacology*, 26(4),1-10.

Penzlin, A.I., Siepmann, T., Illigens, B.M., Weidner, K., & Siepmann, M. (2015). Heart rate variability biofeedback in patients with alcohol dependence: a randomized controlled study. *Neuropsychiatric Disease Treatment*, 11, 2619–2627.

Penzlin, A.I., Barlinn, K., Illigens, B.M., Weidner, K., Siepmann, M., & Siepmann, T. (2017). Effect of short-term heart rate variability biofeedback on long-term abstinence in alcohol dependent patients - A one-year follow-up. *BMC Psychiatry*,17(1),325-332.

Schoenberg, P.L. & David, A.S. (2014). Biofeedback for psychiatric disorders: A systematic review. *Applied Psychophysiology and Biofeedback*, 39, 109-135.

Schönenberg, M., Wiedemann, E., Schneidt, A., Scheeff, J., Logemann, A., Keune, P.M., & Hautzinger, M. (2017). Neurofeedback, sham neurofeedback, and cognitive-behavioural group therapy in adults with attention-deficit hyperactivity disorder: A triple-blind, randomised, controlled trial. *Lancet Psychiatry,* 4(9),673-684.

Strauss, J.L., Coeytaux, R., McDuffie, J., Nagi, A., Williams Jr, J.W. and the Department of Veterans Affairs Health Services Research & Development Services VA-ESP Project. (2011). Efficacy of complementary and alternative therapies for posttraumatic stress disorder, #09-010, 1-79.

Thibault, R.T., MacPherson, A., Lifshitz, M., Roth, R.R., & Raz, A. (2017). Neurofeedback with fMRI: A critical systematic review. *Neuroimage*, 172, 786-807.

Vollebregt, M.A., van Dongen-Boomsma, M., Buitelaar, J.K., & Slaats-Willemse, D. (2014). Does EEG-neurofeedback improve neurocognitive functioning in children with attention-deficit/hyperactivity disorder? A systematic review and a double-blind placebo-controlled study. *Journal of Child Psychology and Psychiatry*, 55(5), 460-472.

Young, K.D., Siegle, G.J., Zotev, V., Phillips, R., Misaki, M., Yuan, H., Drevets, W.C., & Bodurka, J. (2017). Randomized clinical trial of real-time fMRI amygdala neurofeedback for major depressive disorder: effects on symptoms and autobiographical memory recall. *American Journal of Psychiatry*, 174(8),748-755.