

Richard Whitley, MS Director



## **DEPARTMENT OF**

**HEALTH AND HUMAN SERVICES** 



Suzanne Bierman, JD MPH Administrator

DIVISION OF HEALTH CARE FINANCING AND POLICY Helping people. It's who we are and what we do.

## Notice of Meeting to Solicit Public Comments and Intent to Act Upon Amendments to the State Plan for Medicaid Services

Public Hearing June 29, 2021 Summary

Date and Time of Meeting:

June 29, 2021 at 9:06 AM

Name of Organization:

Place of Meeting:

State of Nevada, Department of Health and Human Services (DHHS), Division of Health Care Financing and Policy (DHCFP)

DHCFP 1100 E. William Street First Floor Conference Room Carson City, Nevada 89701

## Teleconference and/or Microsoft Teams Attendees (Note: This List May Not Include All Participants, Just Those Who Identified Themselves)

Suzanne Bierman, DHCFP Gabriel Lither, Senior Deputy Attorney General (SDAG) Emma Curto Kelly Woods, DHCFP Antonio Gudino-Vargas, DHCFP Michael Gorden, DHCFP Gina Callister, DHCFP Sarah Hunt, Nevada Hospital Association (NHA) Gladys Cook, DHCFP Jeffrey Murawsky, Silver Summit Health Plan (SSHP) Agatha Lambey, Agape Family Enrichment Center Yvonne Vestal, DHCFP Rossana Dagdagan, DHCFP Heather Lazarakis, DHCFP Cheri Glockner, SSHP Jill Lecheminant, Optum Jovanna Leid, Gainwell Technologies Steve Messinger, Nevada Primary Care Association Natasha Powell Abigail Bailey, DHCFP Amanda Kiriakopoulos, Optum David Olsen, DHCFP

Jessica Kemmerer, DHCFP Briza Virgen, DHCFP Kaelyne Day, DHCFP Sheila Heflin-Conour, DHCFP Sarah Dearborn, DHCFP Crystal Biselli, DHCFP Rocky B Carin Hennessey, DHCFP Timothy Ryan, DHCFP Jaime Hutchison Rebecca Inserra Sarah Lamb, DHCFP Loretta Cook, DHCFP **Eric Schmacker** Ellen Flowers, DHCFP Tegan Luisiana, AmeriHealth Alex Tanchek, Silver State Government Relations Cara Lee, Optum Kirsten Coulombe, DHCFP Regina De Rosa Alejandro Leon, ICAN Family Services Kurt Karst, DHCFP

- Sarah Bellemare Valerie Balen, Belz & Case Government Affairs Nicole Figles, SSHP Natasha Baker Calvin Kam Sussan Fung, Zane Medical Group Shanna Cobb-Adams, DHCFP Jackeline Obregon, DHCFP Ramona Beasley, The Empowerment Centre Steven Hughey, UMC Brandon Ford, Best Practices Nevada Temyka Miller, Anthem Rosanna Morgan Rodriguez Susan
- Kimberly Adams, DHCFP Toni Inserra Jeffry Majeske, DHCFP David Hardy Jimmy Lau, Ferrari Public Affairs Candice Hill, Mission Treatment Centers Amy Levin, Anthem Theresa Carsten, DHCFP Alejandra Elizabeth Laurie Curfman, Liberty Dental Louis Haynie Vanessa Mark John Frederick

## Introduction:

Jessica Kemmerer, HIPAA Privacy Officer, DHCFP, opened the Public Hearing introducing herself, Suzanne Bierman, Administrator of DHCFP and Gabe Lither, Senior Deputy Attorney General (SDAG).

Jessica Kemmerer – The notice for this public hearing was published on May 27, 2021 and revised on June 7, 2021 in accordance with 42 CFR 447.205.

### 1. Public Comments

A question was asked if the comments could be made on any topic.

Jessica Kemmerer replied that this period is for comments on any subject except for what is on the agenda. Each agenda item will have their own comment period.

### 2. Discussion of Amendments to the State Plan for Medicaid Services and Solicitation of Public Comments

### Subject: Supplemental payment for inpatient hospitals

Gina Callister said this SPA is in reference to the Nevada Medicaid State Plan Attachment 4.19 A, Page 32b affecting Provider Type (PT) 11 – Inpatient Hospitals.

DHCFP's Supplemental Reimbursement Unit is proposing a state plan amendment amending the Indigent Accident Fund (IAF) Supplemental Payment for state fiscal year (SFY) 2022. This will allow the continuation of the IAF supplemental payment program based on inpatient hospital utilization in order to preserve access to inpatient acute services through SFY 2022.

This amendment will decrease the supplemental payments from \$75,496,676.47 in SFY 2021 to \$70,660,110.92 in SFY 2022 which results in a decrease in annual aggregate expenditures of \$4,836,565.55.

The effective date is July 1, 2021.

At the conclusion of Gina Callister's presentation, Jessica Kemmerer asked Suzanne Bierman and Gabe Lither if they had any questions or comments and they had none.

## Public Comments:

Sarah Hunt with Nevada Hospital Association asked if Gina Callister could provide the FMAP that was used to get the numbers.

Sarah Lamb told Sarah Hunt that the FMAP would be sent to her.

Sarah Hunt was hoping the FMAP would be immediately available. She also wanted to know how the FMAP was incorporated and if it wasn't, why wasn't it.

Sarah Lamb said she didn't have that information in front of her, but she would be happy to send it to Sarah Hunt.

Jessica Kemmerer closed the Public Hearing for the SPA on Supplemental payment for inpatient hospitals.

## **3.** Discussion of proposed Amendments to the Nevada Checkup State Plan for Medicaid Services and solicitation of public comments

## Subject: Nevada Checkup Support SPA Amendment to add Behavioral Health Coverage

Michael Gorden reported that the Center for Medicare and Medicaid Services (CMS) released guidance related to Section 5022 of the Substance Use-Disorder Prevention that Promotes Opioid Recovery and Treatment for Communities and Patients Act, referred to as the SUPPORT Act. This provision expands access to services by making behavioral health coverage a mandatory benefit for Separate Children Health Insurance Programs (SCHIP). This requires states with Separate CHIPs on the actions necessary to implement the requirements of Section 5022 of the Substance Use Disorder Prevention that Promotes Opioid Recovery and Treatment for Communities and Patients Act (SUPPORT) Act.

DHCFP is required to add a new section in the SCHIP State Plan, 6.3-BH Behavioral Health Coverage Section 2103(c)(5). The added language provides coverage to prevent, diagnose, and treat a broad range of mental health and substance use disorders in a culturally and linguistically appropriate manner for all CHIP enrollees, including pregnant women and unborn children. Although we are required to add this language to SCHIP, State Plan currently provides all the required coverages as outlined. The scope of medical services available are described in the Social Security Administration (SSA), Section 1905(a).

Michael Gorden specified that these coverages are already in the State Plan. They are just added to the CHIP SPA.

No change in annual aggregate expenditures is anticipated. Michael Gorden added a friendly amendment of an effective date change of July 01, 2020 after conferring with CMS.

At the conclusion of Michael Gorden's presentation, Jessica Kemmerer asked Suzanne Bierman and Gabe Lither if they had any questions or comments and they had none. Public Comments: There were none.

Jessica Kemmerer closed the Public Hearing for the SPA on Nevada State Checkup.

4. Discussion of proposed Amendments to the Nevada Checkup State Plan for Medicaid Services and solicitation of public comments

Subject: Removal of Biofeedback and Neurotherapy services for the treatment of a mental health diagnosis.

Sarah Dearborn advised DHCFP is proposing a SPA to Attachment 4.19-B Page 3b and 3g to eliminate Biofeedback and Neurotherapy services for the treatment of a mental health diagnosis. Neurotherapy is individual psychological therapy incorporating biofeedback training combined with psychotherapy as a treatment for mental health disorders. The elimination of these services is being made as a result of the approved DHCFP budget during the 2021 Legislative session in effort to reduce current costs to the Medicaid program and to address the Governor's mandated budget cuts.

This proposed change affects all Medicaid-enrolled providers delivering biofeedback and neurotherapy type of services. Those PTs include, but are not limited to, Hospital, Outpatient (PT 12); Behavioral Health Outpatient Treatment (PT 14); Physician, M.D., Osteopath D.O. (PT 20); Advanced Practice Registered Nurse (PT 24); Psychologist (PT 26); Physician's Assistant (PT 77); Behavioral Health Rehabilitative Treatment (PT 82), and Certified Community Behavioral Health Center (PT 17, Specialty 188).

An estimated decrease in annual aggregate expenditures:

State Fiscal Year 2022 is \$ 28,024,136

State Fiscal Year 2023 is \$ 28,299,314

The effective date of these changes is July 1, 2021.

At the conclusion of Sarah Dearborn's presentation, Jessica Kemmerer asked Suzanne Bierman and Gabe Lither if they had any questions or comments.

Suzanne Bierman added the division is committed to ensuring needed behavioral health services remain available and wanted to note these services were not funded in the division's final budget. Gabriel Lither had no additional comments.

## Public Comments:

Rosanna (last name not provided) wanted to clarify Neurotherapy therapy and Biofeedback therapy will no longer be paid for by Medicaid.

Sarah Dearborn advised Biofeedback and Neurotherapy Services related to a mental health diagnosis will no longer be reimbursed via the specific CPT codes and Sarah Dearborn offered to list the codes for Behavioral Health PTs. Biofeedback for PTs are listed on the agenda and the CPT code is 90901 and the Neurotherapy Services CPT code is 90875 and 90876. Vanessa (last name unclear) advocated on behalf of neurotherapy feedback. She found some of the statements from the video viewed during legislation to be not supported by the evidence. It was stated neurofeedback is not an evidence-based treatment, which the APA in 2019 recognized as an evidence-based treatment. Providers of neurofeedback are concerned this violates the Parity Law. Medicaid has approved the Parity Law under Nevada State and Policy Statute. They are afraid there is a violation. She also advised taking away a treatment that is not replaceable by talk therapy or medication is also an ethical issue with clients already being served.

Brandon Ford wanted the record to show they have a petition going that people would like to have more time available to really review the information about neurofeedback. He said he did not believe legislators, decision makers, or the governor are really aware of what the service is, what it entails and how it should be properly done. He believes much information given is outdated as recently as 2019. They have consulted with an expert from Maryland, who has shared much more information and they want more time to digest that information and share with DHCFP as well. He feels there are other states that are doing better in mental health and are ranked higher in access to care that have implemented better neurofeedback and biofeedback policies that make it work and he feels the problem is within our policy, which needs to be revised. Information needs to be updated, but services should not be eliminated until the opportunity has been allowed to properly do that.

Suzanne Bierman responded that comments are appreciated and taken into consideration as the issue is examined in the future, but because these services were not funded in the division's upcoming biennium, the plan is to move forward with these recommendations.

Louis Haynie, Nevada Neurofeedback and Hypnosis, advised he believes there are ways to readdress the services to reduce the costs to the state. He said he understood the billing codes are abused by some within the community and some places have turned into pure billing mills on these services. He advised he specifically works with children and young adults where talk therapy and medication has not worked, and other providers typically refer them to him because neurofeedback is basically the only thing they have left. He advised he has been seeing great results. He believes there are ways to save the money without having to completely eliminate the services. One way would be to make doctors request PARs and give them the same service limits therapists have. Another way is to eliminate techs, make it a fully licensed person the number of hours a week being billed would be seen.

Morgan Rodriguez agreed with previous comments and advised even though it has not been budgeted in the next fiscal year to please take it into consideration over the next few fiscal years. She said to have the techs taken away. They have had issues with techs with the company she works with. They require the techs to become fully licensed and recognized by the Board. She also believes the 90876 and the 90875 are not the most effective forms that can be used as far as neuro and biofeedback for clinicians. She said she knew it to be effective when working with someone. The whole focus should be neurofeedback or biofeedback and not the clinician trying to reprocess everything, because there is no timeframe within that code. She asked if the 90901 codes were left to be utilized for patients versus taking everything away. She asked if that could be brought back in the future, and because the codes have been out since the 1970s they are evidence-based and they do work. However, because they do not use techs and it is licensed clinicians who are directly providing the services, a difference is being seen because they are inoffice and try to make the patient comfortable. They find they have better results when responsibility is taken by the patients, whether their issues are mental health, substance abuse or co-occurring disorders. Mark (last name unclear), from Maryland attends the AMA/CBT Editorial Panel meetings, spoke about giving recommendations and submitting changes to Codes 90901, 90875 and 90876. He is also a member of the National Organizations AAPB and ISNR. He commented that much of what he currently does is education on issues of advocacy, and how to practice properly, and how to use the codes properly. He teaches this at conferences and has a book that is in process with the money going to those organizations. He advised when he reviewed the information, he found much misinformation on the shared information, for example, there are comments on FDA Regulations that are inaccurate, bio and neuro feedback are only approved for on label uses to assist in treating certain conditions like phobias and Post Traumatic Stress Disorder (PTSD). All the uses that are paid for under the medical care, all the neuro muscular education and everything else does not even fall under the actual FDA clearances. That is all off-label use of the general relaxation device, so it seems kind of strange and ironic that the claim of the efficacy is not there, and that alone is one example of misinformation. He advised there is a load of misinformation, such as the California Medicaid does not pay (because it does), and that Texas Medicaid does not pay, when Texas actually has a law mandating the coverage of every insurance policy in their state, not just Medicaid, to cover neuro feedbacks for the treatment of traumatic brain injury. He advised there is a whole host of misinformation in many of the reviews and complaints that were brought up and from some of the information he has seen about bio/neuro feedback had nothing to do with bio/neurofeedback. Any other intervention or technologies can be inserted in the place of bio/neuro feedback and what was being done was inappropriate and had nothing to do with the actual intervention. He advised he wanted to put that comment out there and a lot of decisions were made with a significant amount of misinformation. He advised he is available to educate anyone needing it at the state level, and anybody else, on what the actual situation is and all the actual sources. He also wanted to let people be aware that these coverages have been increasing over the past two years, including adding Medicaid in many states. He advised he hoped Nevada would reconsider the decision before even bringing up issues like Mental Health Parity that Nevada has agreed to follow with the Medicaid services.

Susan (last name unclear) advised she knows changes are being made due to budget cuts but asked that the people we are serving not be cut out. When decisions such as this are being made those people must come first. These people should be put at the table to know how it is working for them. She advised that others have made mention of companies making money from this. It is best for Medicaid to require a standard for the services to be paid but taking this off the table is hurtful to the people we are supposed to be serving. She hoped this is looked at and reconsidered. Omitting the whole thing entirely is not fair.

Alejandra (last name unclear) asked if Medicaid is aware of the effect removing these services will cause to the clients being served at this point. He also asked it to be taken into consideration as there will be an economic impact. He realized Medicaid is trying to save money due to budget cuts, but what about the negative impact these clients will have, and services will be more costly in the end.

Elizabeth (last name unclear) said she appreciated everyone's input, but it falls back onto "What do we tell our Clients." It has been devastating telling clients that neurofeedback is being pulled. She advised they have an eleven-year-old who this has completely changed his PTSD and his ADHD. He is now able to sit still in school and his reactions in the classroom has been picture perfect compared to where he was seven months ago. How do we explain to the parents? She advised she has people who have tried to kill themselves and have been put on neurofeedback because medication has not worked, therapy alone has not worked, BST and PSR have not worked. These people have been put on neuro feedback and the changes are incredible. What do we do for them? She advised she understands the finances but there must be other ways of cutting the budget. Cut the salaries of the people not doing their jobs. But they are being asked to send information that the behavioral numbers have been down, get on social media and

tell people to come on in, come back to the office to get their therapy, and then we are turning around and cutting services on the same day she is receiving the email to blast and request people to come back in for services. The clients are the ones who are hurting. She advised there are going to be more intakes in hospitals, there are going to be more people overdosing. This is going to be horrible, especially for the young children they service. She continued that it is very sad services are being cut within a month and we cannot even tell these people the next step, where they can turn to for help. She advised that these people feel Medicaid does not care. She advised they do not know what to tell people when they break down in their offices every day, asking what they are going to do now? They do not want to go back on medication, and they do not want to start hurting themselves again, but they do not know what to do now and the therapists cannot answer that for their clients. The therapists cannot answer why the cuts are coming down so quickly on the pipeline. Elizabeth advised that she and other therapists have given thousands of hours away and they cannot operate this way anymore.

John Frederick wanted to briefly address that neurofeedback is being singled out to be removed from reimbursement because there is a claim that is not evidence-based. His concern is that the claim about neurofeedback is itself not evidence-based, or it is based upon a very narrow or biased view of the literature. In fact, neurofeedback has met a higher standard to evidence then most forms of psychotherapy, except possibly cognitive behavioral therapy. There is an unfortunate series of articles and research literature that has been preoccupied with whether the efficacy of neurofeedback is greater than a placebo control group. Even reviews that argue neurofeedback does not exceed the efficacy of a placebo control, the sham neurofeedback shows neurofeedback has an extremely high nonspecific efficacy. That is powerful, even when it does not beat a placebo control. In other studies, it has beaten the placebo control. It depends on which meta-analysis you read. However, because no other form of psychotherapy has met the standard of evidence, for example, Applied Behavioral Analysis (ABA), which is routinely reimbursed by Medicaid, has exactly the same mechanism of action as neurofeedback. It is a form of learning based upon structuring the rewards in order to increase a desired behavior. However, has Applied Behavioral Analysis been shown to have greater efficacy then a placebo control? No. Has Eye Movement Desensitization and Reprocessing (EMDR) been demonstrated to exceed the efficacy of a placebo control? No. Evidence has been shown that these will do better than a waiting list control group or do equally as well as an established standard of care control group. Neurofeedback has met that standard of evidence. Neurofeedback has met a higher standard of evidence then most forms of psychotherapy. Thus, the claim that it is not evidence-based is not coming from a scientific high-ground. He encouraged the delaying of the decision and doing a more appropriate review of the research literature for concluding neurofeedback is not evidence-based.

Morgan Rodriguez advised she agreed with Elizabeth's statements.

Jessica Kemmerer asked Suzanne Bierman and Sarah Dearborn if they had any questions or comments.

Suzanne Bierman reiterated comments and feedback are appreciated and will be taken into consideration in the future and we remain committed to ensuring that Behavioral Health services are available and staff will be happy to work with any providers and provider community to provide education around other Behavioral Health Services and transitioning to those services. Medicaid will be moving forward with these changes today because these services have not been funded and the Division does not have budgetary authority for these services in the upcoming biennium.

Sarah Dearborn clarified on the codes. The code for biofeedback 90901 is being removed for the Behavioral Health provider types that offer it. Those are Behavioral Health Outpatient Treatment (PT 14),

as well as Psychologists (PT 26). Biofeedback does remain in place for the medical providers that are able to treat different diagnoses with those codes. 90875 and 90876 Neurotherapy codes are being removed for all provider types listed on the agenda.

Jessica Kemmerer closed the Public Hearing for SPA Attachment 4.19-B Page 3b and 3g to eliminate Biofeedback and Neurotherapy services for the treatment of mental health. She reiterated Suzanne Bierman's comments advising their unit is happy to work with providers to educate and support on identifying other behavioral health services that are appropriate.

A caller wanted to clarify that the codes that are being cut are 90875 and 90876 for all provider types but access to 90901 code is being left for medical providers treating medical conditions but taking away all access codes for behavioral providers treating psychiatric conditions.

Sarah Dearborn advised that is correct. 90901 is being removed for the treatment of a mental health diagnosis.

Another caller advised that does not seem like mental health parity.

A caller advised he had a question for Suzanne Bierman. He asked if it is possible to reconsider the vote on the budget that was made because they did not have the proper information. He advised when he asked a Senator an Assembly woman questions or information about bio/neurofeedback nobody had that kind of information. They were not experts or versed on the service to make a fair vote.

Gabriel Lither advised while he appreciates the last couple of comments the public comment period has ended for this agenda item and he does not want there to be a back-and-forth or too many answering of questions because that is not the purpose of the Public Comments session and we have already had public comment.

Suzanne Bierman added DHCFP is happy to have an offline conversation with the commentor if that would be helpful as the public comment period has been exceeded. She reiterated this was a legislative decision made during session and are working to implement the final budget as approved and this is one step in that process.

Another caller asked if this video will be posted for later review.

Jessica Kemmerer answered yes and it will be posted on our website along with the Minutes.

Jessica Kemmerer – Closed the Public Nevada Medicaid State Plan SPA to Attachment 4.19-B Pages 3b and 3g to eliminate Biofeedback and Neurotherapy services for the treatment of a mental health diagnosis

## 5. Adjournment

There were no further comments and Jessica Kemmerer the public hearing at 9:47 AM.

\*An Audio (CD) version of this meeting is available through the DHCFP Compliance office. For more detailed information on any of the handouts, submittals, testimony and or comments please contact Jenifer Graham at <u>jenifer.graham@dhcfp.nv.gov</u> or (775) 684-3685 with any questions.

## Neurofeedback Efficacy Standard of Evidence

Here is a written version of my comments from this morning.

Neurofeedback is being singled out to be removed from reimbursement because there is a claim that it is not evidence based. My concern is that this claim about neurofeedback is itself not evidence based, or it is based upon a very narrow or biased view of the literature.

In fact, neurofeedback has met a higher standard of evidence than most forms of psychotherapy, except possibly cognitive behavioral therapy. There is an unfortunate series of articles in the research literature which has been preoccupied with whether the efficacy of neurofeedback is greater than a placebo control group. In some studies, it has. In others, it has not. It depends on which meta-analysis you read. However, this issue is a distraction, because no other form of psychotherapy has met this standard of evidence. For example, applied behavior analysis, which is routinely reimbursed by Medicaid, has exactly the same mechanism of action as neurofeedback. It is a form of learning based upon structuring the rewards in order to increase a desired behavior. However, has applied behavior analysis been shown to have greater efficacy than a placebo control? No! Has eye movement desensitization and reprocessing been demonstrated to exceed the efficacy of a placebo control? No! These forms of psychotherapy have met a standard of evidence such as doing better than an inactive waiting list control or being show equal to an established standard of care control. Neurofeedback has met and exceeded these standards of evidence. So, the claim that neurofeedback is not evidence based is not coming from the intellectual or scientific high ground. I would encourage you to delay your decision in order to allow for a more appropriate consideration of the research literature. While Medicaid might not legally required to uphold mental health parity, it is still an ethical obligation, and discriminating against neurofeedback because it does not meet a biomedical standard evidence appropriate for pharmaceutical interventions is a violation of mental health parity.

Jon Frederick, PhD, CPC-I

Las Vegas, Nevada

Part of the meeting

Hello Vanessa,

Thank you for all of your information. I am adding Jenifer Graham to the thread as she is the person that takes care of the minutes.

Kind regards,

Jessica

Hi Jessica,

We would like this document which is attached to the link to be part of the minutes in the meeting.

Thanks

Vanessa Becerra B

https://www.brainfutures.org/wp-content/uploads/2021/04/brainfutures-neurofeedback-brief-final.pdf

## **BHAINFUTURES**

# Neurofeedback

An Effcacious Treatment for Behavioral Health



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The opinions and recommendations expressed herein are based on the research of BrainFutures and are intended for informational use only. The content does not constitute medical advice and is subject to change. Before pursuing any course of treatment for a behavioral or medical condition, including neurofeedback, always seek the advice of your physician or other qualifed health provider, and review the information together.

Prepared by Sage Fire, Inc. (Jude O Brien) in conjunction with the BrainFutures leadership team CEO Linda Raines, Cofounder Henry Harbin, MD, and Chief Strategy Offcer Holly McCormack and Advisor Mark Trullinger, PhD, BCN, QEEG D.

## THIS BRAINFUTURES' REPORT HAS BEEN ENDORSED BY









## Neurofeedback

## An Effcacious Treatment for Behavioral Health

### Contents

Acknowledgements	2
Executive Summary	
Introduction	6
Neurofeedback: An Evidence-Based Treatment for ADHD	10
NFB Treatment for a Broader Range of Mental Health Conditions	12
Neurofeedback Explained	14
The History of Neurofeedback	16
What the Research Shows	
Increasing NFB Access and Reducing Roadblocks	25
Details on How NFB Works	29
Recommendations	
Appendices	
Appendix A: What Are Brainwaves?	
Appendix B: EEG Electrode Placement	41
Appendix C: Brain Regions and Functions	43
Appendix D: Quantitative and Statistical NFB Measures	45
Appendix E: NFB Treatment Protocols for ADHD and Other Conditions	47
References	

## Acknowledgements

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## **Executive Summary**

## A CHALLENGING TIME. BRAIN-BASED DISORDERS ON THE RISE

Te incidence of attention-defcit hyperactivity disorder (ADHD) and other behavioral health issues in children, as well as overall mental health challenges in the general population are on the rise. More than 10% of youth in the U.S. are diagnosed with ADHD (Children and Adults with Attention-Defcit/Hyperactivity Disorder [CHADD], 2020), and 25% of children have some form of anxiety (Centers for Disease Control and Prevention [CDC], 2018a). Alarmingly, 64% of children diagnosed with ADHD have at least one additional behavioral, emotional, or mental health disorder (CDC, 2018b). In adults, anxiety afects 20% of Americans (National Institute of Mental Health [NIMH], 2019), with just over one-third of these individuals getting treatment (Anxiety and Depression Association of America [ADAA], n.d.).

Treatment for many behavioral conditions is primarily pharmacological, which itself carries risks and side efects. Many studies show that psychosocial therapies combined with psychotropic medications have better outcomes than medications alone. Yet large portions of the population are not adequately able to access afordable behavioral and mental health services, with recent research indicating that reimbursement for behavioral services represents only 4.4% of total medical spending (Davenport et al., 2020). Of equal note, behavioral conditions when present with a physical disorder contribute to extremely high total medical costs. In other words, there is a grave fnancial burden on payers when behavioral health issues go unaddressed (Davenport et al., 2020).

Te onset of COVID-19 has certainly exacerbated behavioral and mental health issues, as indicated by preliminary research in China and here in the U.S. More than ever, accessible, efective treatments for ADHD and other stress- and adjustment-related mental health disorders are needed.

## NEUROFEEDBACK IS AN EFFICACIOUS AND EFFECTIVE TREATMENT FOR ADHD AND OTHER CONDITIONS

With a more than 70-year history of research and real-life applications with populations ranging from school-aged children to veterans to adults, neurofeedback (NFB) is proven to be an efective standalone or adjunct treatment for ADHD and symptoms of anxiety.

Since 2009, at least four major research reviews by leading researchers in the U.S. and internationally have shown NFB to be an efcacious intervention for the treatment of ADHD. Several studies have found NFB improvement lasting up to a year post-treatment whereas improvements from ADHD medication tend to end immediately with the conclusion of treatment.

Highlights from key studies and reviews include:

- A 2020 review that investigated 2 major meta-analyses, 4 randomized controlled trials (RCTs), and 3 openlabel studies found NFB treatment of ADHD to be efcacious and produce remission rates of 32-47%, with sustained post-treatment efects for 6-12 months (Arns et al., 2020).
- A 2018 meta-analysis reviewed 10 studies, fnding signifcant efect of NFB on ADHD symptoms of inattention and hyperactivity/impulsivity, comparable to medication, and that improvements were sustained 2 to 12 months beyond the end of treatment (Van Doren et al., 2018).
- A 2014 review found that standard NFB treatment protocols have been well-investigated and are specifc and efective at treating ADHD (Arns et al., 2014).
- A 2014 study found that NFB resulted in greater improvements in ADHD symptoms compared to cognitive training or control groups in public elementary schools (Steiner et al., 2014).

• A 2009 meta-analysis found NFB treatment for ADHD to be efcacious and specifc: meaning treatment outcomes were statistically superior to fake treatments (known as sham treatments) or alternative treatments in at least two independent research settings (Arns et al., 2009).

NFB has also been found to be efective as a treatment for anxiety. Biofeedback equipment in general, and more specifcally NFB equipment, is FDA-cleared for relaxation training. Research shows that relaxation is a primary treatment for anxiety and other symptoms of stress- and adjustment-related disorders. As a non-pharmacological option, NFB can be used to treat symptoms of anxiety and alleviate a host of related mental health disorders potentially including PTSD, depression and others.

Results from research on NFB as a treatment for anxiety include:

- A 2020 meta-analysis of 21 studies with 779 participants concluded that neurofeedback is efcacious in the treatment of anxiety and reactive stress disorders (Anxiety Disorders: Rethinking and Understanding Recent Discoveries, 2020).
- A 2008 meta-analysis that reviewed 27 studies found signifcant efcacy for relaxation training as a treatment to reduce anxiety (Manzoni et al., 2008).
- A 2011 study found that NFB reduced anxiety related symptoms (Moradi et al., 2011).
- A 2010 study found that NFB was approximately as efective as medication in treating anxiety and more efective in women with anxiety (Bhat, 2010).

### NEUROFEEDBACK IS EFFICACIOUS AS A FIRST-LINE OR ADJUNCT TREATMENT FOR ADHD AND ANXIETY

Professional practitioner-directed NFB treatment, like any other behavioral health intervention – pharmacological, therapy or other – is based on established, evidencebased protocols implemented by trained professionals on certifed equipment. Tis level of NFB is highly efcacious and efective, and should be considered as a frst-line treatment for ADHD, anxiety, and anxiety-related mental health issues, or as an adjunct treatment to existing protocols such as cognitive behavioral therapy (CBT) or prescription medication.

Given the current rates of ADHD and anxiety-related symptoms and disorders, now is the time for increased adoption of NFB as a frst-line or adjunct treatment. It is imperative that medical practitioners and insurers provide adequate NFB treatments and reimbursements for ADHD and other behavioral and mental health conditions. More than ever, we need easy-to-access interventions that support the mental health and well-being of our nation.

NFB already carries Current Procedural Terminology (CPT) codes, the equipment is FDA-cleared, and the research shows efcacious results. Recent reports on access disparities demonstrate that lack of in-network access can lead to billions of dollars in additional medical and health costs, and immeasurable negative impacts on American lives (Melek et al., 2019; Davenport et al., 2020). While some insurers reimburse for NFB, many others do not. Compliance with the Mental Health Parity and Addiction Equity Act (MHPAEA) is one reason for insurance companies to cover NFB, but more so to make efective treatments for our nation's youth and adults available more broadly, thereby supporting the health and well-being of all Americans.

## Introduction

espite billions of dollars poured into research and treatment eforts, the incidences of behavioral health disorders in the U.S. continue to rise. In particular, ADHD diagnoses in children, by some estimations, have reached epidemic proportions while stress- and adjustment-related symptoms including anxiety are increasing overall (American Psychological Association, 2016). As of the writing of this paper, it stands to reason that the advent of COVID-19 as well as heightened racial injustice concerns will likely have additional impact in these areas in yet unknown ways. Efcacious interventions and treatments for behavioral health, including mental health, are needed now and will be even more valuable in the days ahead.

Interventions and treatments vary depending on conditions and intended outcomes. Neurofeedback (NFB) is a proven treatment for ADHD and other mental health issues. Despite its growth in recent years, it remains signifcantly underused. NFB helps address patterns of dysregulation associated with irregular brainwave activity found in a range of conditions including ADHD, depression, anxiety, behavioral issues, and sleep disorders (McCormack et al., 2015). NFB uses non-invasive sensors and a digital interface to measure brainwaves, allowing individuals to observe and modulate their own brains' activity. A feedback-and-reward system helps patients achieve brain states associated with self-regulation, attention, focus, and other improvements relative to behavioral health conditions. While there exists a strong and rapidly growing evidence base for the use of NFB as a treatment for many behavioral health conditions, currently, the preponderance of evidence is in the domain of ADHD.

## NFB is efective because it helps the brain improve itself via neuroplasticity.

NFB is efective because it helps the brain improve itself via neuroplasticity (Ros et al., 2010). Neuroplasticity is a concept in neuroscience indicating that the brain's neurocircuitry is highly changeable and, with the right stimulus, can undergo positive shifs even as we age. As such, through neuroplasticity, "the brain is capable of 'reprogramming' itself using a wide variety of inputs, including sensations, emotions, thoughts, beliefs, environmental and physical stimuli, relationships, experiences, and even metacognition – what the brain thinks of itself" (McCormack, O'Brien, 2019). Neuroplasticity occurs in every brain, and brain changes and outcomes depend on inputs and feedback. Negative inputs, such as drug use, over-exposure to violence, and so forth, tend to create dysregulation and consequent mental and behavioral health issues. Positive feedback, such as NFB, cognitive behavioral therapy (CBT) and similar techniques, positive learning, and pro-social peer experiences, tend to: create regulation in the brain; improve mental and emotional balance, learning, performance and well-being; and guard against behavioral health disorders.

NFB works within the function of neuroplasticity by providing positive or consequential feedback to the patient in real time in order to infuence positive changes in brainwave activity. In this way, the brain "learns" to improve regulation and be guided toward normal functioning for the age of the patient.

Te experience of NFB is non-invasive and usually relaxing, thereby improving compliance. In a typical NFB session, the patient is in a relaxed or resting position with brainwave-measuring sensors lightly attached to the head. During a standard 20- or 40-minute experience, the patient watches a monitor and/or listens to sounds or music that are part of the NFB feedback technology. Tis visual and auditory feedback cues the brain to modulate brainwaves toward desired regulated states. Te patient is not eforting in any way as the brain "learns" to modulate brainwaves. Ofen following NFB, patients experience improvements in certain areas targeted for behavior change including mood, attention and focus, or other goals of therapy. As brain functioning improves over cumulative sessions, the correlated changes of the targeted behaviors are realized and measurable.

Over the past seven decades, thousands of studies have been conducted demonstrating the various applications for NFB. More recently, meta-analyses confrm the efcacy of NFB as a treatment for ADHD and stress-and-adjustmentdisorder behavioral health conditions. Yet, despite supportive research, and certain biomarker assessments cleared by the Food and Drug Administration (FDA) – such as ADHD diagnostic tools (Wilkes, et al., 2018) that use digital analysis of electrical activity in the brain measured from sensors placed on the head – NFB is not being adequately utilized by psychiatrists and psychologists as a standard protocol for treating these behavioral health disorders.

## NFB AND THE CURRENT ADHD AND BEHAVIORAL HEALTH CRISES

ADHD is on the rise in the United States. Te overall rate of ADHD in children aged 2-17 has increased from 6.1% to 10.2% since 1997 (see Figure 1). Youth aged 12-17 have the highest rates of ADHD, coming in at 13.5% in 2016; and boys are diagnosed three times as frequently as girls, possibly caused by clinicians misreading symptoms in girls (CHADD, 2020). In adults, the lifetime prevalence of ADHD is 8.1% (NIMH, 2017a). Some studies have found NFB to be as efective as medication in treating ADHD, and with longer sustained results post treatment (Arns et al., 2020).

Beyond ADHD, mental health more broadly has become a dominant issue in our society. Rates of stress- and adjustment-related symptoms are climbing, and the number of mental health disorders that produce anxiety, depression, post-traumatic stress disorder (PTSD) and other stress-related symptoms are not showing any sign of letting up. Approximately 20% of adults in the U.S. have a mental illness (NIMH, 2017b).

According to the Anxiety and Depression Association of America, anxiety of all types afects approximately 20% of adults and 25% of teens 13- to 18-years-old. (ADAA, n.d.). Additionally, 7.5% of U.S. children are diagnosed with behavioral problems and 7% with anxiety (CDC, 2018a). Addressing these disorders and other behavioral health conditions puts U.S. national mental health market spending at approximately \$225.1 billion, up 52% from a decade ago (Open Minds, 2020); and yet, many are still not receiving care. For example, only about 37% of total anxiety cases receive treatment (ADAA, n.d.). To complicate matters further, according to the CDC, 64% of children with ADHD have at least one other mental, emotional, or behavioral disorder (see Figure 2). NFB, as a cleared treatment for relaxation, has been shown to be efective in treating and alleviating symptoms of stress- and adjustment-related disorders such as anxiety.

Americans of all ages, and our youth in particular, are under siege from behavioral health challenges. And while we have made concerted eforts in the felds of medicine and pharmacology to address this crisis, in some cases, prescription drugs are showing mixed results while the epidemic continues. Pharmacological remedies have ofered great relief to many and are an indispensable component of modern medicine. Yet, the latest developments in neuroscience remind us that relying exclusively or too heavily on drugs, especially when other proven treatments are available, is not always the best or healthiest solution, even if this is the current established norm. While the immediate benefts of pharmacology for ADHD are clear, much is still unknown about the longterm efects of the use of psychotropics on the developing brains of youth. Some researchers have noted that pharmacological medications used in childhood do not necessarily lead to lasting remission, and may contribute to secondary behavioral health issues such as substance abuse in adulthood (Mannuzza & Klein, 2000). Expanding access to proven protocols, including NFB, is not a countermedication efort, but a strategic treatment add-on that would only help combat the behavioral health crisis, and support the health and well-being of our youth.

### BROADENING THE SCOPE OF EFFICACIOUS AND COST-EFFECTIVE INTERVENTIONS

To truly understand and address the underpinnings of childhood and adult behavioral health, we would need to consider factors beyond pharmacology, including what afects neuronal and neural circuit development, how relationships with self and others afect the brain (i.e. interpersonal neurobiology), how and when normal development gets interrupted and afects life outcomes (i.e. developmental psychopathology), as well as other therapeutic disciplines that similarly consider the interdependent neurological and environmental causes, conditions, and impacts of behavioral health.



### FIGURE 1: INCREASE IN U.S. RATES OF CHILDREN WITH ADHD FROM 1997-2014

### FIGURE 2: PERCENTAGE OF U.S. CHILDREN WITH ADHD AND ANOTHER DISORDER

Centers for Disease Control and Prevention. (2018, September 21). Data and Statistics About ADHD. https://www.cdc.gov/ncbddd/adhd/data.html



Given this complex interdependent nature of medicine, society, and individual genetics – how they all intersect and where they are disparate – we may never be able to align and address all the variables afecting behavioral health. Tis makes behavioral health treatment complicated. Tis also means no one treatment or practice is perfect, just as prescription medication is no panacea for ADHD, nor is, say, a mindfulness practice or talk therapy. However, to the extent that we can understand, adopt, and fully integrate non-harmful and efective interventions like NFB into the primary suite of behavioral health treatment protocols, we can support our nation's citizens, young and old, with accessible techniques and treatments for healing, recovery, and human fourishing.

Currently, while behavioral health rates are on the rise, in-network insurance coverage for behavioral health treatment is falling compared to coverage for primary care (Melek et al., 2019). Tis means that options for ADHD and other behavioral health treatments are fewer, less accessible, and less afordable.

In light of a recent groundbreaking report, insurance companies have more reason than ever to fast-track approval of efective evidence-based behavioral health interventions. Beyond access to coverage, not doing so could also be costing payers billions of dollars. In August 2020, Milliman Inc. provided an analysis of healthcare spending on 21 million commercially-insured individuals. Strikingly, the most expensive 10% of patients accounted for 70% of annual total health care costs; and within this high-cost group, 1.2 million individuals received a behavioral health diagnosis and/or treatment. Tough this subgroup represented just 5.7% of the study participants, they accounted for 44% of annual total health care costs for the entire study population. Tragically, 50% of these individuals received less than \$95 in behavioral health treatment annually, including prescription drugs (Davenport et al., 2020). Former CEO of Magellan Health and advisor to Te Path Forward mental health care reform initiative, Henry Harbin, MD, stated, "Tremendous savings and improved outcomes are achievable if these individuals are identifed early and provided with prompt evidencebased behavioral health treatment" (Mental Health

Association of Maryland, MidAtlantic Business Group on Health, 2020).

Recent brain science encourages the medical feld and insurance providers, when addressing behavioral health, to consider previously undercovered interventions like NFB. As an efcacious treatment for ADHD, for some patients NFB can achieve similar outcomes as medication, CBT and other treatments, by working with the brain's neurocircuitry to help bring about sustained behavioral change. Not only does NFB train brains to function better, heal from trauma and dysfunction, and increase capacity for learning and balanced living, but typically does so at reduced costs to insurers, health systems, individuals, and society.

Tis paper summarizes the more recent evidence for NFB as an efcacious and efective treatment for ADHD, and as an efective treatment for stress- and adjustment-related disorders that produce symptoms of anxiety. Included will be a cogent explanation of NFB for the interested layman to the unacquainted medical professional, including its history, an overview of various modalities and techniques, and a review of the research. Te more technical aspects of NFB are covered in a series of appendices for those wishing to delve deeper.

Overall, our aim is to leave the reader with a confdent, evidenced-based understanding of NFB, its main modes, functions and applications, as well as a solid rationale for the inclusion of NFB in the short list of primary treatments for ADHD and other stress- and adjustmentrelated disorders. Ultimately, the reader will understand the critical fundamentals of how NFB improves brain ftness and behavioral regulation, and relieves symptoms of certain behavioral health disorders, making it a valid behavioral health intervention. In consideration of coverage for behavioral health interventions, the paper also serves to support broader inclusion of NFB as a covered medical expense for the treatment of ADHD and stress- and adjustment-related mental health disorders. Tis is particularly relevant at a time when access to and reimbursement for efective interventions are desperately needed.

## Neurofeedback: An Evidence-Based Treatment for ADHD

ith historically high rates of ADHD showing no signs of abating, patients and families are looking for a full range of interventions that work. ADHD treatment, however, is largely deadlocked in a prescription medication-only scenario, with close to 70% of children diagnosed prescribed some form of psychopharmacological medication. For more than forty years, psychostimulant medications have been the most popular and powerful treatment option for ADHD. However, as new research on NFB is published, fndings are indicating comparable and even superior outcomes with NFB, in some cases.

Undoubtedly, medication has a successful track record of reducing symptoms of ADHD; yet it does not work for everybody or it brings unpleasant side efects for some people due to the stimulant's mechanism of action in the brain. Additionally, potential long-term risks of taking stimulants are top-of-mind for a number of parents, and studies are limited in this regard. Furthermore, some studies suggest that outcomes from medication treatment may not last longer-term, post-treatment, or without increasing dosage. For those uncomfortable with these considerations, NFB as a non-pharmacological intervention should be a mainstream treatment option for ADHD, or at least a standard complement to medication as an adjunct therapy. Additionally, for many families the ADHD diagnosis process is stressful and inconclusive, ofen with difering reports from various sources. EEG, used in NFB and described below (see Neurofeedback Explained), ofers a more defnitive diagnostic tool, and families may prefer medical care that ofers this option.

NFB has a long history and thousands of studies, many of which focus on treating behavioral health conditions, validating NFB's efcacy and efectiveness at improving behavioral health and brain ftness. In the past 11 years, for example, at least four major research reviews by leading researchers in the U.S. and internationally have shown NFB to be an efcacious intervention for ADHD.

## In several studies, the efects of NFB continue after the treatment has ended, indicating progressive, positive neuroplasticity changes in the brain.

Most notably, research fndings show the same rates of remission for ADHD as the leading prescription medications reviewed in the large-scale National Institute of Mental Health Multimodal Treatment Study (NIMH-MTA) for ADHD trial (Te MTA Cooperative Group, 1999). Additionally, ADHD-related studies show positive treatment outcomes last longer post-NFB treatments than post-medication treatments (Arns et al., 2020). Tis means that in several studies, the efects of NFB continue afer the treatment has ended, indicating progressive, positive neuroplasticity changes in the brain. Conversely, ADHD medication does not usually have this outcome. Rather, when medication use ends, so does the reduction in symptoms. Moreover, increasing medication dosage may be required to maintain remission. In the U.S., among children aged 2- to 17-years-old diagnosed with ADHD, 62% take prescription medication. In total, 77% of children diagnosed with ADHD receive some form of treatment: 30% with medication alone, 15% with behavioral treatment alone, and 32% with a combination of behavioral treatment and medication (CDC, 2018b). A full 7% of children and 1.5% of adults in America take medication for ADHD, predominantly methylphenidate, most commonly known as the brand Ritalin (Brennar, 2018.). Many of these children and adults could beneft from NFB as a non-pharmacological standalone or adjunct treatment, from the perspective of both access to treatment and outcomes.

Te 2014 National Survey of the Diagnosis and Treatment of ADHD surveyed 2,495 children aged 4- to 17-years-old with ADHD. A recent analysis of the survey's data found a gap in psychosocial and alternative interventions for school-aged children with ADHD (Danielson et al., 2018). According to the research, medication and school supports were the most commonly used treatments, followed by parent training, peer intervention and therapy, and then more distantly by dietary supplements and NFB. Te authors stated that increasing access to treatments beyond medication and school support is "important to ensure that the millions of school-aged US children diagnosed with ADHD receive quality treatment."

Current common treatment plans for ADHD vary in approach and can be multimodal because a defnitive onesize-fts all solution for ADHD does not exist. Medication and therapy each require a period of trial and adjustment to determine specifc efectiveness for an individual. Similarly, treatment for ADHD with NFB follows this same path: diagnosis, referral, evaluation, treatment plan, trial, feedback, improvement of condition, continuation of treatment, and ongoing patient evaluation and management as needed.

NFB also works very efectively as an adjunct treatment in combination with medication, where it can improve treatment outcomes and increase longer term, positive post-treatment benefts.

As a standalone treatment that is non-invasive and nonpharmacological, NFB may be preferable for some parents who would rather their child(ren) not take stimulants. Even though NFB is powerful and efcacious on its own, NFB is not exclusively a stand-alone or medicationreplacement treatment. NFB also works very efectively as an adjunct treatment in combination with medication or other psychosocial interventions, where it can improve treatment outcomes and increase longer term, positive post-treatment benefts.

Te fact that NFB proves itself as an efcacious and research-validated treatment modality, should only encourage insurance carriers and doctors to increase access to and application of NFB for ADHD—a formidable medical and social challenge. Having multiple efective tools to address ADHD would be a beneft to children and adults with the diagnosis, as well as to their families, doctors, and therapists.

## NFB Treatment for a Broader Range of Mental Health Conditions

hile the preponderance of NFB evidence is in the domain of ADHD, a strong evidence base for the use of NFB to treat other behavioral health disorders is also growing. NFB has demonstrated outcomes of efectively reducing symptoms caused by reactions to severe stress and adjustment (such as PTSD, depression, and anxiety) by improving general relaxation and brain regulation, and by reducing symptoms related to anxiety. It has, for example, been used with U.S. military veterans for more than a decade.

Relaxation training, a common treatment for anxiety, is an FDA-cleared use of NFB equipment. Biofeedback, a broader category that includes NFB, and NFB itself, have been used for decades to promote relaxation, as evidencebased, non-pharmacological methods for treating anxiety. A 2008 meta-analysis that reviewed 27 studies found signifcant efcacy for relaxation training as a treatment to reduce anxiety (Manzoni et al., 2008). More directly, research has shown that various specifc NFB treatments have been found to do the same (Kerson et al., 2009; Moradi et al., 2011). In one study, researchers found that NFB is approximately as efective as medication in this regard (Bhat, 2010). As previously indicated in the CDC data (CDC, 2018a), behavioral health conditions – including mental health issues that cause anxiety – are on the rise, at the same time there exists a lack of accessible and afordable treatments. According to a recent Mental Health America report, the percentage of people in 2020 seeking help with anxiety and depression has increased by 62% since the prior year, with young people ages 11-17 more likely than other age groups to indicate moderate to severe symptoms (Mental Health America, 2020). Adopting efective interventions such as NFB as part of a treatment model not only makes sense but carries lower risks than pharmacological interventions or no interventions. Later, this report will point out that NFB has few and minimal transient side efects, making it a smart choice for reducing anxiety brought on by stress- and adjustment-related disorders. In light of COVID, and with national rates of stress and anxiety in adults and children reaching new highs, now more than ever we need efective, non-pharmacological interventions like NFB to be broadly covered by insurance.

## Neurofeedback Explained

hat exactly is NFB? Simply put, NFB is a technology that allows patients to perceive their brainwave activity. NFB is non-invasive and nonpharmacological. An NFB device does not add electrical currents to the brain. Rather, surface sensors placed on the head, called electrodes, measure electrical output using electroencephalogram (EEG). Te interpreted brainwave data is called quantitative EEG, or qEEG, as it is translated into measurement modes using various quantitative mathematical applications. Trese subtle qEEQ readings are converted into visible or otherwise perceivable forms such as graphs, charts, amplitude readings, colors, animated images, sounds and so forth. Using these technologies, NFB simultaneously measures, monitors and records brainwaves. Te qEEG data is then used to create feedback loops that train the brain towards brainwave states that result in reduction of symptoms and/or improvement in well-being. Normative reference databases can provide trained NFB practitioners with target gEEG measures for age-matched populations as objective starting points for NFB treatment. Tis practice of determining treatment protocol based on historical evidence is in line with many medical procedures that use established reference databases for guidance during treatment. Further, qEEG is the only FDA-cleared, brain-based diagnostic tool for detecting ADHD, which is essentially a brain-based disorder defned by distinctive, abnormal brainwave patterns.

## The brain is modulating its own brainwaves as encouraged by the NFB feedback system.

Te feedback loops ultimately enable patients' brains to modulate their own brainwaves towards healthier or target frequency levels by ofering rewards to the brain in the form of images, sounds, or other stimuli. NFB participants receive real-time and continuous qEEG data about their own brainwaves, and through conscious intention and reward incentives, are able to modulate brainwaves while witnessing the outcome of their eforts. More specifcally, the participant is aware and engaged, but not actively modulating their own brainwaves consciously. Rather, the brain is modulating its own brainwaves as encouraged by the NFB feedback system.

During a typical NFB session, this measure-loop-modulate process continues for approximately 20 to 40 minutes. A trained NFB mental health or medical practitioner monitors the session, sets the protocol, interprets activity, and gets feedback from the patient, which is used to adjust future sessions toward more efective outcomes. Repeated NFB sessions produce lasting changes in brain function and ftness, and consequently lasting improvements indicated by remission or reduction of symptoms in mental and behavioral health disorders.

### HOW NFB IS EXPERIENCED

An adult or child patient receiving NFB treatment for ADHD would likely be referred by a physician, psychiatrist or psychologist following diagnosis, but could also be referred by self or a parent. As with other forms of therapeutic treatment, initial intake and evaluation would capture key symptom information about the patient including, in the case of NFB, a qEEG baseline of the patient's brain for reference and for help in determining a treatment plan. At the point of treatment, a typical session would include the patient sitting in a chair or otherwise in a resting, relaxed pose with four or more sensors connected to their head and ears. Depending on the treatment protocol determined by the practitioner, the patient might use a visual feedback system, like watching a movie or sequence on a screen, or use audio cues such as listening to a song. When the brain is experiencing the intended brainwave, the visual or audio feedback system runs smoothly; and when an unintended brainwave occurs, there may be a visual interruption on the screen or a volume change or skip in the song. Tese changes give the brain feedback to help it self-correct towards target brainwaves. Te treatment would continue for the prescribed amount of time. During treatment the patient is typically awake and aware, but in most cases their conscious participation is limited to a meta-witnessing of the process while the real brainwave work is being done at a faster rate by the brain itself.

Te experience tends to be relaxing and non-efortful, and many patients report feeling calm, alert, and at ease, with similar feelings immediately following the session. Bookending the EEG part of the protocol, treatment would also include patient and practitioner feedback about treatment goals and progress, both from the NFB-reported changes in brainwaves as well as how improvements have translated into the patient's life between sessions. Qualitative feedback is ofen measured using standard tools used to assess human behavior. As with other treatments such as medication or therapy, the practitioner would use this qualitative feedback, along with any quantitative measurements, to adjust the treatment protocol towards optimal efectiveness. Repeated sessions support improvements in brain health and regulation and reduced symptoms and negative outcomes of ADHD. Overtime, improvements become more permanent, typically lasting beyond the end of treatment.

NFB can also be used in other settings, such as classrooms, on more than one student at a time, as demonstrated by a 2014 study that successfully used NFB to treat children with ADHD in grade schools (Steiner et al., 2014). In this setting, children are typically stationed at computers during a specifc time period of the school day where they engage in unique, individually responsive, NFB treatment applications as determined by a licensed practitioner.

## NFB provides the opportunity to afect positive change in the brain without surgery, electric shock, pharmacological medication, or other outside stimulus.

With repeated NFB sessions, the brain is trained to build more robust neuronal networks that facilitate adaptability related to positive behavioral health outcomes. As such, accessing desired brain states becomes easier and more reliable. Te simple and powerful aspect of self-modulating brainwaves through feedback is what makes NFB a unique and potent brain-building treatment or intervention. NFB provides the opportunity to afect positive change in the brain without surgery, electric shock, pharmacological medication, or other outside stimulus, while providing real-time data that signals neuroplasticity changes in the brain.

## The History of Neurofeedback

odern NFB, validated by current research as an efcacious treatment for ADHD and other mental and behavioral health conditions, builds on a century-long study of EEG, and more than a half-century exploration of NFB applications.

In the 1920s, German psychiatrist Hans Berger was credited with recording the frst human EEG. He later proposed that clinical disorders are detectable through EEG abnormalities (Millet, 2002).

Fast-forward to the 1960s, when NFB gained notice through the research of Dr.'s Joe Kamiya and Barry Sterman. Kamiya's work at the University of Chicago was the frst to show that people could control their own brainwaves with EEG feedback, and it established a scientifc basis for modern biofeedback and NFB. Sterman was at University of California Los Angeles studying the ability of cats to increase their own sensorimotor rhythm (SMR) – a unique brainwave – in exchange for a food reward using EEG NFB. Ten, in an unrelated NASA study that researched exposure to rocket fuel, cats from his SMR study were included as test subjects and showed fewer adverse reactions, in particular, no toxicity-related seizures. Tis would lead Sterman to initiate a human trial to see if increasing SMR brainwaves could be a treatment for seizure disorders. While he found some success in this area, the outcomes of positive and prophylactic brain changes opened the door to other areas of study, shifing the focus of NFB research to behavioral health treatments.

By the mid-1970s, Dr. Joel Lubar pioneered using NFB to treat ADHD while Dr. Margaret Ayers used NFB as a treatment for mental health symptoms of traumatic brain injury. In the 1980s, Dr.'s Eugene Peniston and Paul Kokosky developed the Peniston-Kulkosky NFB protocol that was used to treat alcoholism and PTSD in Vietnam War veterans. NFB research continued over the ensuing decades, exploring the possibility of treating dozens of mental and behavioral health conditions as well as physical symptoms, including addiction, anger, headache, hypertension, schizophrenia, sleep disorders, and many more.

Beginning with a 1968 article by Dr. Kamiya in *Psychology Today* about the relaxation effects of alpha wave modulation using NFB (Kamiya, 1968), the research on NFB grew to include 162 studies in the 1970s and '80s, 1,260 studies in the 1990s, 6,100 in the frst decade of the millennium and more than 9,000 publications since 2011.

Taking into consideration all the research and exploration to date, the most powerful and prevalent use of EEG NFB is as a treatment for ADHD, followed by relaxation treatments for reducing the symptoms of stress- and adjustment-related disorders such as PTSD, depression and anxiety.



## What the Research Shows

#### NFB IS EFFICACIOUS AND SPECIFIC IN TREATING ADHD

Research over the past 20 years has signifcantly built on the pioneering NFB studies of the 1970s, '80s, and '90s. New studies, reviews and meta-analyses have investigated the efcacy and efectiveness of NFB under a variety of standard protocols, populations and conditions. Te take away from this review of evidence is that NFB should be a frst-line treatment with certain conditions. Even the vast majority of sham studies – designed to test whether the outcomes of a treatment are valid or little more than placebo efect – showed that NFB does have an efect greater than placebo when properly applied. (See Sham or the Real Deal section below for more information.) Following are summary research findings that support NFB as an efective treatment for ADHD and other conditions.

## NFB should be [a] frst line of treatment for ADHD.

In a 2014 review, psychologist H. Edmund Pigott and neuroscientist Rex Cannon state that NFB should be the frst line of treatment for ADHD. In their review, they point out that while upwards of 70% of children diagnosed with ADHD are prescribed amphetamine medication, medication as a treatment fails to result in sustained benefts for most children. Tey indicate challenges with comorbid symptoms such as anxiety, depression, and learning disorders, that can lead to misdiagnosis, and therefore recommend NFB be used frst in the case of ADHD treatment, as it is efcacious, non-harming, and non-pharmacological (Pigott et al., 2014).

Beyond comparison to medication, NFB was found to be more than twice as efective as the other interventions, which included behavior modifcation, multimodal psychosocial treatment, school-based programs, working memory training, parent training, and self-monitoring, in a 2014 meta-analysis that reviewed outcomes from 14 controlled studies including 625 subjects (Hodgson et al. 2014). Te review focused on NFB as a treatment for ADHD relative to the effectiveness of other evidence-based non-pharmacological treatments.

Similarly, another 2014 study – that randomly assigned 104 grade-school children from public schools diagnosed with ADHD to treatment with NFB, cognitive training (CT), or nothing (control)-found signifcant improvements with NFB treatment (Steiner et al., 2014). After 6 months of interventions, the NFB groups showed a strong reduction in ADHD symptoms indicated by increases in attention and executive function compared to the other two groups. In addition, of the children in the study who were already taking methylphenidate, the medication dose levels for the CT and control groups increased signifcantly over time based on symptoms in order to maintain outcomes, while the NFB group had no signifcant dosage increase. Overall, the study found signifcant improvements for the NFB group in children who were both on or of medication. Tis research supports NFB as both a stand-alone and adjunct treatment for ADHD.

Te research continues to validate the efectiveness of NFB as a treatment across study designs and measures. For example, a 2014 meta-analysis of randomized control trials (RCTs) that summarized research including 263 children (146 using NFB and 117 in active control or sham control groups) found that NFB signifcantly improved inattentiveness, impulsivity and hyperactivity according to parent assessments. (Micoulaud-Franchi et al., 2014). Signifcant improvements in inattentiveness were also reported through teacher assessments.

Meanwhile, large-scale reviews have indicated across research that NFB hits high marks when it comes to efcacy of treatment for ADHD. According to a 2009 metaanalysis that included 1,194 subjects from 10 controlled studies, NFB is efcacious and specifc (classifed as Level 5, meaning statistically superior to sham or alternative treatment) for ADHD (Arns et al., 2009). In the research reviewed, NFB was found to be most effective at treating inattention and impulsivity aspects of ADHD.

To further support NFB as a frst-line treatment, a 2012 study concluded that NFB yields similar initial outcomes to medication (Duric et al., 2012). Tis RCT included 91 children aged 6- to 18-years-old and investigated treating ADHD with either NFB or methylphenidate. Improvements were measured as changes in symptoms reported by parents. Both NFB and medication reported equal improvements during and following treatment: NFB three times a week for a total of 30 sessions, or 1 mg per kg of methylphenidate for the same time period. Te study concluded that NFB signifcantly improved symptoms of ADHD with the same efectiveness as methylphenidate, supporting NFB as a valid primary treatment option for ADHD in children.

Other studies have found similar initial outcomes and further concluded more successful post-treatment outcomes for NFB. A recent meta-analysis investigated the efects of NFB as a treatment for ADHD compared to medication and found that NFB was "superior on non-active control groups [i.e. open-label] and similarly efective for inattention and hyperactivity/impulsivity compared to active treatments" (Van Doren et al., 2018). Further, this same study noted that the "fndings provide evidence that there are sustained clinical benefts afer neurofeedback and active treatments over an average 6–12 month follow-up period, whereas efects of non-active control groups are no longer signifcant at [follow-up]."

A 2019 review of meta-analyses and randomized controlled trials found similar evidence supporting NFB in lieu of medication (Enriquez-Geppert et al., 2019). Te study stated: "... in response to the lack of long-term efects for both medication and behavioral therapy and the side efects of medication... we provide evidence for the efcacy and specificity of standard neurofeedback protocols." Te study concluded that neurofeedback should be a viable treatment for ADHD, while encouraging continued research to further identify specific protocols.

Very recent research reinforces NFB as an equal treatment to medication as compared to the landmark ADHD medication studies. A 2020 quantitative review evaluated the efectiveness and efcacy of NFB by comparing its research outcomes to the NIMH-MTA studies for medication and behavior therapy (Arns et al, 2020). Te review found NFB to be both efective and efcacious as a treatment for ADHD compared to medication and/or therapy, and failed to fnd any side efects from NFB as a treatment. More importantly, in RCTs, ADHD remission rates following treatment with NFB ranged from 32-47%, on par or better than rates for methylphenidate, behavior therapy, or community care as treatment (see Figure 3A). In addition, in four RCTs, NFB resulted in continued improvement in ADHD symptoms afer treatment ended (see Figure 3B). Tis post-treatment increase in improvements was also true for behavior therapy and community care, but not for medication, which showed a decrease in efectiveness at follow-up, indicating that the benefts of medication are immediate and not lasting.

Tis is not to disparage medication or to position NFB as a cure-all replacement for medication. Tere are many behavioral health conditions where the best course of treatment is medication and, in some cases, NFB works well as an adjunct treatment to medication. However, where NFB can be used as a frst-line treatment, as with ADHD, there exists the potential beneft of lasting results afer treatment ends without side efects or further pharmacological intervention.

Te research overviewed above supports both standalone NFB and a combination of NFB and medication as potential best practices for treatment of ADHD, underscoring key points that: NFB is as efcacious and efective as medication when used properly; and NFB treatment can result in long-lasting (6-12 months) improvement in symptoms even afer treatment has ended, whereas medication typically does not show posttreatment improvements. Tese findings support NFB as a frst-line or adjunct treatment for ADHD.

### NFB ELIMINATES AMPHETAMINE-RELATED RISKS

Te CDC reports that ADHD afects almost 10 percent of school-aged children, with approximately 3.3 million U.S. children medicated for unfocused behaviors (CDC, 2018b). As such, it is also important to consider the risks and side

#### FIGURE 3A: NFB COMPARED TO METHYLPHENIDATE MEDICATION

Arns, M., Clark, C. R., Trullinger, M., deBeus, R., Mack, M., & Aniftos, M. (2020). Neurofeedback and Attention-Defcit/Hyperactivity-Disorder (ADHD) in Children: Rating the Evidence and Proposed Guidelines. Applied Psychophysiology and Biofeedback, 45(2), 39-48. https://doi.org/10.1007/s10484-020-09455-2



The above fgure compares effect sizes for several independent studies investigating various treatments for ADHD. L signifes a large clinical effect size (>0.8). All neurofeedback studies employed one of the following standard NFB protocols: sensori-motor Rhythm (SMR), theta/beta neurofeedback (TBR), or slow cortical potential (SCP). In the frst open-label neurofeedback study a QEEG-informed procedure was used to select the right standard protocol and in the second open-label study, subjects were pre-selected on high TBR (TBR RDoC). The RCT medication outcome measures were from the NIMH Multimodal Treatment Study of Children with ADHD (MTA). The MTA study was composed of four arms: combined treatment of medication and therapy (COMB), medication only (MED), multicomponent behaviour therapy (MBEH), and community care—treatment as usual (CC:TAU). The open label medication study was a multi-centre open-label, treatment as usual (TAU) trial of methylphenidate (MPH) treatment.

#### FIGURE 3B: NEUROFEEDBACK EFFECT SIZE AT FOLLOW UP

Arns, M., Clark, C. R., Trullinger, M., deBeus, R., Mack, M., & Aniftos, M. (2020). Neurofeedback and Attention-Defcit/Hyperactivity-Disorder (ADHD) in Children: Rating the Evidence and Proposed Guidelines. Applied Psychophysiology and Biofeedback, 45(2), 39-48. https://doi.org/10.1007/s10484-020-09455-2



This fgure compares effect sizes of neurofeedback results immediately following treatment (purple bar/Pre-Post Treatment) to follow-up 6 months post treatment (yellow bar/Pre-FU) for several randomized control trials investigating various neurofeedback protocol treatments for ADHD. L signifes a large clinical effect size (>0.8). All neurofeedback studies employed one of or more of the following standard protocols: sensori-motor rhythm (SMR), theta/beta neurofeedback (TBR), or slow cortical potential (SCP).

efects of medicating children with amphetamines, and in some cases additional antipsychotic drugs.

Beyond direct comparison between NFB and medication in terms of efectiveness or efcacy, research indicates that drugs have a higher risk of unfavorable side efects and, in other research, drugs and medication have not been shown to increase academic or life-achievement outcomes (Currie et al., 2014; Loe & Feldman, 2007). Rather, a childhood diagnosis of ADHD is usually followed into adulthood by ongoing treatment and related life challenges. Approximately 40% of treated children continue to experience ADHD as adults, and some engage in drug abuse. Adults that were medicated as children with ADHD are more likely to be antisocial, complete a lower level of education, and hold relatively lower level positions at work, while the ADHD-related attentional and impulsivity challenges from childhood tend to persevere (Mannuzza & Klein, 2000).

## [NFB] ofers a plausible alternative for children with ADHD whose treatment may be limited by side efects and/or poor medication response.

In a study that evaluated the efects of Ritalin compared to NFB, researchers found, using the Test of Variables of Attention (TOVA) scores, that NFB treatment resulted in sustained improvements. In the same report, they surmised that treatment with stimulants "would appear to constitute a type of prophylactic intervention, reducing or preventing the expression of symptoms without causing an enduring change in the underlying neuropathy of ADHD" (Monastra et al, 2002). Tese findings should be most importantly understood from the perspective that stimulant medication typically does not produce lasting positive outcomes post-treatment, whereas NFB can. And for some children, especially those with co-occurring disorders, medication may not be the best course of treatment. Researchers have stated that NFB "ofers a plausible alternative for children with ADHD whose treatment may be limited by side efect and/or poor medication response" (Vernon et al., 2004).

Similarly, a 2003 study of 34 children compared NFB to methylphenidate. Twenty-two children received 3 months of NFB and 12 took methylphenidate for the

same time period. Te study found that both NFB and methylphenidate improved attention and reduced ADHDrelated behaviors. Te research concluded that NFB is a viable treatment for ADHD for parents who prefer a nonpharmacological treatment (Fuchs et al, 2003).

It stands to reason that a treatment option showing equal efcacy at reducing ADHD symptoms and promise for lasting outcomes post-treatment would be welcomed by medical and psychiatric professionals. Further, for some children, responsible and calculated treatment plans could begin with the least potentially harmful treatments – NFB and therapy – and progress towards medication as needed, depending on symptoms and outcomes. In addition, particularly in children, the experience of NFB is ofen in the form of watching a "movie" or listening to something, which is an enjoyable activity for children and results in higher levels of voluntary patient compliance.

Given recent comprehensive research reviews and current studies there is no reason for NFB to remain largely sidelined by the medical and psychiatric professions. Even though an ADHD diagnosis afects 11% of children aged 4-17-years in the U.S. today, only 11.4% of those diagnosed have ever received EEG NFB (Danielson et al., 2018). More patients, young and old, deserve covered access to and information about this treatment option.

## NFB IMPROVES ACADEMIC PERFORMANCE AND ACHIEVEMENT

It is easy to get mired down in the comparative efcacy (and ease of use) of various treatments for ADHD from a reductionist perspective – a viewpoint that if symptoms improve, all interventions are equal relative to the scope of those reduced symptoms. Yet, as mentioned earlier, with ADHD and children, it is important to consider more inputs than just treatment modality and reduction of symptoms in addition to sustained benefts. Beyond proven efcacy as a treatment for ADHD, NFB also improves academic and social outcomes.

Families are understandably seeking solutions that maximize cognitive function, emotion regulation, and life outcomes. More pointedly, one important element, and usually one of the primary reasons why parents seek diagnosis, is to improve their child(ren)'s academic performance; another is to bolster self-refective and/or self-regulated behavior. It also stands to reason that with improvements in academic performance, self-esteem improves, while school-related oppositional behaviors and test anxiety could be reduced. Without attempting to evaluate the totality of biological, neurological, and environmental inputs that lead to ADHD, which are numerous, for many families a preferred treatment would not only reduce symptoms by creating improvements in inattention, impulsivity and hyperactivity, but also show greater academic and social outcomes. In addition to grades, parents are seeking improvements in their children's quality of life, and in family or peer socialization that may have been obstructed or diminished as a result of ADHD. While the available research shows that NFB is equally as efective as medication alone at treating ADHD, it also shows that NFB is more efective at improving academic and life outcomes.

For example, a 2013 RCT of boys and girls aged 7- to 14-years-old that compared 40 NFB sessions to treatment with methylphenidate also investigated the impact of treatment on academic performance (Meisel et al., 2013). While the research found that both treatments alleviated symptoms of ADHD, at 2- and 6-month follow-ups, only the NFB cohort showed signifcant improvements in academic performance.

In another study, researchers reviewed data to explore the possible outcomes of treating children with ADHD with medication, not only in terms of improvements in academic performance, but also changes in emotional functioning (Currie et al., 2014). Te research used data from the National Longitudinal Survey of Canadian Youth, which include 8,643 participants who were born in 1985 or later. Te total longitudinal survey lasted for almost 25 years. Te study stated that following increases in the use of prescription medication for ADHD, researchers found "... no evidence that the performance of children with ADHD improved. In fact, the increase in medication use among children with ADHD is associated with increases in the probability of grade repetition, lower math scores, and a deterioration in relationships with parents. When we turn to an examination of long-term outcomes, we fnd that increases in medication use are associated with increases in the probability that a child has ever sufered

from depression and decreases in the probability of post secondary education among girls."

A 2015 review in the Journal of Attention Disorders sought to evaluate the direct impact of all ADHD treatments, or combinations of treatments, on academic outcomes. Te researchers looked at 176 studies that measured longer term academic outcomes (at least 2 years) for students with ADHD with and without treatment (Arnold et al., 2015). Tis research more specifcally defned two measures of academic outcomes: 1) academic achievement as information learned, measurable by test scores: and 2) academic performance as overall success in the school environment. Treatment of any kind showed some improvement in both academic achievement and performance. However, multimodal treatment (that combined more than one treatment) had the highest improvement measures in both categories. According to this study, non-pharmacological interventions performed better at increasing academic performance than pharmacological interventions.

Again, research indicates that while pharmacological interventions may be the simplest and most direct treatment modality to immediately relieve symptoms of ADHD, they are not always the most effective for longterm improvements post-treatment or for improving other outcomes including academic performance and prosocial behaviors. Conversely, non-pharmacological treatments, namely NFB, have been found to result in longer-term post-treatment improvements and increases in academic performance and well-being.

In addition to NFB as treatment for a single child with ADHD as prescribed or directed by doctors or psychologists, as referenced earlier, there exists potential for school-based group NFB interventions for children with ADHD that could improve not only symptoms but also academic and social outcomes. A 2011 study found that computer-based NFB interventions in school successfully reduced symptoms of ADHD (Steiner et al., 2011). Te study found improvements through objective measures including the Conners' Rating Scales-Revised (CRS-R), Behavior Assessment Scales for Children (BASC) and the Behavioral Rating Inventory of Executive Functioning (BRIEF). A 2014 follow-up study by the same researchers found that "participants on medication presented at baseline with the same level of ADHD impairment as those who were not taking medications" (Steiner et al, 2014). Further, they found that because "children on stimulant medication improved to the same magnitude as those not on stimulant medication suggests that stimulant medication does not hamper the therapeutic effect of [neurofeedback] NF. Tis is clinically an important factor regarding NF attention training and has been debated in previous works, and it means that NF is accessible as a stand-alone therapy option or an adjunctive treatment to medication."

### RESEARCH SHOWS NFB ALLEVIATES ANXIETY RELATED SYMPTOMS

As reported earlier, in addition to being an efective treatment for ADHD, research has shown NFB to be efective for other conditions and symptoms. Te words anxiety, stress, and trauma represent different conditions and symptoms, depending on context. Symptoms and experiences of anxiety are common across many behavioral health issues in addition to ADHD, including PTSD, depression, general anxiety disorder (GAD), and a more inclusive general category of stress- and adjustmentrelated disorders. Tis latter category could be caused by disruptive life events such as major challenges at work, in health, relationships, or due to accident or injury, both acute and chronic, that manifest symptoms of anxiety, depression and other experiences and emotions without necessarily indicating diagnosis of those conditions per se. As previously noted, almost 20% of Americans are experiencing some form of anxiety, not to mention the high rates of depression (NIMH, 2019) and stress-related illnesses in the U.S.

When considering NFB as an efective treatment option for these conditions, it is important to remember the original outcomes of NFB, going back to the 1950s and 1960s and the work of Dr. Joe Kamiya. Tese outcomes were increased relaxation efects shown through voluntary, feedback-assisted modulation of specifc brainwaves, namely alpha waves. In other words, NFB got its start in the behavioral health feld by inducing "relaxation" as an antidote to stress, anxiety, depression, addiction, and so forth.

## NFB can be successful at supporting well-being relative to depression, PTSD, trauma, and adjustment disorders.

Growth in NFB technology since the 1960s, along with discoveries in neuroscience, have resulted in greater understanding of relevant brainwaves, along with increased protocol specifcity for producing relaxation outcomes. Tese relaxation outcomes have transferable impact, namely relieving symptoms of anxiety related to other disorders. Interestingly, NFB can be successful at supporting well-being relative to depression, PTSD, trauma, and adjustment disorders in an objective way and without necessarily having to explore the underlying contextual or traumatic experience as might occur in therapy. As such, the benefts of NFB can be used independently to support relief from symptoms of anxiety, or as an adjunct treatment in combination with talk therapy. NFB, on its own, does not heal depression, PTSD or other disorders, but its ability to relieve symptoms in a non-invasive, non-traumatic, psychophysiological way with lasting efects can contribute to remission of symptoms and improved mental well-being. Including NFB in the toolkit of therapeutic treatment for symptoms of anxiety related to various disorders could be a beneft for practitioners, therapists, and even more for people struggling with mental health symptoms like anxiety and stress.

While research in this area is not as robust as for ADHD, biofeedback equipment and its functions, including modulating alpha brainwaves, is cleared by the FDA for relaxation (CFR - Code of Federal Regulations Title 21, n.d.). Relaxation training of various forms, including biofeedback broadly, is one of the most common treatments for anxiety and reactive stress disorders (Manzoni et al., 2008). Relaxation is a broad term that acts as the basis of more specifc improvement outcomes for anxiety and stress-related issues. Because the underlying causes of anxiety, stress, depression and other mental health conditions are varied and broad, NFB research covers an interesting gamut of causes and conditions. Even so, related studies show NFB to be effective at reducing symptoms of anxiety.

A 2020 meta-analysis (Anxiety Disorders: Rethinking and Understanding Recent Discoveries, 2020) of 21 studies with 779 participants concluded that neurofeedback is efcacious in the treatment of anxiety and reactive stress disorders. Te relevant research highlights that regulating alpha brainwaves is an effective treatment for reducing anxiety. (See Appendix A for more about brainwaves.)

Tis meta-analysis states: "Although there are many variants of EEG neurofeedback, the most frequently studied of these in the anxiety disorders have focused on increasing alpha waves. Alpha is the dominant EEG rhythm in healthy adults at rest and is associated with a calm, relaxed state. Among patients with panic disorder, alpha is attenuated, though in GAD patients, alpha is increased. Increasing alpha magnitude can produce a calming efect in high-anxious individuals."

Other, more case-specifc studies support the proposition that NFB is an effective treatment for symptoms of anxiety.

A 2011 study used NFB to treat people diagnosed with anxiety disorder (Moradi et al., 2011). Following 30 NFB sessions over three months, subjects experienced signifcant reduction in symptoms. At one year of followup, subjects' symptom checklist was in the normal range, meaning they were no longer showing clinical signs of anxiety, and self-reports indicated that they continued to experience relief from symptoms afer treatment ended. Similarly, a 2015 study used NFB to treat a cancer patient with anxiety and found signifcant improvements afer 20 NFB sessions as measured by the standard symptom checklist, SCL-90 (Benioudakis et al., 2016). Another 2012 study explored using NFB to reduce anxiety in professional athletes. Twenty professional swimmers participated in 12 NFB sessions and reported signifcant decreases in anxiety compared to a control group (Faridnia et al, 2012).

In more comprehensive research, D. Corydon Hammond, Ph.D., a psychologist and Professor (Clinical) Emeritus of Physical Medicine and Rehabilitation at the University of Utah School of Medicine conducted a review in 2005, exploring the then current research on NFB as a treatment for anxiety, depression and obsessive-compulsive disorder (Hammond, 2005). While he concluded that more controlled trials were needed, he stated that the research to date warranted considering NFB as an efcacious treatment for anxiety.

Still other research looked at the efects of NFB for GAD.

A 2015, quasi-experimental study evaluated NFB as a treatment for patients with GAD versus a control group (Dadashi et al, 2015). After 30 NFB sessions, the NFB group showed improvements in global functioning levels and reduced symptoms of GAD. Along the same lines, a 2010 study compared NFB to antianxiety medication as a treatment for anxiety in 100 patients with psychiatric diagnoses (Bhat, 2010). Te NFB group received treatment 5 times a week for 8 weeks, with follow-ups at 4 and 8 weeks. An interesting outcome was that overall, NFB was almost as effective as pharmacotherapy for symptoms of anxiety, and in female patients, NFB was more effective than medication.

A handful of other studies have explored NFB as a treatment for symptoms of anxiety, PTSD, depression, stress and other emotional and mental conditions. Many of the studies are smaller, but all show promise for, and efectiveness in, relieving symptoms of various conditions. Given the propensity for NFB to be efective as a treatment or adjunct treatment for such symptoms, NFB is a valid option for non-invasive, non-pharmacological treatment for states of anxiety resulting from a host of mental health conditions.

## Increasing NFB Access and Reducing Roadblocks

he research cited throughout this paper clearly shows that NFB is an efective treatment for ADHD and other stress- and adjustment-related symptoms. Applications include frst-line, stand-alone treatment for a variety of conditions, as an adjunct intervention to a medication-based or therapy-based treatment plan, and even as a classroom intervention for school-aged children. Efectiveness of treatment is dependent on proper application protocols and standards, including practitioner training and the use of FDA-cleared equipment. In most cases, however, the research shows positive outcomes, not only in symptom reduction of behavioral health issues, but also in long-term improvements in social behaviors, increases in academic performance, and reduced symptoms of anxiety. While NFB has not yet reached ubiquity as a recommended treatment for ADHD and stress- and adjustment-related symptoms, it undoubtedly has a presence as a valid treatment in these areas.

### CAN NFB BE BILLED TO INSURANCE?

NFB has had a Category I Common Procedural Technology (CPT) medical procedure code since 1978, and many reputable groups acknowledge and/ or recommend NFB as a valid treatment modality. For example, the International Society for Neurofeedback and Research (ISNR) and the Association for Applied Psychophysiology and Biofeedback (AAPB) both recommend NFB as an effacious treatment for ADHD.

Established CPT billing codes allow NFB to be billed to insurance as a standalone treatment or as a component of psychotherapy. Te current standalone code is the same code for biofeedback: 90901. Practitioners may also use mental health codes for sessions that combine NFB with therapy or counseling: 90875 for a 25-minute session and 90876 for a 50-minute session. Trese Category I codes (Criteria for CPT® Category I and Category III Codes, 2017) must satisfy all of the following criteria:

- All devices and drugs necessary for performance of the procedure of service have received FDA clearance or approval when such is required for performance of the procedure or service.
- Te procedure or service is performed by many physicians or other qualifed health care professionals across the United States.
- Te procedure or service is performed with frequency consistent with the intended clinical use.
- Te procedure or service is consistent with current medical practice.
- Te clinical efcacy of the procedure or service is documented in literature that meets the requirements set forth in the CPT code-change application.

Several insurance companies reimburse NFB CPT codes, others may be restrictive based on associated diagnostic codes, and still others may evaluate reimbursement on a case-by-case basis.

Currently, NFB is mandated to be ofered at all Veterans Administration (VA) centers as part of their Whole Health Initiative – a veteran-directed wellness program. More than 26 VA hospitals and major medical centers ofer NFB onsite. NFB is covered in at least 12 states by various insurance plans including Carefrst, Tricare, United Health, Aetna, Cigna, and Kaiser Positive Choice, to name a few. Additionally, in several states NFB is reimbursable by Medicaid. T ese examples prove that scaled uptake is possible.

According to recent proprietary research by ISNR as part of a CPT code application, in 2019 there were an estimated 18,000 biofeedback practitioners nationwide, up to 6,000 of whom are NFB providers based on data from the U.S. Department of Labor's Bureau of Labor Statistics and on estimates from companies which provide training, equipment, and/or sofware to providers. Tis represents an increase of 20% since 2017.

In several states, insurance companies and Medicaid plans cover NFB as a treatment, while in others, coverage depends on case-by-case approval. Currently, dozens of hospitals and medical centers, including many VA hospitals, ofer or cover NFB as a standard treatment.

## The time has come for NFB to be a standard ofering in treating ADHD and other anxiety-related conditions.

Te trend is moving toward a broader inclusion of NFB in the behavioral health and brain ftness treatment toolboxes. Currently, the possibility of a unique CPT code for NFB (not just biofeedback more broadly) is being explored; and recently, the American Psychological Association recognized biofeedback, including EEG NFB, as a professional psychology (American Psychological Association, 2019). Tese steps should further pave the way for the acceptance of NFB as a primary treatment option for ADHD and other conditions and symptoms. Te time has come for NFB to be a standard ofering in treating ADHD and other anxiety-related conditions, both as a frst-line and adjunct treatment. NFB studies only underscore this point.

However, despite increases in trained practitioners and NFB adoption, and the fact that NFB is proven efcacious for behavioral health disorders and has CPT codes, NFB is not consistently reimbursed by insurance companies. Many insurance companies are out of compliance with the MHPAEA, which requires group health plans with mental health and substance use disorder benefts to ofer equal coverage for these disorders as they do for medical/surgical benefts (CMS.gov, n.d.). Te lack of industry adoption of this federal law is leading to increased medical costs and the exacerbation of behavioral health issues across the country. Te 2019 Milliman Research Report, *Addiction and mental health vs. physical health: Widening disparities in network use and provider reimbursement* (Melek et al., 2019), found huge disparities in in-network coverage for behavioral health treatment versus surgical and medical treatment. From 2013 to 2017, out-of-network use for behavioral health increased 85% relative to medical health.

Additionally, across the U.S., reimbursement rates for primary care visits were 30-50% higher than those for behavioral health visits, and behavioral health visits for children were 10 times more likely to be out-of-network than primary care visits. Te researchers also noted that these disparities are only for claims, and do not include data on consumers who did not seek or receive treatment due to inaccessibility or lack of afordability. Te net efect is that while behavioral health issues, including ADHD and anxiety, are increasing, insurance companies may not be covering efcacious treatments in line with the MHPAEA. Tis results in reduced access to intervention options because of network availability and prohibitive costs, and therefore lower rates of treatment for said conditions. When behavioral health conditions are not adequately addressed through the medical/insurance system, they will likely continue to rise in numbers, and for some patients, the severity of the condition will worsen, translating to even greater future costs to address the crisis.

Beyond the impetus to provide equal access to and coverage of behavioral health interventions such as NFB, insurance providers may want to more seriously consider MHPAEA compliance. In July 2020, the Illinois Department of Insurance fned fve major insurance companies for violating the 2008 MHPAEA. CIGNA Healthcare of IL, United Healthcare, CIGNA Health and Life, Health Care Service Corporation (Blue Cross Blue Shield of Illinois), and Celtic were fned more than \$2 million for violations of the MHPAEA. In a press release announcing the disciplinary action, the Kennedy Forum also stated, "Parity enforcement is more critical than ever as Americans grapple with COVID-19 and subsequent economic and social turmoil, which are already contributing to increasing rates of anxiety and depression across the country. Additionally, new data recently released by the CDC show that drug deaths in America hit record

numbers in 2019 and are steadily rising" (Kennedy Forum, 2020). More recently, in November 2020, a federal court ruled that United Behavioral Health was out of compliance with the Employee Retirement Income Security Act of 1974 (ERISA) and ordered the reprocessing of nearly 67,000 behavioral health and substance use related claims (Psych Appeal, 2020).

Including in-network reimbursement of NFB treatment for ADHD and anxiety-related symptoms would be adding a non-invasive, relatively inexpensive, efcacious and efective intervention to the set of available treatments for children and adults with behavioral health disorders. Greater coverage of NFB would also support the intent of the MHPAEA parity law – ensuring that more children and families have access to adequate care.

#### MEETING MAINSTREAM INTEREST IN NFB

Interest and research in NFB as an intervention continue to grow. According to a recent report, the search volume of scientifc papers on NFB has skyrocketed. A PubMed search shows that using the search term "neurofeedback" results in 850% more journal papers published on the topic from just a decade ago (Sorger et al., 2019).

Additionally, personal development and human performance markets are driving increased interest and improvements in consumer NFB technology. As seen from search data, the number of publications available on the web when searching for "neurofeedback" or "EEG biofeedback" has been increasing exponentially (see Figure 4).



Ali, Y., Mahmud, N. A., & Samaneh, R. (2015). Current advances in neurofeedback techniques for the treatment of ADHD. *Biomed. Pharma*. J, 8, 65-177



As research and interest continue to grow, greater familiarity will likely instill increased curiosity in both patients and consumers. While the focus of this paper is strictly on evidence-based treatments by certifed professionals for behavioral health conditions, signifcant increase in NFB use for various cognitive and physical increases in personal performance cannot be denied. It is reasonable to conclude that the increased interest in the consumer market will only support increased demand in the medical feld. Te greatest opportunity for rapid adoption of NFB as an efective treatment depends on practitioner awareness and confdence. As doctors and therapists understand the intervention's efcacy and evidence-base, NFB can take its rightful place as a best-inclass practice for ADHD and other mental and behavioral health disorders.

One of the obstacles in explaining NFB is its complexity. A multitude of brainwaves, electrodes, feedback loops and protocols present a challenge in trying to briefy and succinctly describe its mechanism of action and outcomes. NFB is more complicated than, say, taking a pill. It is more akin to psychotherapy, which employs various protocols to treat diferent causes and conditions, and relies on skilled and experienced therapists as well as positive patientpractitioner relationships to be most effective. In this way, explaining NFB is similar to answering the question: what exactly is psychotherapy and how does it work? Te answer is nuanced, yet once familiar with the essential inner workings of NFB (or with therapy), the practice makes more sense; and NFB undoubtedly holds the potential to become as mainstream as talk therapy.

Te remainder of this paper ofers the reader an opportunity to cultivate a more comprehensive understanding of NFB's inner workings. Even more specifc details about NFB are available in Appendices A-E, which include: What Are Brainwaves?; EEG Electrodes; Brain Regions and Functions; Quantitative and Statistical NFB Measures; and, NFB Treatment Protocols for ADHD and other Conditions. What follows now is a look at how and why NFB works, neuroplasticity and operant conditioning, risks and sham claims, and considerations for how to safely and efectively choose a practitioner.



## Details on How NFB Works

s outlined earlier in this report, NFB is the technology of measuring brainwaves, creating feedback loops with the data, and incentivizing modulation towards healthier brain states and brain regulation. To understand the hows and whys of NFB, a closer and more detailed look is required.

On the conceptual level, the reason why NFB works is neuroplasticity – the ability of the brain to change itself, and in the case of NFB, with specifc, targeted feedback. To understand the basics of how this happens, we need to consider two key functions: reward mechanisms and operant conditioning. Moving into the application level, understanding how NFB "reads" or measures brainwaves requires an overview of brainwaves (see Appendix A) and of electrode sensors, including where they are mounted on the head, and what they are measuring and why (see Appendix B). A level deeper takes us into the diferent lobes of the brain and their correlated behaviors and emotions (see Appendix C). To understand how brainwave data is evaluated and used for feedback, a cursory overview of various analysis techniques is needed (see Appendix D). Fundamentally, brainwave data is analyzed quantitatively as measurements of the aspects of the brainwave signal, such as amplitude, the strength of the brainwave, or as derivative of quantitative data that allows other brain modeling and comparisons to normative databases. Some investigation and learning is required to fully understand how NFB measures brainwaves and uses the data.

Once familiarity with the operation of NFB has been established, a broad summary of which treatment protocols are used for diferent conditions can be considered (see Appendix E). Tis is part of the complexity of NFB as it is not a one-size-fts all treatment. Much in the same way therapy uses diferent modalities or medication uses diferent doses or combinations of medication depending on symptoms and treatment goals, NFB also has diferent treatment protocols. For example, anxiety-related treatments tend to modulate alpha waves, while ADHD treatments ofen seek to adjust the relationship between theta and beta waves. Proper protocols for treating ADHD and stress- and adjustment-related symptoms have been derived from research studies that show efcacy.

Equipment is another consideration. Bona fde professional-level equipment must meet certain standards and capabilities and be FDA-cleared; and it requires the practitioner to have a minimum level of training.

In addition to practitioners needing professional-level application skills – including using electrodes and NFB equipment, and interpreting brainwave data – they should also have skilled capacity to solicit and interpret patient feedback and interact with patients in a therapeutic way as part of the treatment. All together, the combination of technical and therapeutic skills provides key feedback that enables the practitioner to adjust protocols with profeiency and towards greater efectiveness, as with other behavioral health treatments.

NFB is similar to therapy, with varying evidence-based modalities, a number of infuences in determining treatment, and the requirement of a skilled and trained practitioner.

Each of these variables is important, and a basic overview is essential to understand more specifcally how and why NFB works. While at frst glance this may seem complex, it is important to remember how, in many ways, NFB is similar to therapy, with varying evidence-based modalities, a number of infuences in determining treatment, and the requirement of a skilled and trained practitioner to be efective. Taking a look at these key pieces, one at a time, will support a fuller picture of the intervention.

### NFB FOUNDATIONS: NEUROPLASTICITY AND OPERANT CONDITIONING

Self-neuromodulation is the brain's ability to train itself, in this case through NFB, to reach a desired brain state. Trough NFB, a shif in brainwaves and brain regulation occurs, in part as a result of 1) the patient's awareness of the desired brain/brainwave state, and 2) the real-time changes that are happening in the patient's brainwave activity, all through feedback derived from the EEG NFB technology.

NFB is a powerful intervention because it brings to bear self-awareness components that have been found to increase positive outcomes. Te patient's awareness of brain states, awareness of optimal goals or at least directional goals, and awareness of what is happening during the process are the foundation of NFB efects on positive neuromodulation. In addition, NFB as a system works through a behavioral change paradigm commonly known as operant conditioning.

Operant conditioning occurs when specifc events that create positive or negative rewards are connected to ongoing behaviors such that the frequency of certain targeted behaviors/brainwaves are modifed. In the case of NFB, a rewarding event is typically a visual and/ or auditory experience, such as a movie, music and/or video game, that serve to help reinforce the occurrence of specifc aspects of brainwave activity. As EEG readings from specifc brain regions indicate shifs towards target values, the rewarding events are enhanced to encourage the presence of desirable brain function characteristics. In other words, as brainwaves shif towards target frequencies, the brain is rewarded with pleasurable stimuli. Repeated reward stimulus leads to healthier brainwave states that, over time, replace dysregulated brainwave states. Te process of providing a stimulus, measuring the efect in terms of targeted brainwave activity, and modifying the reinforcing stimulus to optimize these brainwaves is an example of operant conditioning. Te use of operant conditioning has a long and well-documented history of efectiveness in many aspects of infuencing and shifing animal and human behavior; and a growing body of literature supports the efective utilization of operant

conditioning principles to train neural responses.

As a very simplistic example, imagine trying to house train a puppy. When the puppy has undesirable behavior, it gets undesirable consequences – lack of praise and being quickly ushered outside. Conversely, when it sits by the door and waits to go outside, it gets desirable feedback in the form of attention and usually food. Over time, the positive feedback wins out, and the new behavior becomes the norm. Similarly, NFB uses feedback methods for incentivizing brain modulation such as watching a movie. In this example, as brainwaves approach a desired state, the movie gets brighter and set to the right volume; as the brainwaves drif away from the desired state, the movie gets dimmer and quieter. Te changes either positively or negatively reward the brain for shifing states/brainwaves, which creates a learning experience for the brain that over time trends toward healthier brainwave states. Te patient is not consciously redirecting brainwaves; this is an automatic action in the brain, much in the same way desiring to pick up a cup causes the arm to reach out and clasp it.

## Repeated modulation towards the goal produces lasting changes in brain ftness and function, which, in turn, lead to lasting improvements in mental and behavioral states.

EEG is an instant measure of brain activity; there is no time delay for confrmation indicators. Terefore, when participants' brains are successful at modulating brainwaves towards a goal, they promptly get a reward in the form of a visual or auditory stimulus. Tis "cookie for the brain" gives a hit of dopamine (Sulzer et al., 2013), a win not unlike "winning" a video game or hitting the bull's-eye with a dart. Te brain likes this form of reward, and the whole system-the participants, their intentions, the neurological and neurochemical brain activity - is incentivized and trained to repeat the efort in anticipation of another reward. Over time, and with practitioner adjustments based not only on quantitative brainwave data but also qualitative participant self-reports, the brain is conditioned into a new state. Repeated modulation towards the goal produces lasting changes in brain ftness and function, which, in turn, lead to lasting improvements in mental and behavioral states.

Tese shifs in brainwaves and improvements in brain regulation are occurring within the context of neuroplasticity – the fact that a human brain can reprogram itself, modify its own neural hardware, modulate brainwaves, and create sustained neural changes. In this case, neuroplasticity is being harnessed by NFB to guide the brain and person towards regulation and improvements in behavior and well-being. Te mechanism of action and target outcomes can be described by operant conditioning. Consequently, repeated treatments result in lasting brain states, and improvements in behavioral and mental health.

### PRACTICE AND PRACTITIONER ARE EQUALLY IMPORTANT

While the technology of NFB efectively modulates brainwaves towards regulation to positively infuence behavioral and mental health, the application of NFB also has human components, including:

- 1. Te patient, who voluntarily engages in the intervention and remains conscious as the brain learns to modulate brainwaves, self-reporting any changes in symptoms or condition (in the case of young children, parents or teachers may observe and report instead of the child); and
- 2. Te practitioner, who is proferent in the use of EEG technology, an expert in protocol selection, adept at understanding brainwaves and their implications in mental and behavioral health, and has the skills needed to interact with the patient.

For these reasons, NFB cannot be viewed as an external application, like a medication that works independently without a patient's (or practitioner's) engaged participation. At least not for the efective treatment of ADHD and symptoms of anxiety.

To this point, while the efcacy and efectiveness of NFB can be compared to medication, the mechanism of action is diferent. NFB is not the same as taking a pill to stimulate a chemical change in the brain without the conscious participation of the patient. NFB is not an external treatment that operates independent of patient and practitioner. As alluded to earlier, NFB is more akin to CBT, where the frst step is a professional intake and assessment of state or condition, followed by diagnosis, a treatment plan with target state or goal(s) identifed, best practices and protocols selected, applied, monitored and modifed, and all with patient awareness and interaction.

## To be efective, researched and efcacious protocols must be applied by trained practitioners on certifed equipment.

Where NFB is similar to medication (and further analogous to CBT), is in that the practitioner and patient work together, cooperatively, according to the treatment plan, toward the goal. In this process, the practitioner observes quantitative and qualitative indicators, using feedback to manage and/or adjust the treatment plan toward optimal efectiveness. Te NFB techniques and protocols used depend on the underlying condition or symptoms, and are determined by the experience and recommendations of the practitioner. It could take up to fve sessions, for example, for the patient, their brain, the computer system/ equipment, and clinician to reach an optimized treatment application. Progress would be continuously monitored to ensure that treatment is efectively enabling the patient to improve through operant conditioning, neuroplasticity and neuromodulation. Improvements would be tracked through assessment and self-report, and treatment modifed as needed towards optimal settings that bring positive results for the patient. To be efective, researched and efcacious protocols must be applied by trained practitioners on certifed equipment.

Tis interdependent system of EEG, patient, and practitioner works to shif brainwave activity toward a healthier or more regulated state. Over a course of sessions, the patient indicates, through evaluation or selfreport, whether they are seeing progress toward goals as indicated by abilities, symptoms or other markers. In time, operant conditioning and neuroplasticity afect signifcant improvements in condition, and in neural structures, which is why the intervention has the potential to be long-lasting even afer treatment ends.

In a professional setting, the practitioner will likely conduct a brain map or some other qEEG evaluation as a baseline to guide treatment and progress, and to identify areas of greater or lesser activity in the brain compared to a normative database or a research-validated theoretical model. Normative data or theoretical models are used as a starting point for treatment and identifying target brainwave activity, not as a determinant of specifc brainwave outcomes. Te practitioner begins the treatment based on evidence and best-practices, engages with the patient to get feedback in various behavioral and emotional measures, and adjusts the treatment accordingly to achieve optimal changes in behavioral health beyond specifc brainwave ratios. Again, this is not unlike the use of pharmacological medications that are prescribed based on normative and typical symptoms, tested for a period with patient feedback, and adjusted or changed until optimal dosage and ongoing outcomes are achieved.

### WHAT IS BONA FIDE NFB?

Similar to CBT or Eye Movement Desensitization and Reprocessing (EMDR) therapy, NFB training is currently not standard coursework for a psychologist or psychiatrist's academic degree, so some post-degree level of training is recommended to ensure professional use. Te American Psychological Association's recent recognition of biofeedback and psychophysiology as profciencies in professional psychology (American Psychological Association, 2019) validate a move towards a potential standard.

Further, organizations such as the Biofeedback Certifcation International Alliance (BCIA) ofer robust certifcation programs (Biofeedback Certifcation International Alliance, 2020); and other organizations, such as ISNR, publish a code of ethics that outlines qualifcation recommendations for professional NFB practitioners including, "members who treat medical or psychological conditions must demonstrate professional competence and relevant licensure as defined by applicable local, state, and national licensing/credentialing laws" (International Society for Neuroregulation and Research [ISNR], 2020a). ISNR also hosts a member directory of licensed, certifed practitioners (ISNR, 2020b). Te AAPB publishes a Code of Ethics and Standards for Performing Biofeedback (Association of Applied Psychophysiology and Biofeedback, 2020), as well as a menu of references and resources for certification, equipment, insurance, practitioners, and so forth.

Te FDA considers any professional EEG NFB or biofeedback equipment to be a medical device, and therefore may only be sold to authorized dealers or licensed/certifed practitioners. Tose seeking NFB treatment for ADHD or other stress- and adjustmentrelated symptoms should use the above listed association resources as a starting point for fnding a qualifed practitioner. As a safety threshold, a bona fde NFB practitioner would be a licensed clinician or therapist and have NFB certification from BCIA.

### NFB TREATMENT HAS MINIMAL SIDE EFFECTS AND RISKS

NFB's side efects are minimal when administered by a certifed professional. Tere are no known long-term risks or side efects associated with proper, certifed NFB treatment. However, below are limited considerations related to transient side efects.

Typical possible transient side efects that any BCIAcertifed practitioner would be aware of are headache and tiredness. Any side efects are best dealt with by adjusting protocol, or in the rare case, discontinuing treatment if a better solution is not available. Similarly, side efects or unintended efects occurring from, say, a Selective Serotonin Reuptake Inhibitor known as SSRI medication (a common type of antidepressants) prescribed by a psychiatrist, or hypertension medicine prescribed by a cardiologist would prompt a change in dosage or protocol in an efort to achieve similar or better positive results without negative outcomes. Adjusting treatment in response to side efects is not unique to NFB, and should be practiced with any treatment by any medical practitioner as a basic clinical skill.

A fair amount of research has been done to evaluate potential side efects from NFB, both applied correctly and potentially incorrectly. For example, to evaluate the potential risks of NFB treatment protocols that modulate SMR brainwaves (typical for ADHD) and upper alpha brainwaves (typical for relaxation), a 2015 study was conducted outside standard NFB protocols on subjects by increasing the amplitude of said waves beyond the norm (Rogel et al., 2015). In other words, this test procedure increased the "dose" to be signifcantly greater than the prescribed protocol. After 10 sessions, twice a week for 5 weeks, the most commonly reported adverse efects were headaches, followed by tiredness, mood swings, as well as feeling high. A few subjects had nightmares, eye aches or nausea. All of these efects were transient, dissipating quickly following the end of the exaggerated treatment.

As with any medical or therapeutic modality, improper NFB application or provider negligence can lead to ill efects or even harm. Similarly, medical mistakes such as wrongly prescribing medication or botching a surgery can also cause harm. However, unlike ingesting the wrong medication or undergoing an incorrect surgery, with NFB, the risks of potential mistakes are typically mild, such as headaches and tiredness, and transient, passing quickly. Tese ill efects are also quickly detectable and protocols can be easily modifed to address them.

In summary, the side efects or risks involved with NFB treatment administered by a trained and competent provider can be considered to be extremely low, especially compared to the risks associated with other medical interventions and procedures.

### NFB: SHAM OR THE REAL DEAL?

Over NFB's seven decades of research, just like all standard treatments, there have been some studies that have indicated a lack of efcacy. Several of the studies that initially reported no diference between NFB and sham treatments have since been shown to have design faws or to lack evidence of an absence of efect. In some other studies, researchers who once concluded NFB's inefcacy have in more recent years published new fndings underscoring its value as a treatment intervention. Based on the full review of evidence, this report concludes that there is sufcient evidence that reinforces NFB's efcacy. Below is a closer look at the top reservations some researchers have had about NFB and why a deeper dive into these concerns still show NFB to be a viable treatment.

Despite empirical evidence to the contrary, some critics of NFB are concerned that research fndings are problematic. Tis concern has grown largely out of the fact that NFB research does not include any large-scale studies. Tere are, however, hundreds of smaller studies that show efcacy. Additionally, since 2018, two distinct meta-analyses – regarded as a higher level of evidence than single studies or large trials by clinical associations such as the American Medical Association – found NFB to be an efective treatment for ADHD, and further to have sustained efects afer treatment has ended (Van Doren et al., 2018; Arns et al, 2020).

Some of the researchers in the feld who, 10 to 15 years ago, were skeptical or even critical of NFB as a frst-line treatment (Loo & Makeig, 2012), have now co-authored a paper in support of NFB as a treatment for ADHD. Te recent publication supports NFB as a valid treatment ofering long-term improvements as it states, "Compared to non-active control treatments, [NFB] appears to have more durable treatment efects, for at least 6 months following treatment" (Van Doren et al., 2018).

Further, attempts to discredit NFB as an efective treatment for ADHD or other disorders have typically tried to apply one protocol for all conditions and patients. Tis is an invalid approach, as a key requirement for efective NFB treatment is adjusting protocols to the individual, much in the same way that medication dosage would be adjusted to the individual.

Some skepticism is related to the subjective nature of evaluating treatment outcomes for ADHD. Symptoms and outcomes of children's ADHD-related behavior are most frequently evaluated by parents and teachers, and therefore not evaluated using blinded study measures. In other words, during some of the studies, the parents or teachers reporting on improvements may know that their child is receiving NFB, which has the potential to bias their impression of any improvement in outcomes. As such, an argument against NFB's positive research outcomes would state that because the parents knew the children were receiving NFB treatment, they could have falsely perceived improvements. Tis could be grounds to consider whether or not parent-reported outcomes were real or a form of placebo efect.

In subjective reports about improvements, these biases are possible. However, many NFB studies have sought to eliminate the possibilities of "false readings" by implementing objective measurement tools and behavioral rating scales such as TOVA, IVA, and other computerized performance measures normed on age. TOVA is a continuous performance test that measures how a subject tracks visual stimuli – both target and non-target stimuli –



and produces a quantitative, objective report on levels of inattention, impulsivity and hyperactivity. A 2015 study found, using TOVA scores, that a combination of NFB and medication was more effective than either one alone, and that NFB alone improved executive control more than medication (González-Castro et al., 2015).

Te efcacy of NFB as validated by objective measures goes back to the work of NFB pioneer Dr. Joel Lubar, who used TOVA scores in his research on NFB for the treatment of ADHD (Lubar et al., 1995). Similarly, another early study found no signifcant diference between NFB and Ritalin in treating ADHD as measured by TOVA scores (Rossiter & La Vaque, 1995). More importantly, the same, potentially biased, subjective, parent and teacher reports on improvements in children's ADHD symptoms are also used to measure outcomes for treatment with medication, therapy and other interventions. In fact, due to the social nature of childhood ADHD, parent and teacher observations are critical for monitoring progress, regardless of treatment modality.

Critics would also like to see a single oversight body as well as universal certification required for all NFB practitioners. Board certification is available from BCIA, but practitioners are not required to carry this credential. As such, a universal "stamp of validation" is yet to be defined for the feld, and this frustrates some. Such a development for the feld may in fact be a good step, but the current absence of it does not diminish the strength of NFB research outcomes. Rather, trained NFB practitioners are similar to generally trained mental health therapists with post-degree specialized training for a specific treatment modality, one that may or may not have a central certifying body or national licensure. Critics have also taken issue with the lack of a single protocol per condition in NFB. As with other treatments, recommendations for protocols come from clinical studies and can be varied and demonstrate efcacy. Similarly in CBT, a therapist may select from multiple efective protocols when administering or adjusting a treatment plan based on how an individual is presenting and/or responding to an intervention. Tis report fnds multiple, evidence-based protocols a positive aspect of NFB treatment, as practitioners and patients have access to a range of proven treatment protocols that can be used to optimize individual treatment plans.

NFB has been subject to specifc types of research studies designed to attempt to disprove the efcacy of a treatment for various conditions, known as sham studies. While some of these studies have sought to discredit NFB as placebo or sham, a more thorough review of the sham research revealed design faws and failure to prove evidence of an absence of efect. More specifcally, some of the sham studies lef out key parts of standard treatment protocols or proved that NFB is indeed more efective than placebo.

For example, a 2018 review analyzed six sham-controlled NFB trials that reported no evidence of efect from NFB (Pigott et al., 2018). Upon review, it was determined that in each of the six trials, the methods used prevented participants from getting accurate reward feedback that would allow them to self-neuromodulate through operant conditioning. As described earlier, operant conditioning is the process of learning through feedback or consequence. For NFB, accurate reward feedback for an intended brain state is a necessary and required component for efective "learning" and treatment. In other words, the sham studies conducted a form of NFB outside of the protocols that have been shown to work. Tis would be analogous to administering medication outside of dose and prescription guidelines.

In the six studies reviewed, rather than accurate, real-time reward feedback as part of the treatment protocol, the NFB system was adjusted every 15 to 30 seconds to give positive reward feedback up to 80% of the time to participants, regardless of performance. Because clear and accurate feedback loops and reward systems are key components of any NFB protocol, a treatment that automatically adjusts rewards upwards would not be considered an accurate application of NFB. In fact, one of the forefathers of NFB for ADHD, Dr. Joel Lubar, was a proponent of lower reward levels for efective NFB treatment as a way to more powerfully rely on operant conditioning to incentivize reward-based neuromodulation.

A more recent study concluding no specifc efect of thetabeta ratio (TBR) protocol on ADHD (Arnold et al., 2020) was shown to include a Type III error, or "false no-efect" error (Trullinger et al., 2019). Tis type of error occurs when a faw in the study's control group design renders the results inconclusive. In this particular study, the authors found that NFB treatment did not difer substantially from the control group treatment. However, the control group in this study actually showed a substantial improvement in ADHD symptoms comparable to improvements seen by combined medication and behavioral treatment in previous studies. In other words, the control group was a fully active treatment, comparable to medication and behavioral therapy, not an inactive or inert treatment. In this study, then, NFB was found to be not substantially diferent in its efects as compared to a fully active treatment for ADHD. Tis means that the authors found a "false no-efect," as the design of the control group did not allow them to truly determine that NFB was inefective.

By comparison, the volume of published research that shows efcacy for NFB as a treatment, particularly for ADHD, eclipses the few sham studies that exist (Perl & Perl, 2019). Te discrepancies inevitably come down to study design. In cases where proper protocols and application are followed, a significant degree of efectiveness results.

NFB has at times been over-championed by proponents who let their enthusiasm trump research and who have made exaggerated treatment claims, triggering some of the sham studies previously mentioned and seeding doubt about the treatment modality. However, time and time again, valid research studies show that NFB applied by certifed medical or mental health practitioners within defned protocols and standards, over a period of time, is highly efcacious at treating ADHD and effective at treating other stress- and adjustment-related disorders.

## Recommendations

ven with a strong evidence-base, NFB is still not fully adopted as a frst-line or adjunct treatment for ADHD and anxiety. Meanwhile, the behavioral health arena remains desperate for effective treatment options as rates of disorders continue to rise. In part, the diversity of NFB techniques and applications, along with the complexity of the intersection of brain science and novel technology, have presented obstacles for easily understanding NFB. However, the medical and mental health felds are obligated to overcome these challenges, as patients deserve and need access to the full range of effactious treatments available today. To help ensure NFB is broadly accessible this report makes the following recommendations:

1

## CONSUMERS AND PATIENTS MAKE THEIR INTEREST IN NFB CLEAR TO PROVIDERS

With growing awareness of neuroplasticity and brain health and ftness, consumers and patients can advocate for medical and psychological practitioners to make NFB part of a broader standard toolkit to address mental health, brain ftness, and well-being. By directing providers to this brief and other NFB resources, including the websites of state, regional, and (inter)national professional associations for NFB and biofeedback, the public can greatly infuence the attention providers pay to this intervention. 2

## PROVIDERS AND PAYERS RECOGNIZE NFB THROUGH TREATMENT OPTIONS AND COVERAGE

Te fastest path to clinical and responsible access is for insurance companies and medical providers to acknowledge NFB as a frst-line or adjunct treatment for patients with ADHD or stress- and adjustment-related symptoms. Tis means taking action toward greater access and afordability through more practitioners ofering/ referring NFB and by more insurance companies covering the treatment. Increasing coverage of NFB would also help in the battle to reduce rates of behavioral health conditions across the population and give insurance companies an opportunity to come into greater compliance with the MHPAEA parity law.

With advances in technology and technique in the feld of NFB, and more rigorous certification available to ensure treatment standards (Biofeedback Certification International Alliance, 2020) there has never been a better time to increase adoption of NFB into the mental and behavioral health treatment paradigms for ADHD and anxiety, and as a treatment for improving brain health and well-being.

Neurofeedback

## Appendices

## Appendix A: What Are Brainwaves?

n NFB, brainwaves are the markers of overall brain activity that indicate regulated or deregulated states of brain ftness or behavioral health. Brainwaves are patterns of neural activity generated by the central nervous system also referred to as neural oscillations. Tese oscillations are electrical pulses that occur as a result of spontaneous nerve cell frings refecting the communication between diferent areas of the brain. Te electrical pulses can be detected by EEG technology, and together with specialized computer analytic sofware, form brainwave activity readings such as frequency and amplitude.

**Frequency** is a count of how ofen a brainwave repeats – how many times a wave completes its pattern in a given period. Frequency is measured in units of Hertz (Hz), which are equal to the number of cycles per second. One cycle per second equals 1 Hz. If a wave has a frequency of 5 Hz, it completes its wave cycle fve times every second.

**Amplitude** is the height of the wave, and can grow taller or shorter, depending on brain activity, without changing frequency. Amplitude can be thought of as volume or intensity. Higher amplitude tends to be "louder," or more easily detected. Changes in amplitude are the primary unit of measurement in quantitative EEG data – how much the intensity of size of a wave has increased or decreased.

Brainwaves are divided up into diferent categories as defned by their frequency ranges and where they occur in particular regions of the brain. How brain regions and brainwaves communicate to other specifc regions can be correlated to specifc types of human perceptions, motor, or thought activity. Te fve primary commonly referred brainwave types (see Figure 5) are: delta, theta, alpha, beta, and gamma. Beyond the fve primary waves, additional, more specifc brainwaves like Sensorimotor Rhythm (SMR), are also used in NFB and neuroscience. A more complete list of brainwaves that may be applicable to specifc NFB treatments can be found in Figure 6.

#### FIGURE 5: BRAINWAVES

Different Types of Brainwaves: Delta, Theta, Alpha, Beta, Gamma : Itsu Sync, Brainwave Entrainment and Binaural Beats. (n.d.). Itsusync.com. https://itsusync.com/different-types-of-brain-waves-delta-theta-alphabeta-gamma-ezp-9





Theta Waves - (4 - 8 Hz)



Alpha Waves - (8 - 13 Hz)



Beta Waves - (13 - 32 Hz)

Gamma Waves - (32 - 100 Hz)



NFB protocols for ADHD or other conditions are precise, and work with specifc brainwaves or sets of brainwaves. For example, theta waves are more present in a dreamy, sleepy, distracted state while beta waves are more present in a focused, alert state. Several efective protocols for treating ADHD involve training the theta/beta ratio (TBR) into states that alleviate dysregulation and reduce ADHD symptoms. Tese TBR protocols typically involve decreasing levels of theta waves in relation to levels of beta waves, or increasing beta in relation to theta. Successful treatment using this type of protocol would decrease inattention and distractibility (lower theta), and increase alertness and focus (higher beta). Achieving this repeatedly over time can result in lasting mental, behavioral, academic, and brain ftness changes. In a diferent approach, treatments for anxiety would employ protocols that target and enhance alpha waves, which are related to relaxation and peacefulness.

To fully understand brainwaves, how they work in the brain, their interdependent relationships and how they correlate to different emotions and behaviors is a deep dive into neuroscience, and beyond the scope of this paper. Tis cursory overview should sufce to ofer a basic understanding of why NFB works with brainwaves. Brainwaves are detected and recorded by EEG, which senses the unique electrical signals of different brainwaves and feeds data into an interface that measures, tracks and informs feedback loops. Te location of EEG sensors on the head, as referenced in Appendix B, is also an important consideration, because similar to how brainwaves correlate to experiential states, the diferent areas of the brain correlate to generalized behaviors and experiences. Taking EEG readings of the correct waves at the correct locations on the head is an important component of efcacious protocols for treatment of ADHD and other conditions.

#### FIGURE 6: COMMON BRAINWAVES

Marzbani, H., Marateb, H., & Mansourian, M. (2016). Methodological Note: Neurofeedback: A Comprehensive Review on System Design, Methodology and Clinical Applications. *Basic and Clinical Neuroscience Journal*, 7(2). https://doi.org/10.15412/j.bcn.03070208

Common brainwave frequency	Frequency range (Hz)	General characteristics Sleep, repair, complex problem solving, unawareness, deep- unconsciousness			
Delta	1-4				
Theta	4-8	Creativity, insight, deep states, unconsciousness, optimeditative state, depression, anxiety, distractibility			
Alpha	8-13	Alertness and peacefulness, readiness, meditation, deep relaxed			
Lower alpha	8-10	Recalling			
Upper alpha	10-13	Optimize cognitive performance			
SMR (sensorimotor rhythm)	13-15	Mental alertness, physical relaxation			
Beta	15-20	Thinking, focusing, sustained attention, tension, alertness, excitement Intensity, hyperalertness, anxiety			
High beta	20-32	Intensity, hyperalertness, anxiety			
Gamma	32-100 or 40	Learning, cognitive processing, problem solving tasks, ment sharpness, brain activity, organize the brain			

## Appendix B: EEG Electrode Placement

s mentioned in the main report, electrodes are sensors placed on the head of a patient to measure brainwaves and help facilitate feedback from NFB devices to the brain regarding targeted brain states. Specifc areas of the skull and face are defined and correspond to specifc brain regions and brainwaves. To label these for EEG-NFB treatment, electrode placement points are depicted with letters and numbers that identify areas of the brain (See Figures 7 and 8).

Te letters F, P, T, O, and C correspond to the frontal, parietal, temporal, occipital, and central areas of the brain. Numbers identify the hemisphere of the brain odd numbers for the lef hemisphere and even numbers for the right. In addition, the subtext z instead of a number indicates a point that is along the central channel between the hemispheres. Te letter A indicates the ear region, used for ground and/or reference electrodes.

As an example, F4 would be a point on the right side of the head over the frontal lobe, P3 would be a point on the lef side of the head over the parietal lobe. A1 and A2 are the lef and right reference areas near or on the ear, and Fz and Pz would be points along the centerline of the skull over the frontal and parietal lobes, respectively.

A treatment protocol would not only indicate which brainwaves to target at what frequencies and amplitude, but also where EEG readings should be taken on the scalp — in other words, the specifc points for mounting electrodes. Depending on the equipment and treatment protocol, NFB practitioners typically connect 2 to 19 electrodes for EEG-NFB. More detailed brain reading EEG applications may use more electrodes.

#### FIGURE 7: LOCATION OF EEG POINTS ON THE HEAD

Sharbrough, F. (1991, January). American Electroencephalographic Society guidelines for standard electrode position nomenclature. *Journal* of Clinical Neurophysiology, 8, 200-202.



### FIGURE 8: LOCATION OF EEG POINTS, SIDE VIEW

Malmivuo, J. & Plonsey, R. (1995). Bioelectromagnetism – Principles and Applications of Bioelectric and Biomagnetic Fields. Oxford University Press. http://www.bem.f/book/13/13.htm



## Appendix C: Brain Regions and Functions

n addition to unique brainwaves correlating to emotional and behavioral characteristics, areas of the brain (or lobes) correspond to diferent human functions and experiences (See Figure 9 and 10). Te following are simplifed ways to describe the lobes of the brain and the primary functions they ofen serve:

- Frontal lobes relate to sustained attention, time management, working memory, executive function, social skills, emotion and empathy.
- Parietal lobes process problem-solving, naming objects, complex language and speech, as well as mathematical processing.
- Temporal lobes are more uniquely divided. Te lef temporal lobe works with reading, learning and memory, and positive mood. Te right temporal lobe processes facial recognition, anxiety, sense of direction and music.
- Occipital lobes hold visual memories and other recall, as well as traumatic experiences and fashbacks, seeing colors, identifying objects, writing, spelling and recognizing familiar environments.
- Te central area of the brain holds the sensorimotor cortex which controls motion and body movements used in playing an instrument, typing, writing, operating machinery, speaking and being aware of one's own physical body.

Tis is by no means a comprehensive description of the brain areas and their functions, but an outline of the essential roles of diferent brain areas. NFB uses neuroscience – the brain function by area, and the behavioral or symptomatic experiences correlated to brainwaves – to develop relevant treatment protocols. Treatment protocols use evidence-based standards to work very specifcally with these brain elements towards efcacious and proven outcomes. Professional NFB treatments are in no way random or imprecise; they are specifc and based on research fndings.

FIGURE 9: PRIMARY BRAIN REGIONS



### FIGURE 10: BRAIN LOBES, EEG SITES AND RELATED FUNCTIONS

Demos, J. N. (2005). Getting started with neurofeedback. WW Norton & Company.

	Sites	Functions	Considerations
Parietal lobes	$P_z P_3 P_4$	LH: Problem solving, math, complex grammar, attention, association	Dyscalculia sense of direction learning disorders
		RH: Spatial awareness, Geometry	
Frontal lobes	$\begin{array}{c} {\sf F}_{{\sf P}_1}{\sf F}_{{\sf P}_2}{\sf F}_{{\sf P}_2}\\ {\sf F}_z{\sf F}_3{\sf F}_4{\sf F}_7{\sf F}_8 \end{array}$	LH: Working memory, concentration, Executive planning, positive emotions RH: Episodic memory, social awareness	LH: Depression RH: Anxiety, fear, executive planning, poor executive functioning
		Fontal poles: attention judgment	
Temporal lobes	$T_{3}T_{4}T_{5}T_{6}$	LH: Word recognition, reading, language, memory	Anger, rage, dyslexia, long-term memory, closed head injury
		RH: Object recognition, music, social cues	
		Facial recognition	
Occipital lobes	$0_{2} 0_{1} 0_{2}$	Visual learning, reading, parietal-temporal- occipital functions	Learning disorders
Sensorimotor cortex	C <sub>z</sub> C <sub>3</sub> C <sub>4</sub>	LH: Attention, mental processing, RH: Calmness, emotion, Empathy Combined: Fine motor skills, manual	Paralysis (stroke), seizure disorder, poor handwriting, ADHD symptoms
		dexterity, sensory and motor integration and processing	
Cingulate gyrus	$\mathbf{F}_{PZ}  \mathbf{F}_{Z}  \mathbf{C}_{Z}  \mathbf{P}_{Z}  \mathbf{O}_{Z}$	Mental fexibility, cooperation, attention, motivation, morals	Obsessions, compulsions, tics, perfectionism, worry, ADHD symptoms, OCD & OCD spectrum
Broca's area	$F_7 T_3$	Verbal expression	Dyslexia, poor spelling, poor reading
Left hemisphere	All odd numbered sites	Logical sequencing, detail oriented, language abilities, word retrieval, fuency, reading, math, science, problem solving, verbal memory	Depression (underactivation)
Right hemisphere	All even numbered sites	Episodic memory encoding, social awareness, eye contact, music, humor, empathy, spatial awareness, art, insight, intuition, non-verbal memory, seeing the whole picture	Anxiety(overactivation)

# Appendix D: Quantitative and Statistical NFB Measures

Due to the complexity of the brain, its diferent regions, diferent brainwaves and what they indicate, several unique protocols could be used for the treatment of the same condition, depending on diagnosis, symptoms, and intended outcomes. As with the treatment of any condition under any modality, the frst steps are evaluation and diagnosis, and then treatment plan and goals, at which point the practitioner, depending on training and approach, would determine the best course of NFB treatment. Initial treatments would be evaluated for effectiveness and adjusted as needed to help the patient approach a healthier status/state or reduction of symptoms.

How brainwave data is analyzed and a treatment is validated depends on the technique for measuring and evaluating EEG output. A variety of methods exist but all fundamentally fall into one of two categories: quantitative or derivative, roughly speaking.

### QUANTITATIVE MEASUREMENTS

Quantitative EEG is the most commonly used measurement and evaluation technique. Tis technique reads amplitude and other measures as a direct measure and indicator of a brainwave's character relative to another reference or location, such as the earlobe, that does not produce electrical activity or relative to other active areas of the brain. As treatment progresses, the quantitative measures – meaning increases or decreases in brainwaves as indicated by these measurements – show progress towards or away from the protocol-defined target values being achieved. Following are some examples of quantitative NFB measures ofen derived and monitored in treatment:

- Sensorimotor Rhythm (SMR) Tis is the idle rhythm for the motor strip in the brain. Typically, as this rhythm increases, a person becomes more relaxed. SMR is a primary measurement/wave in many NFB treatments for ADHD.
- Theta/Beta Ratio (TBR) Tis measurement was created by Dr. Joel Lubar of the University of Tennessee in the 1970s. It measures the relationship between theta waves and beta waves across the frontal and central areas of the brain. A higher ratio is indicative of ADHD, meaning theta waves – associated with dreaming and distraction – are greater relative to beta waves – associated with focus and attention. As beta increases relative to theta, the ratio value goes down. A lower ratio corresponds to reduced symptoms and/or remission of ADHD symptoms, and ofen improvements in behavioral and academic outcomes. In 2013, the FDA approved TBR as a marker for the diagnosis of ADHD as part of the Neuropsychiatric

EEG-Based Assessment Aid for ADHD (NEBA) system. Tis is the only brain-based diagnostic tool for assessing ADHD.

- Slow Cortical Potentials (SCP) Tis is a measurement of low frequency brain activity, usually less than 1 Hz, that is generated primarily by glial cells, a group of non-neuronal cells that maintain balance in brain health and brain activity. SCPs can be used to evaluate and infuence the overall health and functioning of the brain.
- Alpha/Theta Protocol (A/T) Tis protocol was developed by Peniston and Kulkosky and frst used for the treatment of alcoholism in Vietnam veterans. A/T is also used to reduce symptoms of anxiety and PTSD. Te protocol could involve increasing both waves or only alpha waves, depending on the treatment application. Tis protocol can be used for treatment of stress- and adjustment-related symptoms.

#### DERIVATIVE AND STATISTICAL MEASUREMENTS

Other methods of data analysis fall into the category of derivative and statistical measurements. T ese techniques measure multiple variable quantitative outputs and use complex calculations to fnd statistical output readings that can be compared to normative databases or translated into 3D imaging, among other uses. Following are examples of some of the derivative methods:

- **Z-Score Training** Tis is a complex calculation of multiple variable measurements from at least four electrodes that looks at how a brain is functioning compared to a normative database of "healthy" brain behavior. Te treatment can be used to reward the brain toward a healthier state for various conditions.
- LORETA Refers to low-resolution electromagnetic tomography. Tis technique uses EEG frequency measurements to create a 3-dimensional, color-coded image of the brain. Typically, at least 19 electrodes are used to generate enough data to estimate current density in various brain areas. Tis is a brain-mapping technique for visual reference to brain states and changes in brain activity.
- Infra-low Frequency (ILF) and Infra-slow Fluctuation (ISF) – Tese terms refer to very low brain frequencies, below 0.1 Hz only recently detectable and trainable through advances in brainwave amplification technology. Te idea is that the lowest base frequencies in the brain infuence all the frequencies above it. Since the higher frequencies are harmonics of the lower frequencies, by training the low frequencies, the whole brain benefts.
- Multichannel Coherence Tis newer method of measuring and using qEEG data can be thought of as neurofeedback 2.0. Whereas in a typical NFB setup, a single stream of data is processed and used for feedback and rewards, with Mulitchannel (or Multivariate) NFB, two or more data streams are being used to create diferent feedback systems simultaneously. In this way, the research suggests that, during a single session, the brain can be trained in more than one way at the same time (Coben et al., 2018).

## Appendix E: NFB Treatment Protocols for ADHD and Other Conditions

he majority of research that shows successful treatment of ADHD with NFB uses TBR, SMR, or a combination of both. Te tables in Figure 11 show some of the significant studies and include the treatment site on the head, number of sessions, age of children, and outcomes.

#### FIGURE 11: NFB TRAINING PROTOCOLS

Marzbani, H., Marateb, H., & Mansourian, M. (2016). Methodological Note: Neurofeedback: A Comprehensive Review on System Design, Methodology and Clinical Applications. Basic and Clinical Neuroscience Journal, 7(2). https://doi.org/10.15412/j.bcn.03070208

Study	Site of Treatment	NFB Protocol	# of Sessions	Age Range in Years	Outcome
Linden, Habib, & Radojevic, 1996	CZ	Enhance beta Inhibit theta	20	5-15	Improvement in mental functions and accuracy
Palsson et al., 2001	CZ	Theta/beta, SMR	40	9-13	Improvement in effects of ADHD
Orlandi, 2004	CZ	Theta/beta, SMR	40	9-11	Improvement in attention, focus and memory
Lévesque, Beauregard, & Mensour, 2006	CZ	Theta/beta, SMR	40	8-12	Improving performance of anterior cingulate cortex
Leins et al., 2007	CZ	Theta/beta	30	8-13	Improvement in attention, hyperactivity and distraction
Gevensleben et al., 2009	CZ	Theta/beta	18	9-12	Improvement in combined treatment of neurofeedback protocols
Perreau-Linck, Lessard, Lévesque, & Beauregard, 2010	CZ	Theta/SMR	40	8-13	Improvement in the effects of ADHD

## ADHD NFB Training Protocols for Children

Study	Site of Treatment	NFB Protocol	# of Sessions	Outcomes
(Rasey, Lubar, McIntyre, Zoffuto, & Abbott, 1995)	Central-posterior region (CPZ , PCZ)	Enhance beta (16-22 Hz) and inhibit high theta and low alpha	20	Improvement in attentional performance
(Egner & Gruzelier, 2001)	(12-15 Hz) at right central region (C4) and (15-18 Hz) at the left central region (C3)	Enhance low beta (12-15 and 15- 18 Hz), inhibiting theta (4-7 Hz) and high beta (22-30 Hz)	10	Successful enhancement of attentional performance
(Vernon et al., 2003)	CZ	Enhance low beta (12-15 Hz), inhibiting theta (4-8 Hz) and high beta (18-23 Hz)	15	Enhance cognitive performance
(Egner & Gruzelier, 2001)	CZ	Enhance SMR (12-15 Hz) and inhibit theta (4-7 Hz) and high beta (22-30 Hz)	10	Improve perceptual sensitivity
(Egner & Gruzelier, 2001)	CZ	Enhance low beta (15-18 Hz), inhibiting theta (4-7 Hz) and high beta (22-30 Hz)	10	Increase cortical arousal
(Vernon et al., 2003)	CZ	Enhance SMR (12-15 Hz) and inhibit theta (4-7 Hz) and high beta (18-22 Hz)	8	Increased recall in semantic working memory
(Lubar, Swartwood, Swart- wood, & O'Donnell, 1995)	FCZ , CPZ	Enhance beta (16-20 Hz) and inhibit theta	40	Reduction of inattention, hyperactivity and impulsivity
(Fuchs, Birbaumer, Lutzen- berger, Gruzelier, & Kaiser, 2003)	C3, C4	Enhance beta (15-18 Hz) and SMR (12-15), inhibit theta	36	Improvement in attention and intelligence
(Heinrich, Gevensleben, & Strehl, 2007)	C4, CZ	Enhance SMR and inhibit theta		Treatment epilepsy disorder and ADHD
(Heinrich, Gevensleben, & Strehl, 2007)	CZ, C3	Enhance beta (13-20 Hz) and inhibit theta		Treatment ADHD

Beta Training Protocols for Various Cognitive Performance Improvements

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## **BRAINFUTURES**

B rainFutures was launched in 2015 by the nation s second oldest mental health advocacy organization, the Mental Health Association of Maryland (MHAMD). For more than 100 years, MHAMD has addressed the mental health needs of Marylanders of all ages through programs that educate the public, advance public policy, and monitor the quality of mental healthcare services. Building on this success, and bolstered by a cross disciplinary advisory board of leading experts, BrainFutures brings together diverse stakeholders, policymakers, funders, and infuencers to accelerate and scaffold national adoption of effective practices targeting four main areas: youth, workforce, mental health treatment, and older adults. Breakthroughs in our understanding of the brain have the potential to improve learning outcomes for children, optimize functioning at work, enhance treatment for mental health or substance use problems, and maintain sharp thinking as we age.

BrainFutures writes evidence based issue briefs and releases recommendations that fll knowledge gaps related to brain focused applications targeting the above segments of society. These educational resources highlight the latest advances in brain plasticity and how their application is transforming quality of life for people of all ages. Through this process, we not only gain insight from experts and innovators, we also foster support for change, building coalitions and cross disciplinary collaborations to advance both adoption and access to new breakthrough applications. Ultimately, by informing the public, cultivating infuential relationships, and connecting communities of diverse advocates we help propel the change that is needed to make meaningful progress.

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