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Aim and Scope

NeuroRegulation is a peer-reviewed journal providing an integrated, multidisciplinary perspective on clinically relevant research, treatment, and public policy for neurofeedback, neuroregulation, and neurotherapy. The journal reviews important findings in clinical neurotherapy, biofeedback, and electroencephalography for use in assessing baselines and outcomes of various procedures. The journal draws from expertise inside and outside of the International Society for Neuroregulation and Research to deliver material which integrates the diverse aspects of the field. Instructions for submissions and Author Guidelines can be found on the journal website (http://www.neuroregulation.org).

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Therapists' Experiences With Integrating Neurofeedback Into Therapy for Complex/Developmental Trauma

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Abstract

Introduction. Trauma has been found to have a significant impact on the brain, particularly when it occurs during developmental years. Some studies have found neurofeedback to be effective for treating symptoms of complex/developmental trauma. There is minimal guidance on integrating neurofeedback into therapy with this population. In this qualitative study, the researcher used interpretative phenomenological analysis to gain an understanding of trauma therapists' experiences with integrating neurofeedback into their clinical work with complex/developmental trauma and how this impacts the therapeutic relationship. **Methods**. Sixteen mental health professionals who self-identified as specializing in complex/developmental trauma and used neurofeedback as part of their therapeutic approach participated in this study. Data collection consisted of a demographic survey and semistructured interviews. **Results**. Analysis revealed five superordinate themes: the process of learning neurofeedback; integrating neurofeedback into trauma therapy; grounded in neuroscience and focused on context; building awareness; and shift in dynamics. **Conclusion**. The results of this study offer practical suggestions for getting started with neurofeedback and integrating it into trauma therapy. Additionally, special considerations when practicing neurofeedback with complex/developmental trauma were identified, including shifts in the therapeutic relationship that occur with the addition of this modality.

Keywords: trauma; complex; developmental; neurofeedback; therapy

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Background

Trauma has been found to have a significant impact on the brain. This is particularly true when trauma occurs during developmental years (Thomason & Marusak, 2017). Due to the increasing body of research demonstrating these impacts, neuroscience-informed approaches have been encouraged when working with trauma survivors in a mental health context (Ross et al., 2017). One approach that more directly addresses the functioning of the brain is neurofeedback, also known as electroencephalogram (EEG) biofeedback. Neurofeedback is a noninvasive training process that uses aspects of classical and operant conditioning to help individuals shift patterns within their brains. Frequency/power neurofeedback, the most commonly used type of neurofeedback and the primary modality explored in this study, focuses on training individuals to increase and/or decrease brainwave frequencies in different parts of the brain (Marzbani et al., 2016). Clinicians conduct initial and ongoing assessments using a combination of objective and subjective data to develop individualized training protocols (Thompson & Thompson, 2016).

Although neurofeedback can be beneficial, if it is practiced by someone lacking appropriate training there is a potential for harm (Hammond et al., 2011). This is especially important to be aware of when using neurofeedback in specialized areas such as trauma therapy, since additional training and experience is necessary to work with this population (Hamlin, 2018). For example, Demos (2019) cautioned that some individuals may experience relaxation-induced anxiety when engaging in neurofeedback training that induces relaxation and emphasized that trauma survivors may be especially impacted by this.

Trauma is an overwhelming experience that can have a lasting impact on an individual's functioning (van der Kolk, 2014). When trauma is repeated or occurs over an extended period of time, the impact can be more complex (e.g., Herman, 1992; International Society for Traumatic Stress Studies [ISTSS] Guidelines Committee, 2018). Two terms commonly used to refer to prolonged or repeated trauma are *complex trauma* and *developmental trauma*.

Complex trauma is a term used to describe both a type of trauma and a symptom profile, and the definition varies between sources (Van Neiuwenhove & Meganck, 2019). For example, the diagnosis of complex posttraumatic stress disorder (CPTSD) included in the International Classification of Diseases (ICD-11) focuses on symptomology instead of type of trauma (World Health Organization [WHO], 2019), whereas several sources define complex trauma as prolonged and repeated traumatic experiences (e.g., Cloitre et al., 2011; Herman, 1992; van der Kolk, 2014). Developmental trauma overlaps with complex trauma and is used to refer to prolonged or repeated interpersonal trauma that occurs during critical periods of development (van der Kolk, 2005). Attachment rupture is a key component of this type of trauma (Fisher, 2014). Developmental trauma is often referred to as a type of complex trauma (e.g., Sar, 2011; van der Kolk, 2005). For the purposes of this study, the term *complex/developmental trauma* was used to acknowledge the complexities and the impact on development.

Some research has been conducted on the effectiveness of neurofeedback for treating trauma symptoms, and most have found positive results. Panisch and Hai (2018) conducted a systematic review of existing research on using neurofeedback with PTSD. They reviewed 10 studies published between 1991 and 2017 and reported all studies demonstrated a reduction in PTSD symptoms in the majority of their participants who received neurofeedback. A few studies have focused specifically on using neurofeedback to treat symptoms of complex, chronic, and/or developmental trauma (e.g., Frick et al., 2018; Gapen et al., 2016; Rogel et al., 2020; van der Kolk et al., 2016). In their research, Frick et al. (2018) studied a sample of 30 adolescent females with developmental trauma living in a residential treatment center. They found that after 25 sessions of neurofeedback, participants showed improvements in areas including memory, attention, cognitive flexibility, and executive functioning. Van der Kolk et al. (2016) examined the effectiveness of neurofeedback treatment to increase affect regulation and decrease symptoms of chronic PTSD using a randomized, waitlist-controlled trial. They found the clients who received neurofeedback had significant improvements in symptoms and ability to regulate affect when compared to the control group. At the initial assessment all participants met criteria for PTSD within the past month, and at the posttreatment assessment, 72.7% of those who had received neurofeedback no longer met criteria for the diagnosis.

Based on existing evidence, neurofeedback has gained recognition as a modality with potential benefits in the treatment of PTSD. Chiba et al. (2019) suggested neurofeedback can be an effective way to relieve PTSD symptoms without the distress that comes with processing traumatic memories. When considering the phase-based model of trauma therapy, neurofeedback could be easily integrated into the stabilization phase (Gerge, 2020). Regulating and stabilizing the brain can help facilitate engagement in therapy and may help increase receptiveness to interventions in trauma therapy (Aroche et al., 2009; Askovic & Gould, 2009).

There has also been some movement in legitimizing neurofeedback as a treatment for trauma. In the ISTSS treatment guidelines for PTSD, neurofeedback was listed as an intervention with emerging evidence (Berliner et al., 2019). Additionally, the company GrayMatters Health recently received clearance for a device (Prism) specifically intended to treat PTSD. A trial of this device with 79 participants showed a reduction in PTSD symptoms after 8 weeks of interventions, which were maintained after 3 months (Zagorski, 2023).

Integrating neurofeedback into trauma therapy presents several challenges, including the need for additional education. Therapists who choose to add neurofeedback to their practice typically lack a background of extensive education in brain science and technology; therefore, there can be a steep learning curve (Hamlin, 2018; Weiner, 2016). Neurofeedback is typically taught in 4- to 5-day workshops, although multiple authors (e.g., Demos, 2019; Hammond et al., 2011) caution that this is not enough for someone to claim competence. After the initial workshop, it is necessary to continue receiving education through additional trainings, webinars, and mentoring sessions. It is important for neurofeedback clinicians to select and purchase the necessary equipment and to learn to use the technology involved in collecting and analyzing data. If a clinician wants to specialize in a specific area (e.g., treating trauma with neurofeedback), additional training and experience is necessary (Hamlin, 2018). Needless to say, ethically integrating neurofeedback into clinical practice involves a significant amount of time, energy, and financial resources.

In addition to requiring specialized education, integrating neurofeedback into trauma therapy creates a shift in the therapeutic relationship. Fisher (2014) identified aspects of integrating neurofeedback that impact the therapeutic relationship, including providing education about benefits and risks, the introduction of touch when placing and removing sensors, transference, and the trust that clients are putting in the therapist when working together to change brain patterns. Fisher (2014) pointed out that some of these shifts are especially challenging for trauma survivors and encouraged providers to have open discussions with clients about changes in the therapeutic relationship when introducing neurofeedback.

Other than Fisher's (2014) guidance on how to introduce clients to neurofeedback, there is minimal literature on the process of integrating neurofeedback into trauma therapy. Some other neurofeedback providers have written about the integration of neurofeedback into clinical practice (e.g., Hamlin, 2018; Weiner, 2016), but these do not address the specific challenges that come with treating trauma survivors. There is one qualitative study that examined therapists' experiences with what impacts effectiveness of neurofeedback with trauma survivors (Currie et al., 2014). This study addressed the importance of the therapeutic relationship in neurofeedback but primarily focused on how this impacts the effectiveness of treatment and not on the process of integrating neurofeedback into psychotherapy.

Methods

This study aimed to gain an understanding of trauma therapists' experiences with integrating neurofeedback into their clinical work. A qualitative approach was selected since the goal was to gain an understanding of participants' experiences (Pietkiewicz & Smith, 2012). The qualitative method used in this study was interpretative phenomenological analysis (IPA), an approach that aims to understand participants' individual perspectives instead of trying to identify an objective statement to describe a phenomenon (Smith et al., 1999).

Participants

Sampling methods for this study aimed to access participants who met the following criteria: (a) located in the United States, (b) licensed as a mental health therapist, (c) specialize in working with complex/developmental trauma, and (d) use neurofeedback with psychotherapy to treat complex/developmental trauma. The decision to limit participants to those located in the United States was made due to the preference for a more homogenous sample in IPA studies (Pietkiewicz & Smith, 2012). However, this criterion was removed during the data collection process due to international interest. The researcher determined the sample would still be homogenous enough with the remaining three criteria.

A flyer and written description of the study were posted in two online neurofeedback communities: The International Society for Neuroregulation and Research (ISNR) Listserv, and a Facebook Group titled Neurofeedback Protocol Consultation (Licensed Clinicians Only). The flyer and study description included the researcher's contact information, and individuals interested in participating were asked to reach out via phone or email. A total of 16 individuals participated in the study (see Table 1 for demographic information).

Table 1
Participant Demographics

Variable	Number of Participants (*n* = 16)
Location	
United States	12
Northeast	4
Midwest	2
Southeast	2
West	4
Sweden	3
Australia	1
Gender identity*	
Female	15
Male	1
Age	
Range (years)	32–78
Mean	51.67
Race and ethnicity*	
White	15
Hispanic/Latino	1

Table 1
Participant Demographics

Years working with complex/developmental trauma	
Range	3–40
Mean	14.31
Years practicing neurofeedback	
Range	>1–25
Mean	7.63
BCIA** certification	
Yes	7
No	8
Working towards	1

Note. *Additional options were provided for gender identity and race and ethnicity but were not included in the demographic table due to no participants selecting them.
**Biofeedback Certification International Alliance

Procedures

Data were collected using a demographic survey and semistructured interviews. All data collection was done online using Qualtrics for the demographic survey and Zoom for the interviews. The demographic data were utilized to gain an understanding of who was participating in the study. This survey included questions about years of experience practicing trauma therapy and neurofeedback, geographic location, age, licensure, gender identity, and race and ethnicity (see Table 1). The semi-structured interviews were conducted using an interview schedule of open-ended questions formulated based on the literature review and research questions. All interviews were video recorded with participant consent.

Data Analysis

During the data collection process, the researcher completed a verbatim transcription of each interview. These transcripts were then printed and used for data analysis. Data in the current study were analyzed using a process based on the steps for interpretative phenomenological analysis identified by Smith et al. (2009). Since interviews were video recorded and transcribed by the researcher, steps of analysis were changed slightly to include a review of the transcript. The researcher adjusted the process outlined by Smith et al. (2009) into the following steps: (1) review transcript, (2) initial read-through and noting, (3) reread and noting, (4) identify emergent themes, (5) look for connections between themes, (6) bracket, (7) repeat steps 1 through 6 with each interview, and (8) look for patterns across interviews. The majority of the analysis process was done using paper and pen, although Nvivo was used during the data analysis process to connect quotes to themes or nodes.

Ethical Assurances

This study was developed and completed as a dissertation at an online university. Approval was obtained through the university's institutional review board (IRB) prior to recruitment and data collection. Informed consent was obtained from all participants prior to participating in the study, and participants were notified they could withdraw consent at any time.

Results

Five superordinate themes emerged during data analysis related to trauma therapists' experiences with integrating neurofeedback into therapy with complex/developmental trauma: the process of learning neurofeedback; integrating neurofeedback and trauma therapy; grounded in neuroscience and focused on context; building awareness; and shift in dynamics. Subordinate themes emerged under each superordinate theme (see Table 2).

Superordinate Theme 1: The Process of Learning Neurofeedback

Participants spoke about their experiences with the process of learning neurofeedback, including how they learned about neurofeedback, what drew them to seek education in this field, and barriers they faced as they were getting started. Based on participants' responses, five subordinate themes emerged: discovering neurofeedback, personal experiences with neurofeedback, the learning curve and ongoing learning, investment of time and money, others' perceptions of neurofeedback, importance of mentoring, finding community, and desire for growth and accessibility.

Subordinate Theme 1.1: Discovering Neurofeedback. Participants shared how they discovered neurofeedback and what factored into their decision to seek training. More than half of participants had learned about neurofeedback through a colleague, family member, or friend. A couple participants had witnessed or heard about a family member having success with neurofeedback, and others learned about it through another source such as a workshop, book, or documentary. Most

Table 2
Superordinate and Subordinate Themes

	Number of contributing participants (*n* = 16)	Percentage of contributing participants (*n* = 16)
Theme 1: The process of learning neurofeedback		
1.1: Discovering neurofeedback	16	100.00%
1.2: Personal experiences with neurofeedback	8	50.00%
1.3: The learning curve and ongoing learning	16	100.00%
1.4: Investment of time and money	12	75.00%
1.5: Others' perceptions of neurofeedback	14	87.50%
1.6: Importance of mentoring	13	81.25%
1.7: Finding community	12	75.00%
1.8: Desire for growth and accessibility	11	68.75%
Theme 2: Integrating neurofeedback into trauma therapy		
2.1: Specializing in neurofeedback and complex/developmental trauma	16	100.00%
2.2: Special considerations with complex/developmental trauma	13	81.25%
2.3: Finding balance	11	68.75%
2.4: Searching for something that works	13	81.25%
2.5: Ability to engage in therapy	13	81.25%
2.6: Benefits for the therapist	9	56.25%
Theme 3: Grounded in neuroscience and focused on context		
3.1: Connecting the physiological and psychological	16	100.00%
3.2: Importance of the therapeutic relationship	13	81.25%
3.3: Cultural considerations	13	81.25%
Theme 4: Building awareness		
4.1: Using multiple sources of information to track progress	13	81.25%
4.2: In-the-moment processing and reflecting	12	75.00%
Theme 5: Shift in dynamics		
5.1: Technology and the therapeutic relationship	7	43.75%
5.2: Touch	16	100.00%
5.3: Working together	13	81.25%

participants were working with complex/developmental trauma in the mental health field prior to starting neurofeedback, except for two who started practicing neurofeedback prior to becoming therapists.

Participants reported varying responses to first learning about neurofeedback. Some reported feeling skeptical or uncertain in part due to the technological aspect and the anticipated learning curve. Participant 10 shared that her initial reaction was, “I don’t need to be a rookie at something else. I don’t want to look at a computer.” Others expressed feeling curious or hopeful. Participant 2 said, “it sounded like it would calm some of the symptoms that people have that make therapy so difficult.” A few participants shared they were not interested when they first heard about neurofeedback, but this shifted when they heard about Fisher’s (2014) work with developmental trauma. For example, participant 12 indicated he had heard about neurofeedback but lacked interest until he read Fisher’s (2014) book. He said Fisher framed therapy as changing neural systems and working with the brain-body interface, and that “we can try to access that through the mind, through what we call mind, but we can actually get much more direct results if we train it.”

***Subordinate Theme 1.2: Personal Experiences With Neurofeedback*.** About half of participants reported personal experiences with neurofeedback; some prior to deciding to seek training in neurofeedback, and others while learning how to practice neurofeedback. For some, having a personal experience solidified their belief in this intervention. Participants used words like “fantastic” and “wow experience” to describe their experiences, and reported experiencing changes in energy levels, sense of self, and perception of the world around them after training. Some participants indicated their personal experiences solidified their belief in neurofeedback. Participant 4 reported two different experiences during her training. When she trained with a higher frequency protocol, “my energy level went from already pretty high to like, exponential.” The following day she tried a different protocol and explained, “my brain felt like it had been massaged and it was finally where it needed to be.” Experiencing “both ends of the spectrum” convinced her, “if you can do an appropriate assessment and really get a feel for what that person’s nervous system and brain is, you can have significant impact on their life and functioning.”

Subordinate Theme 1.3: The Learning Curve and Ongoing Learning. Participants shared their experiences with learning the neuroscience, physiology, and technology necessary to understand and practice neurofeedback. When describing their initial training, participants used phrases like “completely overwhelming,” “so freaking intimidating,” and “my brain exploded.” Some participants reflected on the lack of education about neuroscience and physiology in their training to become a mental health professional, which resulted in a steep learning curve when learning neurofeedback.

Participants also reflected on the learning curve when taking their knowledge from the initial training (typically a 4- or 5-day intensive workshop) to their clinical practice. Several participants expressed nervousness when beginning to practice with clients. Participant 12 described this as “entering a new world.” Participants reported being in a spot of not knowing. For example, Participant 3 expressed, “I was looking at the screen. I had no idea what I was doing. Absolutely no idea. I forgot that there’s a human there because I was like ‘what is going on here?’” Despite these challenges, participants pushed through, and attributed this their passion and excitement for the field.

Along with the initial learning curve, participants spoke to the need for keeping up with a changing field through continuing education and consultation. Regardless of how long they had been practicing neurofeedback, most participants reported ongoing learning. Participant 13 concisely expressed what many participants implied: “the more I learn, I understand how little I know.”

Subordinate Theme 1.4: Investment of Time and Money. Participants spoke about the investment of time and money necessary when learning and practicing neurofeedback, and several reported expense as a barrier to beginning to practice neurofeedback. Participants mentioned the expense of the initial training, equipment, software, mentoring, consultation, and continuing education. Along with investing money into learning neurofeedback, participants noted the amount of time they have invested. Participants reported spending significant amounts of time learning through independent study, workshops, consultations, and mentoring sessions.

Some participants identified difficulties making a return on their financial investment in neurofeedback. An issue participants identified around this was the lack of consistent insurance coverage for neurofeedback. Although there are billing codes for neurofeedback and some coverage through insurance companies, participants reported difficulties getting reimbursed. In addition, participants shared that when insurance companies did reimburse for neurofeedback, the rates did not make up for the cost of providing the service. Participant 10 explained she was initially excited to discover some insurance companies provided reimbursement for neurofeedback, but then discovered “the hour I get paid $90 for to do therapy is costing me all this money more because of the equipment, and they’re going to pay me less than half.”

Subordinate Theme 1.5: Others’ Perceptions of Neurofeedback. The majority of participants spoke about others’ perceptions or lack of knowledge about neurofeedback as a barrier to their practice. Some spoke about the need to provide education to others around them (e.g., other professionals, colleagues, clients) to help increase understanding. They reported challenges such as invalidation from other professionals due to belief that neurofeedback is “quackery” or misunderstandings of what neurofeedback entails. Some participants attributed this to lack of regulation in the field, resulting in neurofeedback practitioners who “don’t do it properly.” Multiple participants indicated colleagues tended to become less skeptical as they witnessed results. Participants who had been practicing for longer periods of time observed an increase in acceptance of neurofeedback over the years.

A few participants spoke about misconceptions they encountered when introducing neurofeedback to clients. One common misconception participants identified is that neurofeedback is something that is “done to” clients. Participant 6 reported having this misconception when she began practicing, which she passed onto her clients. She remarked she is now very clear "that it's their brain that's doing the work and to be mindful about that, or to let their brain do it because sometimes people try too hard and then it gets in the way." Participants also reported some clients expressed paranoia about things like electrical currents or the therapist being able to read their minds. Participant 12 expressed that even when he explains to clients there is no electricity or voltage involved in neurofeedback, they sometimes struggle to understand this. He shared, "I might explain it every session and then inevitably, like five sessions in, somebody's like, 'so wait a minute, is there voltage added?'"

Subordinate Theme 1.6: Importance of Mentoring. Participants emphasized the importance of mentoring with a more experienced neurofeedback practitioner as part of their learning process. They identified both individual and group mentorship as beneficial. Participant 11 agreed with the importance of mentoring, while also recognizing that mentors cannot always help when they are not experiencing the client: "you're the one in the room with the client, and whatever you present in the mentoring sessions is always limited and already filtered."

A few participants commented on the accessibility of mentoring due to expense. Additionally, looking for someone who specializes in neurofeedback with complex/developmental trauma limits the pool of mentors to select from, and may come with a higher price. Participants framed mentoring as a necessary investment in themselves and their businesses to ensure they provide high quality services to clients.

Subordinate Theme 1.7: Finding Community. Several participants mentioned building community as an important part of their learning process. Some identified this was especially important to counter isolation they felt when beginning to practice neurofeedback. Participants who had been practicing for longer periods of time reported difficulties finding colleagues who practiced neurofeedback when they got started, which they described as "isolating" and "no fun." Those who experienced community identified it was helpful to find colleagues who were also excited about neurofeedback and spoke to the benefits of being able to "geek out" with others. Participant 5 expressed, "it's just so nice to be in an environment where everybody speaks your language, that people don't look at you like you have five heads."

Subordinate Theme 1.8: Desire for Growth and Accessibility. Many participants expressed desire for growth and increased accessibility of neurofeedback. They mentioned the healing they have witnessed since adding neurofeedback to their practices and expressed hopes that more trauma therapists will get trained to broaden accessibility for clients. Participant 11 expressed, "seeing clients really recovering fully from trauma is something that I rarely saw before with developmental trauma, and I see it now." She continued, "seeing how many people are suffering, and how many people we can reach if more of us are doing neurofeedback, I would just like to encourage other therapists in the trauma field, for benefit of their clients, but for their own benefit as well, for their mental health. Let's embrace neurofeedback."

Some participants articulated the challenges with making neurofeedback accessible and affordable for clients. They acknowledged that clients who have experienced complex/developmental trauma may face additional social or economic barriers to accessing services. Due to the inconsistent insurance coverage of neurofeedback, many clients need to pay out of pocket, which impacts who can access services. A few participants identified difficulties finding a balance between offering sliding scale options and making enough money to cover the expense of being a neurofeedback practitioner. Participant 10 framed accessibility of neurofeedback as an ethical issue, and expressed, "it is an absolutely necessity that what happens next is to make it available regardless of ability to pay."

Superordinate Theme 2: Integrating Neurofeedback and Trauma Therapy

Participants shared their experiences with integrating neurofeedback and trauma therapy. Five subordinate themes emerged under this theme: specializing in neurofeedback with complex/developmental trauma, special considerations with complex/developmental trauma, finding balance, searching for something that works, and ability to engage in therapy.

Subordinate Theme 2.1: Specializing in Neurofeedback With Complex/Developmental Trauma. Participants shared their experiences with finding education on neurofeedback with complex/developmental trauma. Some reported difficulties finding information and research specifically focused on neurofeedback with this population. Half of the participants referenced Fisher's (2014) book as a primary source for learning about integrating neurofeedback and trauma therapy. Participants who started practicing prior to the publication of Fisher's book reported primarily learning through experiences. A couple participants identified that the lack of available information motivated them to contribute to the field through research or providing trainings.

Subordinate Theme 2.2: Special Considerations With Complex/Developmental Trauma. Participants reflected on their experiences and knowledge about neurofeedback training with clients with complex/developmental trauma, including special considerations with this population. Participants advocated for the need for specialized training and cautioned about harm than can occur if a clinician is not properly trained in working with this population. Several participants used words like "sensitive" or "vulnerable" when talking about the brains of those with complex/developmental trauma. Participants identified noticing that these clients are more sensitive to changes to protocols (e.g., length of training, placement of sensors, adjusting reward bands) than clients with other presenting concerns.

Most participants framed symptoms of complex/developmental trauma as adaptive. They expressed understanding that symptoms that now interfere with clients' functioning were beneficial for survival at some point. Several participants expressed feelings of admiration for their clients and their ability to find ways to self-regulate, even when their attempts to cope were ultimately destructive (e.g., self-harm, drug use). Through this lens of symptoms as adaptations for survival, participants spoke about difficulties clients may experience when change starts to happen. They identified the importance of moving slowly and taking time to process changes with clients. Participant 9 provided an example of one of her clients who experienced fear as she began to see change. She explained, "so much has changed that she is even scared that this change goes too quickly. 'Because who am I,' she asks, 'if I'm not the one who is always thinking about killing myself?'"

Participants also described clients' emotional reactions to the idea of neurofeedback and how this can be impacted by trauma history. Some participants reported encountering skepticism or paranoia from clients around neurofeedback. If clients were willing to try it, Participants shared various approaches they took to minimize discomfort. For example, Participant 11 observed, "sometimes I have to put sensors on myself and train myself just to show them it's not harmful." When clients have a history of torture involving electrocution she explained, "the process is longer. So sometimes it's just to come to the room and just stand at the door and just see equipment."

Subordinate Theme 2.3: Finding Balance. Participants reflected on their process of finding balance between neurofeedback and psychotherapy, both in their practices as a whole and within individual sessions. Some participants identified neurofeedback as a central component of their practice, and reported they prioritize clients who are interested in neurofeedback. A couple participants expressed they would not want to continue working with complex/developmental trauma if they were no longer able to use neurofeedback, which they attributed to the change they have seen since adding neurofeedback to their practices. Participant 4 explained, "[neurofeedback] is the only thing I've seen time and time again to have quick and lasting results."

In terms of balancing neurofeedback and psychotherapy within a session, participants varied in their approaches. Several identified challenges with finding a balance between talk therapy and neurofeedback training in the standard 50- to 60-min timeframe, particularly since neurofeedback involves preparation and cleanup. Some participants identified a preference for starting with neurofeedback and leaving the second half of session for talk therapy. These participants observed changes in their clients' abilities to engage in talk therapy after neurofeedback training. For example, Participant 3 shared, "we do the [neurofeedback] sessions and then we do the therapy, and then we can get to places that before were too much." Other participants reported offering options and encouraging clients to decide how to spend the session time.

Subordinate Theme 2.4: Searching for Something That Works. Several participants commented on clients coming to them for neurofeedback after having tried many other approaches without success. They described clients who seek neurofeedback as "stuck," "desperate for something that works," "seeking relief," and at "the end of the line." Participant 3 noted clients will come in for neurofeedback saying things like, "I tried everything, I'm treatment resistant" and "you're my last hope and I'm going to kill myself if this one doesn't work."

Participants also reported they were searching for approaches that would better help their clients, which is what led many of them to neurofeedback.

Several spoke about recognizing the limits of talk therapy alone throughout their work with complex/developmental trauma. Participant 12 explained, "a number of people are already kind of toasted on doing talk therapy." He indicated neurofeedback has been helpful because, "I think just the fact that they can do work without really having to directly talk about things, at least at the start, is really appealing." Other participants echoed this sentiment, and shared examples of clients who were able to get unstuck after adding neurofeedback.

Subordinate Theme 2.5: Ability to Engage in Therapy. Most participants reported noticing changes in their clients' abilities to engage in therapy after adding neurofeedback to their practice. They identified noticing changes in areas including self-regulation, ability to access and utilize coping skills, ability to engage in deeper therapeutic work, and sense of self. Participant 6 shared she sees the role of neurofeedback as being "to help with the flexibility of the brain to move from one thing to another, and enough stability in the brain to stay with something long enough." She continued, "but mostly just to be in a good zone to be able to do the therapy." Along with increased ability to engage in the therapeutic process, participants identified witnessing changes in clients including less frequent hospitalizations, increased ability to engage in interpersonal relationships, and gaining more of a sense of self and identity.

Subordinate Theme 2.6: Benefits for the Therapist. In addition to noticing benefits for clients, several participants reported noticing benefits for themselves because of integrating neurofeedback into their practices. Participant 4 asserted neurofeedback has "helped me significantly with clinician burnout." She explained, "I don't know how long I would've lasted with the heavy hitters on my caseload if I didn't have the regulation from neurofeedback." Participants identified using neurofeedback to help clients learn to self-regulate relieved them from needing to be the ones to regulate them. They expressed benefits including feeling less exhausted, more hopeful, and more able to be present for clients without being pulled into their pain.

Superordinate Theme 3: Grounded in Neuroscience and Focused on Context

Participants identified the focus on neuroscience and physiology in neurofeedback, but shared they make decisions based on this knowledge in the context of the individual client. Context involves identity, relationships, and larger systems. Three subordinate themes emerged under this superordinate theme: connecting the physiological and psychological, individualized approach, and cultural considerations.

Subordinate Theme 3.1: Connecting the Physiological and Psychological. Many reported learning about neuroscience and physiology was beneficial for their understanding of clients' presentations. Participants identified that focusing on the science behind trauma-related symptoms can help clients feel less stigmatized. Additionally, participants explained they provide education about neuroplasticity to encourage hope. Participant 6 shared she explains to clients, "the brain created a brain to serve whatever your needs were early on, and now the good news is the brain is plastic and we can change it."

Subordinate Theme 3.2: Importance of the Therapeutic Relationship. Although neurofeedback focuses on physiology, participants identified the relationship as an essential part. Some participants spoke about awareness of their own presence during neurofeedback training. Participant 10 shared, "your warm, curious presence is profoundly healing, regardless of what's happening in the neurofeedback." Participants articulated the necessity of building a foundation of trust and identified this as particularly important with clients with complex/developmental trauma. Some participants explained this foundation can help encourage clients communicate more openly about their experiences during training. Participant 5 cautioned about the potential for damaging trust when a training protocol does not go well: "if for whatever reason we make a mistake in choosing a protocol or making a shift, that can actually break the trust pretty quickly." She added, "we can also gain it back pretty quickly by saying, 'okay, we did this based on this, and now we know that your body system doesn't like that so we're going to do this.'"

Subordinate Theme 3.3: Cultural Considerations. Participants shared their observations about neurofeedback and cultural considerations. A few participants identified they have found the scientific nature of neurofeedback makes it easier to introduce to clients from various backgrounds than traditional talk therapy. Language barriers were mentioned by a couple participants, who shared their experiences working with interpreters during neurofeedback. Participant 11 explained, "with interpreters around, it's the interpreter that you're telling—so visual prompts and trying to understand. And we have also a model of the brain to explain how we're trying to impact on calming the nervous system."

Participants also shared their observations about neurofeedback and gender, race and ethnicity, and socioeconomic status. Some participants expressed an understanding of the impact of difference in the therapy room. For example, Participant 12 explained, "as a male in the field especially I have to be really intentional about how I do things. So I always verbalize what I'm going to do before I do it." A female participant who worked primarily with male clients reported similar awareness of gender when applying sensors to her clients' heads.

Participants acknowledged socioeconomic status as a barrier to neurofeedback, particularly due to inconsistent insurance coverage. Additionally, participants spoke about the impact of not having basic needs met. Participant 5 spoke about the intersection between race, ethnicity, and socioeconomic status in the community she works in. She shared, "I work with children who are Navajo and children from Mexico, as well as the majority of kids being from a low socioeconomic status" and reported noticing her results are "not as good" as what others presented at conferences or webinars. She expressed, "I attribute this to a number of variables including the intergenerational piece and the home environment that my kids live in while we are training." Participants acknowledged that individuals with low socioeconomic status and/or people of color may have a history of experiences that make it challenging to trust providers and highlighted the importance of building the therapeutic relationship. Participant 12 shared he works with several indigenous clients and explained he does "significant work to understand my privilege, understand how white culture is very different from Navajo culture, and to take the time to become identified as an ally before bringing the neurofeedback practitioner side of me into the room." The participants who spoke about privilege in the context of neurofeedback identified this as important to acknowledge due to its impact on the therapeutic relationship.

Superordinate Theme 4: Building Awareness

Participants spoke about neurofeedback as a way to help clients build awareness. Two subordinate themes emerged under this theme: using multiple sources of information to track progress, and in-the-moment processing and reflecting.

Subordinate Theme 4.1: Using Multiple Sources of Information to Track Progress. Participants identified using a mixture of objective and subjective sources to track progress in neurofeedback training. These sources include questionnaires about psychological and physiological symptoms, observation during sessions, client self-report, and gathering information from others who interact with the client. Participants contended having multiple sources of information can be especially important when clients struggle to observe and report their internal experiences, which can often be the case when someone has experienced trauma. When observing clients during sessions, participants spoke about looking for "nuances" and "subtleties" in facial expressions and body language.

Subordinate Theme 4.2: In-The-Moment Processing and Reflecting. Participants spoke about building in-the-moment awareness with clients through processing and reflecting throughout neurofeedback training. Participant 14 commented, "clients, especially clients with trauma, are not tuned into their bodies and their brains at all, or very little." She shared she helps build awareness by "educating them, then training, educating them more." Participants framed helping clients build awareness as part of the therapeutic process. Some participants reported they pause training when they notice something shift to help clients make connections. Participant 11 provided an example of how she would encourage clients to build awareness during a pause: "now beta is going up, those are fast frequencies. I'm wondering what is happening in your body in this moment."

Superordinate Theme 5: Shift in Dynamics

Participants reflected on shifts in dynamics that occurred when they integrated neurofeedback into their practices. Three subordinate themes emerged: technology and the therapeutic relationship, touch, and working together.

Subordinate Theme 5.1: Technology and the Therapeutic Relationship. Participants spoke about the impact of bringing technology into the therapeutic relationship. Some identified difficulties adjusting to having technology in the room, especially at the beginning. Participant 3 shared, "it's nerve-wracking when you sit in front of the computer and you have to make sure everything works. But it's like, 'yes, let's work with the human.'" Some participants reported clients also had difficulties adjusting to the addition of technology in the relationship. Participant 12 explained, "if I was a client, I think would feel pretty invalidated if I came in to see somebody that I actually had a relationship with and all they wanted to do was have me do some computer stuff.*"* Participant 15 noted some of her clients chose to discontinue neurofeedback and return to talk therapy "because they're hungry for that connection, that human connection." She explained with neurofeedback, "we're not making eye contact. They're staring at a screen and they're tired of screens. So that can be a neurofeedback barrier."

Subordinate Theme 5.2: Touch. Participants addressed the impact of the touch involved in neurofeedback, which can be particularly sensitive when working with complex/developmental trauma. Some participants spoke about shifts in the therapeutic relationship with the addition of touch. For example, Participant 10 described touch as "equalizing," and explained, "for most of my clients I think it's disarming in a really positive way. Like, it's a vulnerable position and it's also kind of protected in a way, cause they're looking away from you." A few participants reported adjusting their approach to applying sensors to reduce client discomfort, including demonstrating putting sensors on themselves first or coaching clients through applying the sensors themselves if they prefer not to be touched by the clinician. Participant 4 identified, "ears are really sensitive and actually can be a pretty intimate touch area. So usually in the beginning I'll ask people if they want to clean their ears off, and I'll show them how to put the ear clips on."

A few participants explained they view clients' reactions to touch as an assessment and pointed out the potential for the touch to be healing. Participant 11 observed changes she has seen over time in clients' response to touch: "for many clients initially touch is not desirable. And I could see them cringing when you try to rub their ears, especially touching earlobes." She explained, "but over time touch becomes therapeutic and really important." Similarly, Participant 6 spoke about touch with a client whose past experiences with touch were primarily violent: "he still will sometimes be tearing when I put on the [sensors], and I touch him very gently, and sometimes I linger that touch because I want him to have different experiences.*"* In terms of their own experiences with touching clients, some participants identified feeling "awkward" at first. However, several participants used words like "sacred" and "special" when describing applying sensors to their clients' heads and ears.

Subordinate Theme 5.3: Working Together. Participants identified neurofeedback as a collaborative process between clinician and client and emphasized the importance of engaging the client. They used words and phrases like "team effort," "warm closeness," and "doing this together." Participant 12 explained he tries to "make it as collaborative of a process as possible. And I think that's been key. And anytime someone feels like it's being done to them, those people tend to drop out pretty quickly." Similarly, Participant 10 described, "it's a collaborative feeling and a warm closeness that I prefer to the formality of therapy."

Discussion

This study aimed to gain insight and understanding into trauma therapists' experiences with integrating neurofeedback into their clinical work with complex/developmental trauma. In this section, the five superordinate themes identified in this study are examined in connection to existing literature. These interpretations are based on the patterns and themes that emerged throughout the process of analyzing the 16 semistructured interviews.

The Process of Learning Neurofeedback

When sharing about their experiences with learning neurofeedback, participants identified barriers and factors that were helpful with the learning process. Barriers included the learning curve, investment of time and money, and others' perceptions of neurofeedback. Existing literature on neurofeedback echoes participants' sentiments about the steep learning curve, with several sources commenting on the lack of training in neuroscience and technology in mental health education programs (Chapin, 2016; Hamlin, 2018; Weiner, 2016). The literature also supports participants' reports that the learning curve is ongoing with the need to continue learning after the initial training (e.g., Demos, 2019; Hammond, 2011). The initial and ongoing learning also involves significant investments of time and money; on top of paying for trainings, clinicians need to purchase or rent the necessary equipment and software (Hamlin, 2018). Due to these factors, Chapin (2016) described integrating neurofeedback into therapy as a "challenging, time-consuming, and expensive endeavor" (p. 156).

Existing literature supports participants' reports about skepticism that exists about neurofeedback, including attributing the effects of neurofeedback to placebo (e.g., Thibault & Raz, 2017; Thornton, 2018). Although empirical research on neurofeedback does exist, it is criticized for not being rigorous enough (Luctkar-Flude et al., 2018). The skepticism and criticism of existing research has been correlated with lack of insurance coverage due to neurofeedback being viewed as experimental (Hamlin, 2018; Hammond et al., 2011). Orndorff-

Plunkett et al. (2017) commented, “despite growing interest, there persists a level of distrust and/or bias in the medical and research communities in the USA toward neurofeedback and other functional interventions. As a result, neurofeedback has been largely ignored, or disregarded within social neuroscience” (p. 2). Additionally, although clinicians can become certified in neurofeedback through BCIA, this is not a requirement to practice neurofeedback (Hammond et al., 2011), meaning the level of training and mentoring providers have can vary significantly.

Despite these barriers, participants expressed dedication to the neurofeedback field and hopes for the future, and some were motivated by the barriers they faced to contribute to the field to help future clinicians. Similarly, Currie et al. (2014) reported the trauma therapists who participated in their qualitative study expressed hope for the future of neurofeedback. They wrote, “participants described the neurofeedback field as being ‘cutting edge,’ ‘growing exponentially,’ ‘up and coming,’ and having ‘endless possibilities’” (Currie et al., 2014, p. 230).

Factors that participants identified as helpful during the learning process included mentoring, building a community, and their excitement for the field. Mentoring was emphasized as an important part of learning and developing in the field by participants, which aligns with existing literature (e.g., Hammond, 2011; Weiner, 2016). Hammond (2011) explained that part of the importance of mentoring, particularly early in the learning process, is to reduce the potential for harm that can occur when someone provides neurofeedback without sufficient training. As clinicians gain experience with neurofeedback, mentoring can eventually be replaced with peer consultation (Weiner, 2016). Connecting with colleagues in the neurofeedback community was identified as helpful by several participants, particularly to counter isolation they experienced when starting to practice. Having access to community also provides opportunities for peer consultation.

Integrating Neurofeedback into Trauma Therapy

In terms of integrating neurofeedback into therapy with complex/developmental trauma, participants spoke about the need for specialized training in this area. Existing research has demonstrated differences in structure and functioning of the brain in individuals with complex/developmental trauma (e.g., Edwards, 2018; Marinova & Maercker, 2015; Thomason & Marusak, 2017). For example, complex/developmental trauma has been associated with increased amygdala activity, a part of the brain found to play a role in detecting threats (Edwards, 2018; Gerge, 2020; Thomason & Marusak, 2017). Therefore, it is important for clinicians who specialize in neurofeedback with complex/developmental trauma to learn about the impact of trauma on the brain as part of their education.

Completing thorough initial and ongoing assessments to determine protocols is essential for neurofeedback with any client, but with complex/developmental trauma there are often comorbidities and difficulties with self-reporting that create additional complexities (e.g., Fisher et al., 2016; Lanius et al., 2015). Research on the brain activity of traumatized individuals has shown heterogenous results, and there has not been any specific EEG biomarker for trauma-related disorders discovered (Fisher et al., 2016). For this reason, there is no set approach to neurofeedback with complex/developmental trauma and an individualized approach is necessary (Fisher, 2014; Fisher et al., 2016). There have been attempts at identifying biomarkers and protocols for PTSD, including the creation of the Prism device by GrayMatters Health to specifically target areas of the brain that are typically impacted by trauma (Zagorski, 2023). More research will be necessary to determine if interventions like Prism are applicable in cases of complex/developmental trauma.

Several participants observed that clients with complex/developmental trauma who came for neurofeedback had typically already tried several other therapeutic approaches with minimal success. Participants spoke about recognizing the limitations of talk therapy alone, which is part of what led them to seek additional ways to help their clients and to find neurofeedback. They identified that, although talk therapy was helpful to an extent, clients struggled to get unstuck and some felt burnt out with talk therapy. Several participants noticed their clients were more able to engage in the therapeutic process after the addition of neurofeedback. This aligns with existing literature, which found once clients’ brains were more regulated and stabilized, they were more receptive to interventions in trauma therapy (Aroche et al., 2009; Askovic & Gould 2009; Askovic et al., 2017). Helping clients learn to regulate their brains can create more ability to self-regulate throughout the therapeutic process (Bell et al., 2019), and this physiological regulation can be particularly helpful prior to attempting to engage in trauma processing (Othmer & Othmer, 2017). Neurofeedback can also provide a way to work on reducing trauma-related symptoms without diving into trauma processing, which can be especially helpful if a client lacks the skills necessary to go into deeper work (Chiba et al., 2019).

Grounded in Neuroscience and Focused on Context

Neurofeedback was identified as grounded in neuroscience and physiology while also acknowledging the client's context. All participants spoke about the focus on neuroscience and physiology that comes with neurofeedback and how this has impacted how they view complex/developmental trauma. Despite this shift in focus, participants recognized the importance of context when applying this knowledge to individual clients. Context includes interpersonal relationships, larger systems the client is a part of, cultural background, and other factors that play into the client's identity.

Several participants identified using psychoeducation about the brain and physiology to help destigmatize symptoms and externalize trauma. This lens acknowledges that human physiology is designed to promote survival and has built in systems that activate when a threat is present (van der Kolk, 2014). In stressful situations physiological changes occur in the brain and body that are useful for threatening environments in the short term, but long term this can have negative impacts on development and functioning (Thomason & Marusak, 2017). Some participants asserted learning more about the neuroscience and physiology of trauma convinced them further of the importance of having a physiological component to trauma therapy. This relates back to participants' comments on the limits of talk therapy alone.

The therapeutic relationship was identified as an important part of neurofeedback when integrated into trauma therapy. Some participants spoke about the therapist's presence and attunement as a component in the healing properties of neurofeedback. Participants reported paying attention to how they are showing up in the room with clients and trying to create an environment where they feel safe enough. Leddick (2015) addressed the importance of creating a sense of safety in order to open the possibility for change, "the patient's CNS [central nervous system] must actually assess the present context and itself as safe enough and requiring fewer of said constraints in order for change to occur" (p. 121).

Participants also identified having a foundation of trust in the therapeutic relationship was beneficial when integrating neurofeedback into their work with complex/developmental trauma. They shared their approaches for this, including taking time to introduce neurofeedback, having open conversations about the process, and encouraging clients to speak up during the training if anything does not feel right. Fisher (2014) noted that it requires a certain amount of trust for clients to allow the therapist to look at and train their brain. Building trust in the therapeutic relationship with clients with complex/developmental trauma can be challenging since this type of trauma often involves negative experiences with interpersonal relationships (McFetridge et al., 2017; Van Nieuwenhove & Meganck, 2019).

When speaking about working with clients with complex/developmental trauma from different backgrounds and cultural groups, some participants identified areas they feel influence neurofeedback training. Several participants identified the impact of socioeconomic status on clients' abilities to access neurofeedback. Since neurofeedback is inconsistently covered by insurance companies, the potential out-of-pocket expenses create barriers for those who do not have the financial means to cover what insurance does not. Participants also identified engagement in therapy can be challenging for clients who live in a state of ongoing stress and whose basic needs are not being met. Gender was addressed by a couple participants, specifically related to the touch that is involved when applying sensors to clients' heads. Both participants commented on their experiences of touching clients of a different gender than themselves and identified staying mindful and being intentional in these interactions. A couple participants spoke about their experiences working with interpreters with clients who spoke a different language, one of whom identified this as a challenging part of her work. Finally, a few participants spoke about race and ethnicity. A couple participants who identified as White recognized clients of different races or ethnicities may be hesitant to trust White providers due to factors including differences in power/privilege and historical incidences of mistreatment of communities of color in healthcare settings.

Meyer and Zane (2014) examined the impact of cultural elements on clients' experiences with mental health services by having clients (n = 102) complete questionnaires. They found that for clients from marginalized racial and ethnic groups having a therapist of the same race or ethnicity was associated with perceiving services as accessible and perceived quality of care. This was also marginally associated with overall satisfaction with services. Applying this information to neurofeedback, having diverse providers could help clients from marginalized communities perceive neurofeedback as more accessible. No information could be found on the demographics of providers in the neurofeedback field; therefore, the ability to access diverse providers is unknown. There has been research on provider demographics in other related fields. For example, the American Community Survey examined data from 2005 to 2013 and found that although there was growth in psychologists from marginalized racial and ethnic groups over the years, they continue to make up less than one fifth of psychologists (Lin et al., 2015). Although psychologists are only one type of mental health professional, this suggests diversity is limited in the mental health field.

Cultural considerations are minimally covered in existing literature on neurofeedback. In a review of existing EEG research, Choy et al. (2022) identified a lack of recruitment and retention of participants who are members of minority groups. They identified one barrier to inclusion in EEG research is hair type. The methods commonly used to record EEG data require contact with the scalp and are most effective with short or thin hair. This can lead to exclusion of participants with thick, curly, or braided hair due to obtaining less clear EEG recordings. Choy et al. (2022) pointed out that this often leads to exclusion of participants of African or Caribbean descent from EEG research. The authors recommended trying alternative types of electrodes to collect data and reported some efforts in this direction (Choy et al., 2022, pp. 17–18).

Currie et al. (2014) reported therapists in their qualitative study identified multicultural factors had minimal impact on neurofeedback outcomes with the exception of socioeconomic status. Fisher (2014) wrote about the potential for neurofeedback to be accepted where typical therapy is not: "psychotherapy is a Western tradition that is sparsely practiced in the rest of the world. Neurofeedback is cross-cultural: it doesn't depend on language, verbal processing, or cultural bias" (p. 247). The Biofeedback Certification International Alliance (2016) has a section on multiculturalism and diversity that encourages providers to seek education and work to recognize beliefs and biases. In this section they wrote that professionals who are certified through BCIA "are encouraged to recognize that, as cultural beings, they may hold attitudes and beliefs that can detrimentally influence their perceptions of and interactions with individuals who are different from themselves ethnically, racially, in sexual orientation, or gender identity" (BCIA, 2016, p. 2). Harvey et al. (2015) wrote about the importance of making sure individuals in underserved or marginalized groups have enough information about biofeedback to make informed decisions and suggested having information available in different languages to increase accessibility.

Building Awareness

Participants reported using a variety of methods to track progress and change, such as self-report measures, observation and attunement, involving a family member or significant other, and monitoring EEG. When someone has a history of complex/developmental trauma, their ability to recognize and identify body sensations and emotional states is often impaired (Fisher, 2010; Lanius et al., 2015; van der Kolk, 2014). Due to this, participants identified helping clients build awareness as part of the therapeutic work in neurofeedback.

Existing literature supports the connection between neurofeedback and building awareness. Neurofeedback has been connected to mindfulness and meditation, as these approaches focus on building awareness in the present moment (e.g., Baldini et al., 2014; Brandmeyer & Delorme, 2013). Bagdasaryan and Quyen (2013) spoke about building awareness as a part of neurofeedback: "the major task is to support the subject in the process of introspection and self-discovery to achieve control over neural activity" (p. 7). They also wrote about the importance of connecting first- and third-person data in neurofeedback. Hammond (2011) advocated for the use of objective assessment (e.g., examination of raw EEG data or a quantitative electroencephalogram [qEEG]) to supplement less objective assessment measures when determining protocols for neurofeedback. These sources support participants' approach of using multiple sources of information for tracking progress and focusing on helping clients build awareness.

Shift in Dynamics

Participants identified a shift in dynamics that occurred when they integrated neurofeedback into their work with complex/developmental trauma. Standard talk therapy involves clients and therapists sitting across the room from each other and engaging in conversation. With neurofeedback added to therapy, technology and touch are added to the therapeutic relationship. The therapist is not only paying attention to the client, but also watching a computer screen. Participants shared their experiences with introducing technology into the therapeutic relationship and reported some clients struggled to adjust to the change in dynamics. Some spoke about the potential of getting pulled into the technical aspects and focusing less on the therapeutic relationship, especially when getting started. The impact of bringing technology into the therapeutic relationship is addressed in existing literature. Fisher (2014) wrote about some of her clients' reactions to having computers as part of their therapy. She wrote, "if you are bringing neurofeedback into an established setting and established relationship, the computers can feel like intruders" (Fisher, 2014, pp. 141–142). Leddick (2015) called the computer a "third" in the relationship and expressed this presence "requires attention and holds therapeutic potential" (p. 132).

A second shift in the therapeutic relationship is the addition of touch. Participants shared their experiences with this change, including their approach to introducing touch into the relationship, thoughts on potential healing qualities of the touch involved in neurofeedback, and ways of working with clients who are uncomfortable with being touched at all. Overall, participants indicated they are intentional about touch and mindful about clients' reactions. Since complex/developmental trauma is often interpersonal, touch can be an especially sensitive issue (Fisher, 2014). Existing literature acknowledges these challenges and also addresses the potential for the touch involved in neurofeedback to be beneficial. For example, Fisher (2014) posited that therapists "may in fact have a unique opportunity, in pasting the sensors on and then taking them off and cleaning the paste off the head, to rehabilitate touch for some patients, to remind them of, or introduce them to, nurturing touch" (p. 101). Leddick (2015) also wrote about the potential for touch to have nurturing qualities.

Overall, neurofeedback was identified by participants as a collaborative process and several expressed feeling a sense of working together with clients. They reported involving clients in decisions about the process when appropriate. Participants spoke about making sure clients understand neurofeedback is not something being "done to them," and emphasized the importance of choice. Some reported noticing clients are more likely to drop out if they feel like neurofeedback is being done to them. Research by Currie et al. (2014) found the therapists in their study also identified neurofeedback as a team effort, with the client and therapist working together to determine if protocols are appropriate. Part of working together in neurofeedback is identifying what the client hopes to see change and developing goals to work towards (Weiner, 2016).

Implications

Participants' accounts of what was beneficial when getting started could serve as guidance for trauma therapists hoping to add neurofeedback to their practices. Finding community and working with a mentor are two factors participants identified as most helpful, which is supported by existing literature (e.g., Hammond, 2011; Weiner, 2016). Identifying barriers to learning and integrating neurofeedback could help therapists understand the barriers and challenges they may encounter to make an informed decision regarding the appropriateness of neurofeedback. The barriers and challenges mentioned most frequently by participants were the learning curve, others' perceptions or stigma of neurofeedback, and the investment of time and money. These challenges align with those referenced in existing literature (e.g., Chapin, 2016; Orndorff-Plunkett et al., 2017; Thornton, 2018; Weiner, 2016). Having additional guidance for clinicians starting off with neurofeedback will be beneficial for the field. For example, the results of this study suggest having access to mentoring and building community with others who are learning and practicing neurofeedback would be an asset to clinicians interested as they begin integrating neurofeedback into their practices.

In addition to getting started with neurofeedback in general, the results from this study offer practical suggestions for integrating neurofeedback into therapy with complex/developmental trauma. Therapists who hope to specialize in this area should seek specialized education. Several participants shared that Fisher's (2014) book was one of their main resources for specialization. Additional resources for specializing that participants mentioned were webinars, existing research, and mentoring with someone who specializes in neurofeedback with complex/developmental trauma. Therapists will also need to learn about the neurobiology and physiology of trauma.

On top of these educational needs, participants shared special considerations with complex/developmental trauma and the ways they address these. One of these considerations is touch, which can be a sensitive issue with clients with complex/developmental trauma (Fisher, 2014).

Having a conversation with clients about the touch involved in neurofeedback provides space to process through any concerns or emotions related to this. When applying sensors to clients' heads, talking clients through the process can help them understand what is happening. For example, therapists can let clients know when and where on their head they are going to touch before doing so. For clients who cannot tolerate being touched, participants came up with ways of adjusting the process. One way of doing this is teaching clients how to apply the sensors to their own heads.

Another consideration with complex/developmental trauma is the potential of clients having difficulties noticing and expressing internal experiences. Individuals with a history of complex/developmental trauma may lack interoception or struggle with alexithymia (Fisher, 2010; Lanius et al., 2015; van der Kolk, 2014). This can create challenges since neurofeedback relies at least partially on self-report for progress tracking. A few methods participants used for gathering information when clients struggled with awareness were focusing on physical symptoms (e.g., headaches, bowel movements), getting observations from a significant other in the client's life, and observing changes in the client's behavior and mannerisms. Awareness can be built over time by processing and reflecting in the moment during neurofeedback training. For example, if the therapist notices a shift in the raw EEG or in the client's facial expressions, they can check in with the client about what they are experiencing. Multiple participants in the current study reported pausing the training to when they noticed a significant change to process with clients.

Neurofeedback integrated into therapy can be viewed as a collaborative relationship between therapist and client. Selecting protocols involves gathering background information and speaking with clients about their current concerns and goals. Contextual factors are also important to consider, including factors that may impact a client's ability to consistently attend sessions (e.g., transportation, insurance coverage), and whether they are subject to ongoing chronic stress. Clients remain active participants throughout the training process by providing reports on what they notice during and after sessions. Participants in the current study emphasized the importance of following the client's lead when using neurofeedback with complex/developmental due to their experiences that this population has more sensitive brains. If a client reports negative side effects after a protocol (e.g., headaches) the therapist may want to look at adjusting or changing the protocol.

Neurofeedback may be perceived as a modality that shifts attention away from relationships; however, the results of this study demonstrate the relational aspects of neurofeedback. Although neurofeedback focuses on physiology and involves adding technology into the therapy room, the therapeutic relationship remains an essential part of the work. Building a therapeutic relationship with individuals with complex/developmental trauma can be challenging due to difficulties trusting resulting from traumatic experiences in interpersonal relationships (McFetridge et al., 2017). Participants spoke about the benefits of having a foundation of trust when integrating neurofeedback into work with complex/developmental trauma, which indicates therapists should focus on building this foundation with clients.

Family members and other significant people in a client's life can be included in neurofeedback by providing their observations throughout the training process. A few participants who worked with children and adolescents shared their experiences with involving parents and guardians. Some participants who worked with adults also reported reaching out to significant others (with consent from the client) to share their observations. This can be particularly helpful when working with complex/developmental trauma, since internal awareness and ability to self-report are often limited (e.g., Fisher, 2014; Lanius et al., 2015). Neurofeedback can also involve larger systems. For example, two participants provided therapy and neurofeedback in a school setting, which allowed them to communicate with teachers about their clients' behaviors. Similarly, one participant worked in a residential treatment center and commented on the benefits of getting observations and reports from staff members.

In addition to the ability to get progress reports about clients, incorporating neurofeedback into systems such as schools and residential treatment centers can help increase accessibility. The participants who worked in public schools were able to get funding to provide services to clients who otherwise would not be able to access this kind of help. Neurofeedback was an integrated part of the therapy services they provided, so cost was not a barrier for clients like it can be in other settings. Offering neurofeedback in these types of settings can also increase accessibility by bringing services to the client. For example, students who received services in a school setting do not need to worry about finding transportation to appointments. Assessing for barriers to clients' abilities to access and consistently participate in neurofeedback training (e.g., expense, transportation, ongoing stress in the home environment) could provide insight into ways to increase accessibility.

Limitations

Limitations of this study include recruitment methods and reliance on interpretation. In order to participate in the study participants needed to reach out to the researcher and did not provide any incentive (financial or other) for participation, meaning participants had to be motivated enough to take the initiative. The reliance on interpretation in qualitative research creates challenges with appraising quality of data and analysis (Dixon-Woods et al., 2004). Although the primary researcher attempted to bracket biases and experiences by maintaining reflexive notes throughout analysis, fully controlling for biases is nearly impossible. The primary researcher is White, raised as female, and lives in the United States, which may play a role in how results were interpreted. This researcher is also a trauma therapist who offers neurofeedback, and inevitably holds assumptions and biases that could impact development of research questions, interview questions, and interpretation. Member checking was used to increase credibility by emailing participants their transcript and a list of themes that arose from the initial interpretation. They were given the opportunity to reach out to the researcher with any comments or questions about the transcript or interpretations. No follow-up comments or questions were received from the participants regarding the transcripts.

Future Research

Overall, there is limited research (quantitative and qualitative) on integrating neurofeedback into therapy with complex/developmental trauma. A mixed methods or quantitative study on integrating neurofeedback with therapy for complex/developmental trauma is recommended to expand on the information gained in this qualitative study. Larger-scale research on this process could be helpful for producing additional guidance on seeking education to specialize in neurofeedback and complex/developmental trauma, developing competence, and integrating neurofeedback with trauma therapy. In addition to getting started with neurofeedback, it would be beneficial for future research to examine the ongoing process of using neurofeedback as a part of trauma therapy (e.g., when to add neurofeedback, assessing progress, and modifying protocols). Future research could also examine clients' experiences with neurofeedback integrated into trauma therapy, including any changes to the therapeutic relationship and the impact of touch. This could provide additional insight for the integration process. Additional research on the relational aspects of neurofeedback integrated into trauma therapy would also be beneficial. The current study examined this through therapists' perspectives using a qualitative approach. Future research could include quantitative or mixed methods studies in this area from both the therapist and client perspectives.

Two additional areas for future research are touch and cultural considerations and how these show up when integrating neurofeedback into therapy with complex/developmental trauma. In the current study, participants shared their experiences with the touch involved in neurofeedback and special considerations around this with complex/developmental trauma. Touch is addressed minimally in existing literature (e.g., Fisher, 2014; Weiner, 2016).

Cultural considerations are also minimally addressed in existing literature. In the current study, socioeconomic status was a cultural factor that several participants identified as having an impact on neurofeedback and trauma therapy due to expense and inconsistent insurance coverage. This finding was supported by some existing literature (Currie et al., 2014). Other factors were discussed by participants in the current study but were not addressed in existing literature. Additional research on cultural considerations in neurofeedback is necessary in general, along with more specific research on cultural considerations with complex/developmental trauma.

Many participants in the current study expressed they hope to see more accessibility in the future. In order for insurance to more consistently cover neurofeedback as a part of trauma therapy, more outcome-based studies will likely be necessary. For this reason, future research on the effectiveness of neurofeedback with complex/developmental trauma would be beneficial. There are a few existing studies in this area (e.g., Frick et al., 2018; Rogel, et al., 2020; van der Kolk et al., 2016) that can provide inspiration and guidance for future research. Participant 11 shared challenges she had with conducting research trials due to participants lacking trust for the process and struggling with the lack of choice they had in their treatment. This will be important to keep in mind when developing future studies in this area.

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NeuroRegulation

Clinical Effectiveness of AAC Intervention in Minimally Verbal Children With ASD: A Systematic Review

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Abstract

Background. Autism spectrum disorder is defined as neurodevelopmental disability by (DSM-5). One third to half of minimally verbal children could benefit from augmentative and alternative communication (AAC) intervention. In children and adults with developmental disabilities, AAC enhances social interaction and daily routines. **Objective**. Clinical effectiveness of AAC interventions is being studied in improving outcome variables like social communication, interaction, speech production behavior and expression and their implementation in clinical practice for children with autism spectrum disorder (ASD). **Method.** We searched electronic databases PubMed, Web of Science, and Scopus from inception to January 2022. Randomized controlled trials with multiple baselines and multiple probe designs were selected for this review. **Results**. Four hundred sixty-eight articles retrieved with recruitment criteria, eight studies selected, three with multiple baseline designs, two with multiple probe designs, one with both and two randomized controlled trials (RCT) selected. Tau-U analysis and improvement rate difference (IRD) were used for analyzing the data, ranging from 0.80 to 1.00 for single-case experimental design and 0.90 to 0.95 for RCTs. **Conclusions**. AAC aids are effective tools for increasing communication in ASD children, but high-tech aids were more effective in increasing social communication, interaction, and speech production than low technology. Children also prefer high tech.

Keywords: autism spectrum disorder; augmentative and alternative communication; manual sign; voice output communication aids; picture exchange communication system; visual scene display; speech-generating devices

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Introduction

Autism spectrum disorder (ASD) is defined as neurodevelopment disability according to the *Diagnostic and Statistical Manual of Mental Disorder* (5th ed.; DSM-5; American Psychiatric Association [APA], 2013). Prevalence of ASD in children is estimated to be approximately 1 in 68, and it has significantly heightened in the last 20 years (Baio et al., 2018). The cause is known to be idiopathic boys are more prone than girls. The core feature of ASD is deficit in social communication, social interaction, repetitive and restricted patterns of behavior and interest (e.g., repetitive body movement such as flapping of hand, sensory sensitivities, and circumscribed interest) along with the absence of eye contact or no response when their name is called (Mazurek et al., 2017). Speech is the most portable and ideal form of communication. In ASD, about 25% to 30% of children do not develop or fail to develop any language (functionally spoken) and remain minimally verbal (Norrelgen et al., 2015). In one of the studies, it was found that 25% of minimally verbal children have increased aggression level and social withdrawal during adolescence. Because of limited social interaction, adaptive behavioral skills, academic achievement, vocational accomplishment, and social relationships are also affected (Binger et al., 2010; Wodka et al., 2013).

Augmentative and alternative communication (AAC) techniques and strategies are used in social-communication-deprived children (Ganz, 2015). There are two major groups of AAC intervention: high technology (speech-generating devices [SGD]) and low technology (e.g., gestures, body language, Picture Exchange Communication System [PECS], and manual sign). AAC is further classified as aided (requiring external supports) including PECS and SGD; whereas unaided included manual sign languages, KWS, and gestures (Mazurek et al., 2017).

Low Technology Devices

Picture Exchange Communication System (PECS). Originally developed for nonverbal children with ASD, PECS is used to teach various spontaneous functional communications through symbols and pictures that can be easily and inexpensively created and programmed into intervention. Two of PECS' reported merits are its required eye contact and oral motor skills, which are lacking in ASD children (Bondy & Frost, 1998).

Children use PECS to communicate by exchanging pictures with a partner in order to access preferred items and activities or to initiate social interaction. There are six phases in PECS that they progress through with training. The communications begin with exchanging a single picture card to request preferred items and then progresses through phases designed to increase vocabulary and mean length of utterance as well as to expand the function of the system, including commenting (Alzrayer et al., 2019).

Sign Language and Key Word Sign (KWS). ASD children have significantly impaired gestures, one of the predictors of language impairment (Dimitrova et al., 2016; Yoon & Bennett, 2000). Social, cognitive, and motor abilities are a few of the developmental skills required for successful gesture communication (Wray et al., 2016).

Body language, manual sign, and gestures help in teaching receptive and expressive vocabulary in children with speech impairments. Children here are taught to make a request or mand using photographs, symbols of real or partial objects, or lines. Manual signs require single stimulus whereas symbols requires multiple stimulus (Yoder & Layton, 1988; Yoder & Stone, 2006; Yoon & Bennett, 2000). Intervention including symbols with visual resemblance is likely to be learned more easily by people with language development difficulties than when symbols have weak visual relationship.

Sign language and key words are used to increase vocalization and speech production in people with speech impairment. Therefore, minimally verbal and nonverbal children require more sign language as it increases vocalization. For individuals who have difficulties in conditional discrimination, sign language is often recommended.

The goal of KWS is to support the development and use of functional communication, comprised of core vocabulary and fringe vocabulary. Fringe vocabulary contains specific words and messages individualized from person to person, whereas core vocabulary consists of words and phrases which are universal. KWS was specifically designed to provide support to children with complex communication needs like practicing social etiquette, exchanging information, and developing social closeness (Tan et al., 2014).

High Technology Devices

Speech-generating Devices (SGD). A frequently used AAC intervention and previously known as voice output communication devices, SGD are electronic devices which are portable and include features such as graphic symbols and written language along with digitized and synthesized speech output. (Mirenda, 2003). One of the merits of SGD is instantaneous speech production, which makes messages easier to understand, even for a communication partner not familiar with this device. This advantage facilitates greater participation in a natural setting (van der Meer et al., 2013; van der Meer & Rispoli, 2010). Nowadays, several tablet devices like iPhone, iPod, and iPad are designed in such a way that they can function as an SGD at a low price and with multifunctional abilities. SGD can save vocal messages and be given to children in a noisy environment or as a long distance intervention when implementing for those with communication disabilities (Alzrayer et al., 2019).

Quick speech production facilitates development of language, enhances pairing of graphics and spoken symbols, improves conversation, and builds independence in SGD users (Gilroy et al., 2018).

Vocabulary organization is one of the core features of SGD. Methods of grouping vocabulary on graphic mode AAC systems include taxonomic (i.e., by category), alphabetic, schematic (i.e., by event or activity), chronologic (i.e., by daily schedule sequence), and semantic-syntactic (i.e., by part of speech) apart from this frequency of use (Thistle et al., 2018).

Visual Scene Displays (VSD). The use of VSD with beginning communicators or those who are learning to communicate has been suggested as an alternative to traditional AAC approaches (Light et al., 2019). Here photos of different and meaningful events are present on either computer tablets or mobile phones with preprogrammed vocabulary hotspots. Upon touching the screen, the hotspot produces speech and plays a poem or song. It has been shown that there is a positive result when using VSD in children and adults with development disability in the context of number of turns (social communication) and production of different vocabulary items during social interaction routines (Holyfield, 2019).

The benefits for children are that the contextual support provided by the photographic image preserves or improves the functional and proportional relationships required for building communication in society and appears to play an important role in supporting the effective use of the AAC system (Light et al., 2019). For example, when the hotspot for an apple seen on a kitchen countertop on VSD is selected, the VSD produces the corresponding auditory output “apple” with a visual scene showing either the benefits of the apple or how to pronounce apple (Gevarter et al., 2014).

In a review of literature, researchers also found that implementing AAC as a mode of communication for children with ASD or other pervasive development disorders did not result in reduced speech production but rather an increase in vocalization (Cagliani et al., 2017). Similarly, another study reported beneficial effects of AAC on social interaction and daily routines in children and adults with developmental disability (Laubscher et al., 2019).

To date there is a lack of interventional studies examining the characteristics of exchanges between child and adult partners with respect to social context, such as the proportion of self-initiated exchanges or reciprocal communication (Thiemann-Bourque et al., 2016). Also, if not diagnosed in earlier stages ASD can result in social withdrawal, effecting quality of life and causing stress in adolescence (Chapin et al., 2022).

Thus, the purpose of this systematic review is to evaluate the clinical effectiveness of AAC in minimally verbal children with ASD and among all AAC intervention which is the most clinically effective in improving social communication and interaction, speech production, behavior and expression in these children.

Methods

Protocol and Registration

The review protocol was registered in PROSPERO (https://www.crd.york.ac.uk/PROSPERO, registration number CRD42021279344), which is an international database of prospectively registered systematic reviews.

Search Strategy

This systematic review is designed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement (Page et al., 2021).

A systematic search was done on electronic databases such as PubMed, Web of Science, and Scopus, starting from inception to January 2022. To retrieve relevant studies, in an advanced search using the drop-down menu under the “title/abstract” category, each phrase was combined with “autism spectrum disorder” OR “augmentative and alternative communication” using the Boolean operator “AND” with:

- Social communication
- Speech-generating devices
- Picture Exchange Communication System
- Multistep requesting
- Manual sign
- Low technology devices
- Visual scene display
- Voice output communication aids
- High technology devices

Inclusion Criteria

Our inclusion criteria were:

- Population: Children under 13 years of age with prediagnosed ASD who were minimally verbal, with utterance less than 20 or more than one spontaneous or functional word.
- Intervention: Given either in classroom, at school, or by researcher.
- Study Design: Randomized controlled trials (RCT), non–RCT, and single-case experimental designs (SCED).

Exclusion Criteria

The following exclusion criteria were followed for this study:

- Nonverbal children
- Uncontrolled seizures

- Diagnosed with any congenital or genetic anomalies like Fragile X syndrome or Down syndrome, with and without ASD
- Any motor impairment that could hinder the interventions given to children (cerebral palsy), as well any other factors affecting their social communication abilities
- Intervention given like peer-mediated approach, naturalistic teaching approach, or a computer-based intervention like Therapy Outcomes by You (TOBY).

A total of 468 articles were retrieved after applying the filter of recruitment criteria, and eight studies met the inclusion criteria.

Data Extraction

In this review process, four reviewers were involved; two reviewers (A. A., C. S.) searched various databases (PubMed, Web of Science, and Scopus) in order to retrieve all plausible studies. Any disagreements regarding the eligible studies were resolved either by discussion or by the involvement of other two reviewers (M. N., G. J.).

Data Collection

Characteristics for all included cases were according to study design; that is, multiple probe design (MPD), multiple baseline design (MBD) and RCT; participants characteristics (age, verbal status, and communication skills), intervention setting (clinical, school), type of intervention (PECS, SGD, VSD, manual sign, key words), dependent variable (object request, speech production, behavior, communication turn-social interaction), functional outcomes, and interobserver agreement. Also, the quality assessment of the included study was done by using PEDro (RCT) and single-case experimental design (SCED) for MPD, MBD design. The score for SCED ranged from 7/10 to 8/10, whereas for RCT it was 8/10.

Quality Synthesis

PEDro Scale and Scoring for RCT

The methodological quality assessment of each included trail is very important while conducting a systematic review. Many scales are there for assessing the quality of clinical trials; among them, the PEDro scale is most commonly used. This scale scores 11 items: random allocation, concealed allocation, similarity at the baseline, subject blinding, therapist blinding, assessor blinding, more than 85% follow-up for at least one key outcome, intention-to-treat analysis, between-group statistical comparison for at least one key outcome, as well as point and variability measures for at least one key outcome. Evaluation is done to determine the integrity of the steps involved in conducting a systematic review. Based on these criteria the PEDro score ranges from “fair” to “excellent” with interrater reliability (intraclass correlation coefficient [ICC] = 0.53 to 0.91) for clinical trials of physiotherapy-related interventions (Cashin & McAuley, 2020).

Single-Case Experimental Design (SCED) Scale

For multiple baseline design and multiple probe design, scoring is done based on a SCED scale that scientifically provides an alternative for RCT for clinically determining the effectiveness of an intervention. The strongest SCED includes more than one participant. When comparing SCED with RCT, SCED requires fewer sources and can be performed in setting as well as on studies that do not require large populations. When implemented properly, SCED can provide a strong internal validity to determine the casual relationship between the intervention and outcomes as well as also control external validity when generalizing the finding on larger setting and populations. It is an 11-item rating scale where item 1 assesses clinical history information and items 2–11 allow for the calculation of a quality score (higher score equates to higher quality). No study provided information on power calculation. However, in SCED it is stated that the higher the scoring, the better the quality of the study (Lobo et al., 2017).

Data Analysis

Quality Assessment

The quality assessment of the included study was done by using PEDro and SCED.

PEDro was used for two RCT and both reported a good scoring of 8/10 (McDuffie et al., 2012; Yoder & Stone, 2006). Discussing MPD and MBD, SCED was used and reported as 7/10 (Chapin et al., 2022; Laubscher et al., 2019) and 8/10 (Alzrayer et al., 2020; Ganz et al., 2009; Sigafoos et al., 2018; Tan et al., 2014).

Interpretation of Result

Improvement Rate Difference (IRD)

In SCED, some researchers use IRD to analyze their data. It is a new overlap effect size for two contrasted phases (like baseline versus intervention, including generalization and maintenance if included in that corresponded study). Parker et al. (2011) estimated that IRD scores around .50 to .70 indicate a moderate effect, whereas scores ranging from .70 to .75 show higher effects (Lobo et al., 2017).

Tau-U Analysis

Some researchers analyzed their data by using Tau-U analysis. It is distributed as a free, nonparametric technique which is suitable for small sets of data that do not follow a normal distribution curve and is used to evaluate changes in the dependent variable. Tau-U analysis controls for monotonic trend and provides conservative effect size. According to Parker et al. (2011) the scores of Tau-U can be interpreted as 0.065 (weak effect), 0.66 to 0.92 (moderate effect), and 0.93 to 1.0 (strong effect; Lobo et al., 2017).

Along with this fidelity of treatment, in their study several researchers also assessed to what extend the treatment given by the primary practitioner is accurate. The analysis is either done by the same researcher involved in this study or by another person who is not part of the study, using a 5-point rating scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, 5 = *strongly agree*).

Result

Search Strategy and Systematic Review

A total of 1,292 articles were identified from various databases (PubMed, Web of Science, and Scopus). After removing duplicates, 468 articles were retained. Once title and abstract screenings were done, 31 articles were selected for full text review. Finally, eight articles met all of the inclusion criteria of this study: three MBD, two MPD, one MBD-MPD combination, and two RCT. Studies included in this review were performed on children with mean age between 18 months to 9 years. A total number of 88 participants with ASD who were minimally verbal with vocabulary ranging from one or more words, scripted phrases (Alzrayer, 2020; Chapin et al., 2022; Sigafoos et al., 2018; Tan et al., 2014) to less than 10 words (McDuffie et al., 2012; Yoder & Stone, 2006) were evaluated. Interventions were provided in schools, clinical settings (Alzrayer, 2020; Chapin et al., 2021; Ganz et al., 2009; Laubscher et al., 2019; Tan et al., 2014) and university-based clinical setting (McDuffie et al., 2012; Sigafoos et al., 2018; Yoder & Stone, 2006). Two out of six studies included VSD as their main intervention (Chapin et al., 2021; Laubscher et al., 2019), which were delivered to participants with mean duration of 3 to 4 months. SGD- and PECS-based intervention ranged between 4 to 6 months (Alzrayer, 2020; McDuffie et al., 2012; Sigafoos et al., 2018; Yoder & Stone, 2006). One study examined the effect of KWS and manual sign, where intervention lasted up to 3 weeks (Tan et al., 2014). Five out of eight articles focused on social communication and interaction either in the form of requesting, accepting, or rejecting items either desired or undesired, or of the participants with their partners. Speech production was included as an outcome variable in almost all the articles and delivered either through any modes of AAC, whereas behavior and expression were primarily focused in two articles.

Effect of AAC Intervention on Speech Production

Most of the selected articles either primarily or secondarily focused on speech production. Four out of eight articles showed significant improvement in speech production with AAC techniques like PECS, SGD, and KWS, while the remaining four were also on speech production in either form of requesting or rejecting.

A study done by Ganz and colleagues (2009) aimed at determining changes or improvement in speech production when PECS was used as a treatment aid. During baseline all three participants did not use any picture, whereas during intervention phases all three participants showed an increase in picture use ranging between 1 and 13, with an average of 6.6 picture exchanges. Two out of three participants showed a significant improvement in spoken words (0–100%). Data were analyzed using IRD for both baseline as well as intervention phases. IRD calculated in this study showed large effects for words used and speech production across all three participants. The treatment fidelity of this study was assessed by another observer for intervention phases, which ranged from 93 to 100% for all three participants (Ganz et al., 2009).

However, another study conducted by Alzrayer (2020) aimed at determining the proportional increase in speech production in children with limited requesting when they moved from PECS to SGD. All four participants showed a correct response using picture book across baseline, between 9 and 9.4 out of 10 responses. Whereas, for SGD-based requesting, none of the participants showed great vocalization during baseline, but after intervention phases all four participants and data showed a positive increase in vocalization value ranging between 7.4 and 9.3. Result gain from this study showed a significant improvement in speech production in children with limited requesting. This study used Tau-U analysis to analyze their data which ranged between 0.80 and 0.96, showing moderate to higher effects that were statistically significant, $p = .01$ (Alzrayer, 2020).

Figure 1. *PRISMA Flow Chart Diagram Depicting the Systematic Process Followed to Include Articles Captured in This Review*.

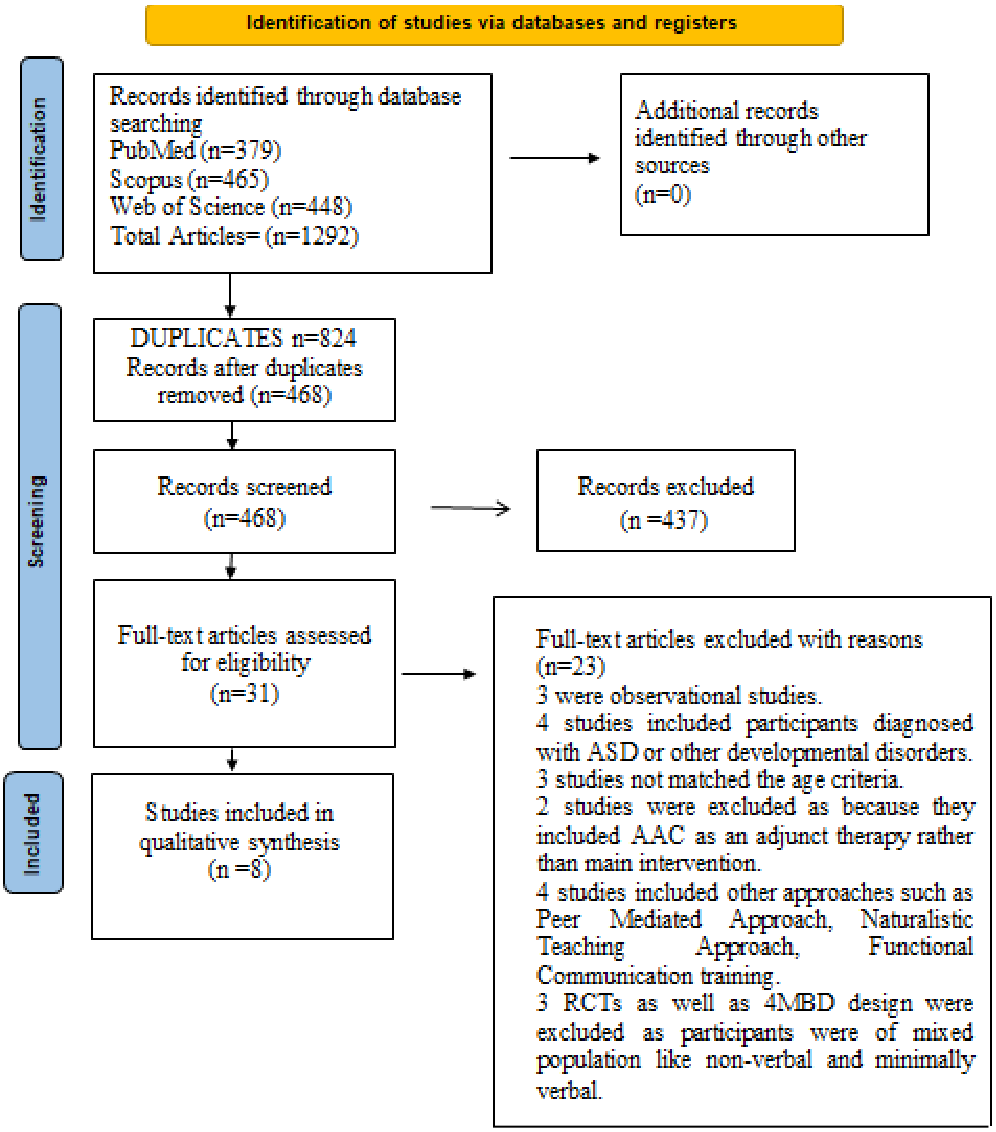

Table 1

Characteristics of the Included Randomized Controlled Trial Determining the Effect of Various AAC Interventions on Communication, Social Interaction, Speech Production, Behavior and Expression

Study	Design	Participants	Intervention setting	AAC intervention	Dependent variable	Outcomes	Interobserver agreement
Yoder & Stone, 2006	RCT	36 participants. 19 randomly allocated to PECS group and 16 to RPMT group.	Three 20-min individual therapy sessions over a period of 6 months.	PECS in comparison with RPMT.	Facilitating object exchange, turn taking, as well as requesting. ADOS and ESCS scales used for pre- and postassessment.	RPMT shows greater improvement as compared to PECS.	Mean interobserver agreement for PMRT was 99% and for PECS was 90%. Average ICC was 0.85 pretreatment and 0.95 posttreatment.
McDuffie et al., 2012	RCT	36 participants. 16 randomly allocated to PECS group and 16 to RPMT group.	Three 20-min individual therapy sessions over a period of 6 months.	PECS in comparison with RPMT.	Effect on object request. ADOS and ESCS scales used for pre- and postassessment.	Children in RPMT group showed greater increase in object request in comparison with PECS group.	Mean interobserver agreement for RPMT was 99% and for PECS was 90%. ICC for object interest was 0.90 at pre- and posttreatment.

Note. All participants met the criteria of having ASD unless otherwise indicated. This table is depicting two randomized controlled trials (RCT) included in the review, which fulfilled the criteria. ADOS: Autism Diagnostic Observational Schedule; ESCS: Early Social-Communication Scale; ICC: intraclass correlation coefficient; PECS: Picture Exchange Communication System; RPMT: Responsive Education and Prelinguistic Milieu Teaching.

Table 2

Characteristics of the Included Single Case Experimental Design (SCED) Determining the Effect of Various AAC Interventions on Communication, Social Interaction, Speech Production, Behavior and Expression

Study	Design	Participants	Intervention setting	AAC intervention	Dependent variable	Outcomes	Interobserver agreement
Ganz et al., 2009	MBD-MPD	Three children minimally verbal, age 3–6 years.	Clinical setting, ten 5-min sessions in each baseline and intervention phase, 3–5 times per week.	PECS with pictures.	Picture use. Words use. Maladaptive behavior.	Increase in picture exchange with increased request. Increase in word production with increased speech. Decrease in maladaptive behaviors.	Picture use during intervention was 100%, 94%, and 91%. Words use during intervention was 100%, 100%, and 67%. Maladaptive behavior was 97%, 100%, and 100%.

Table 2

Characteristics of the Included Single Case Experimental Design (SCED) Determining the Effect of Various AAC Interventions on Communication, Social Interaction, Speech Production, Behavior and Expression

Study	Design	Participants	Intervention setting	AAC intervention	Dependent variable	Outcomes	Interobserver agreement
Chapin et al., 2022	MPD	Three participants minimally verbal, age 3–5 years.	School setting, 5-min session, 2–3 times per week, in each baseline and intervention phase, over a period of 3 months for two children and 4 months for one child.	VSD with indiviualized set of videos based on child's interest.	Communicative turns (social interaction done by children) Speech or words used by children. Eye contact, body orientatior or movement with communication partner.	All three children exhibited increase in communication turns (social interaction). One child did not show significant increase in speech or words used. Increase in eye contact, body orientation, or movement with communication partner.	Interobserver agreement was 90.8% across all studies.
Laubscher et al., 2019	MPD	One participant minimally verbal, age 8 years.	School setting, 2-month period, conducted with 5-min sessions in each baseline and intervention phase, 3–5 times per week.	VSD	Effect of intervention on communication turn (social interaction).	Incease in communicative turns (social interaction).	Interobserver agreement was between 93% and 100%.
Tan et al., 2014	MBD	Three participants, minimally verbal, age 3–4 years.	Clinical setting, three 10-min sessions during baseline and intervention phase, over a period of 12 weeks with 3 sessions per week.	Use of KWS and manual sign.	Speech production and gestures.	All three childen showed a significant increase in speech production. One child did not show a difference in gestures, while the other two showed an increase in gestures.	Interobserver agreement was 87–94% from baseline to intervention.

Table 2

Characteristics of the Included Single Case Experimental Design (SCED) Determining the Effect of Various AAC Interventions on Communication, Social Interaction, Speech Production, Behavior and Expression

Study	Design	Participants	Intervention setting	AAC intervention	Dependent variable	Outcomes	Interobserver agreement
Sigafoos et al., 2018	MBD	Two participants, minimally verbal, age 7–9 years.	University clinic room, 1:1 teaching session once per week for ~60 min. One child had 19 weekly clinic visits over a period of 5 months and two children had 22 clinic visits over period of 6 months.	SGD	Requesting preferred items and rejecting nonpreferred item, communication responses for multifunction.	Results showed a positive response for communication and SGD used to treat different communication function in different contexts.	Interobserver agreement was 98% for one child and 95% for second child.
Alzrayeret al., 2020	MBD	Four participants, minimally verbal, age 3–5 years.	Clinical setting, one 15-min session per day, four sessions per week over a period of 4 months.	Moving from PECS to SGD.	Effect on speech production, PECS-based requesting and SGD-based requesting.	Increase in speech production on moving from PECS to SGD, as well as increase in requesting in childen with limited speech.	Interobserver agreement mean for SGD and PECS requesting was 99% and for speech production was 93%.

Note. All participants met the criteria of having ASD unless otherwise indicated. Experimental design included KWS: key word sign; MBD: multiple baseline design; MPD: multiple probe design; PECS: Picture Exchange Communication System; SGD: speech-generating device; VSD: visual scene display.

In RCT conducted by Yoder and Stone (2006), the study compared the efficacy of PECS with RPMT in facilitating object exchange, turn taking (social interaction), as well as facilitating request (speech production) with a hypothesis that PECS is superior in improving request in comparison with RPMT. The result also favored the hypothesis of this trial, and PECS was found to be superior in improving request in comparison with RPMT but only in those participants who were not taking any joint attention therapy or had not taken any other therapies. Pretreatment scales used were the Autism Diagnostic Observational Schedule (ADOS) and Early Social-Communication Scales (ESCS). The average ICC was 0.85 during treatment and 0.95 posttreatment. This study also used a 3-point fidelity of treatment rating scale (1 = *poor*, 2 = *good*, 3 = *excellent*) for both RPMT and PECS (Yoder & Stone, 2006).

This follow-up study by Yoder and Stone (2006) used a similar methodology aimed only at facilitating object request because that provides integral steps for social communication and help in acquiring spoken language. The result showed a significant improvement in object requesting in children who were undergoing RPMT treatment as compared with PECS. Objects that are basically used in our day-to-day routines are primarily enforced to the children, along with prompting and rewarding for intentional communication. The practitioner can use this routine object in a positive way on children. For building a triadic interaction with the children, routine action provides a better support. However, participants in this study were not getting joint attention initiation treatment, which could have influenced the findings of the study. Hence, results or improvements were purely based on interaction (i.e., RPMT or PECS). Scales used for preassessment were the same

(ADOS and ESCS), whereas the scales used for postassessment scale were the Mullen Scales of Early Learning (MSEL). Interobserver reliability was conducted for object request and found to be 0.90 (McDuffie et al., 2012).

A study conducted by Alzrayer (2020) showed a positive result in speech production in children with limited requesting when they moved from PECS to SGD. All participants showed a correct response using a picture book across baseline between 9 and 9.4 out of 10 responses. Whereas for SGD-based requesting, none of the participants showed great vocalization during baseline, but after intervention phase all the four participants and data showed a positive increase in vocalization value ranging between 7.4 and 9.3, showing a significant improvement. Tau-U analysis ranged between 0.80 and 0.96, showing moderate to higher effects that were statistically significant, p = .01 (Alzrayer, 2020).

A study by Tan et al. (2014) aimed to evaluate the effectiveness of keywords in manual sign on production of speech and gestures. All participants showed a significant increase in speech production; for gestures, only two participants revealed significant improvements. Tau-U analysis for two out of three participants' data ranged from 0.82 to 0.94, whereas p value was found statistically significant for speech production and ranged between .016 and .036 for all participants. The average reliability index for baseline was 85% to 97% and for intervention was 84% to 93% (Tan et al., 2014).

Effect of AAC Intervention on Social Communication and Interaction

Two articles used VSD as their treatment aid, and their findings suggest that VSD was effective in increasing social communication and interaction.

Laubscher et al. (2019) during baseline natural speech along with communication turn for participant for different activities was 11/47, 8/64, and 5/57, which increased postintervention to 35/47, 53/64, and 53/57, respectively. Tau-U analysis for all activities reported values between 0.1 to 1.0, whereas the mean Tau-U was 0.8, indicating large effect size following treatment. An average procedural integrity was 100% for both baseline and intervention (Laubscher et al., 2019).

Chapin et al. (2022) used the same intervention aid (i.e., VSD) but with different methodology. During baseline the communication turn taken by the participants was much less (i.e., 0–1), but following intervention all the participants showed a significant improvement in communication turns (social interaction). Tau-U analysis was 1.0 for all of the participants, showing a stronger effect size. The procedural integrity checklist for baseline, intervention, and generalization was found to be 100%, 97%, and 94%, respectively (Chapin et al., 2022).

Effect of AAC Intervention on Behavior

Ganz and colleagues (2009) indicated the efficacy of PECS improving maladaptive behavior. IRD of this study showed a questionable effect for maladaptive behaviors for all three participants because one participant showed a decrease in maladaptive behavior during baseline, followed with an increase in maladaptive behavior in intervention (i.e., 1.75–2.8); whereas two participants showed a decrease in maladaptive behavior during intervention and baseline phases but an increase in generalization phases ranging between 2.3 and 4.0, respectively (Ganz et al., 2009).

Effect of AAC Intervention on Expression

We found only one study primarily focusing on use of SGD as an effective mean for improving expression in children with autism.

In 2018, Sigafoos and colleagues' study result revealed heightened response for communication using SGD in treating communication in different contexts. Mean of one participant's rate of rejecting increased to 66.25% (0–100%), whereas another participant's rate of requesting improved up to mean of 40% (0–100%). A procedural integrity checklist showed 80–100% correct implementation (Sigafoos et al., 2018).

Discussion

The finding in this study primarily focused on the use of AAC to support communications and functions. through different forms of requesting like object request, accepting preferred items and rejecting nonpreferred items, socially interacting with the partners, and vocal requesting as well as commenting.

Functions like object request were taught successfully in all trials, according to McDuffie et al. (2012). For the development of spoken language and early communication, object-based routines provide a wide variety of skills that are important for this development. If children are provided different varieties of objects and play action, it gives them more opportunities to use different sets of vocabulary words. Addressing object request may help in overcoming problems like stereotypes and repetitive actions which an ASD child often faces. Hence, object request could be considered as developmentally appropriate and a strength-based goal for children with ASD who are minimally verbal (McDuffie et al., 2012).

Teaching skills in more social communication function (i.e., interacting, requesting, commenting) helps in establishing strength for children with ASD who are minimally verbal and could be a key to eventually increasing communication for purely social ends and consequences. Requesting for social games and routines or responses like greeting or acknowledgement of questions will direct towards more socially oriented outcomes (Laubscher et al., 2019).

Effect of AAC Intervention on Speech Production

According to Tan et al. (2014), PECS in ASD children showed a positive change in speech production and gestures. For clinical practice this study showed that the child with communication needs progresses from no use of sign to use of sign and speech for repertoire to communicate their wants and needs. At the end, the visual and statistical analysis from this study showed a significant improvement in speech production and gestures. It also suggests that for children with little functional speech communication this approach of sign and speech-based intervention was appropriate as it provides a model in sign of targeted vocabulary with addition of multiple prompts.

KWS is comprised of core vocabulary and fringe vocabulary. Fringe vocabularies contain specific words and messages individualized from person to person, whereas core vocabularies consist of words and phrases which are universal among all people. KWS is specially designed to provide support to children with complex communication needs like practicing social etiquette, exchanging information, and developing social interaction (Tan et al., 2014).

Ganz et al. (2009) discussed the use of PECS with respect to make request, use of words to increase speech and decrease in maladaptive behavior. This study showed a clear relationship between uses of pictures to make request when given PECS as an intervention aid and suggest a rapid acquisition of PECS by children with ASD; PECS was found to be effective for picture use for all three participants. Maladaptive behavior seen in participants might be due to rejection of undesired items or the participant ignorance by the surrounding people. Also, participant's maladaptive behavior examined during interventions was not targeted specifically as a primary variable. Investigation using PECS as treatment aid for longer duration could help in evaluating whether the changes found in these studies like decrease in maladaptive behavior were primarily due to PECS or some other factors affecting the decreased in behavior patterns. Studies could be done to investigate the effect of PECS on rate of speech or use of echolalia level in children with little or speech (Ganz et al., 2009).

Alzrayer (2020) supports and provides evidence that synthetics speech output devices like SGD have a positive effect on increasing spontaneous vocal requesting in children with limited functional speech. Speaking skills like vocalization, word approximation, and echolalia were all limited when requests were made from PECS, but after implementing SGD vocal production improved. Also, this synthetics speech output device increased participants' motivation to use this device for requesting. Findings also stated that participants opted more for SGD than PECS book during posttraining intervention, providing a support for the practitioner that they can transition between modalities when children learn discrimination skills. The practitioner should consider the allocated and effort response for determining the optimal AAC modality option for their learner (Alzrayer, 2020).

Effect of AAC Intervention on Social Communication and Interaction

AAC provides a new tool for supporting expressive communication in children with complex communication needs. Videos embedded in VSD have language concepts which provide a strong conceptual support for communication; familiar videos in VSD provide strong support for increasing communication turn for children who are minimally verbal or nonverbal (Chapin et al., 2022). Holyfield and colleagues also stated that an increase in communication behavior is the first step towards advanced communication (Holyfield, 2019).

VSD-based intervention is effective in increasing social communication and interaction in children with ASD, and this improvement was seen in a relatively short period of time. This communication turn from baseline to intervention was purely based on AAC application. In context of supported communication interaction, children learn new language and motor skills followed by increase in speech. These communication gain results are consistent with the earlier finding that AAC intervention does not hinder their speech production (Cagliani et al., 2017; Laubscher et al., 2019).

Effect of AAC Intervention on Expression

Sigafoos et al. (2018) provides the valid point that learning gained by the children through SGD helped them in accomplishing important communication function like expressing their wants, needs, and preferences, affecting minimally verbal children directly. Expressing one's needs and wants, accepting preferred items, and rejecting or not accepting nonpreferred items are all communication functions and typically the very first features in developing children. Therefore, these domains can be termed as foundational skills and should be to taught to children who are deprived of communication and social interaction, as appears in ASD children. Only one command and one symbol were given to the participants either in baseline or intervention phases. So, the change of error was rare and an easy learning environment was created, further suggesting that an errorless learning environment is appropriate for children who are initially learning AAC (Sigafoos et al., 2018).

Conclusion

The findings of this review display an emerging support for the effectiveness of both aided and unaided intervention in minimally verbal children with ASD in improving the wide variety of communication functions like object requesting, accepting preferred items and rejecting nonpreferred items, socially interacting with the partners, and vocal requesting as well as commenting.

Studies included in this review were based on high technology, like VSD and SGD, and low technology, like PECS and manual sign. All these aids provide effective tools for increasing communication in children with ASD who are minimally verbal, but high technology was found to be more effective in increasing social communication and interaction along with speech production and expression. Children also preferred high technology over low technology, although low technology like PECS and manual sign were found to be effective in increasing speech production (core vocabulary) and functional communication (requesting).

Addressing issues like delayed speech production, noninteraction, no communication turns, and finding out appropriate interventions offers the potential to reduce challenges faced by children with ASD (e.g., social communication) to a greater extent.

Future Scope

The studies in this review relevantly address significant communications and learning needs of children with ASD who are minimally verbal and provide an evident need for further research focused on varied communication functions which are socially motivated so as to improve the quality, quantity, and consistency of the evidence.

Areas for future research include investigating the effectiveness of both aided and unaided intervention on different populations like Down syndrome, or any pathological condition in people leading to delayed speech production or no speech at all. Also, a younger nonverbal population can be included. Studies directly focusing on maladaptive behaviors could be studied along with functional analysis to rule out the cause of this maladaptive behavior in ASD children. Other child-related factors like joint attention should also be taken into consideration as it predisposes children benefits more from one intervention to another. Requirement of different intervention mediates one's outcome. Studies need to be done to rule out whether AAC interventions are sustainable or generalizable. Future research can also help clinicians make an informed decision about more potential benefits of AAC intervention and how to implement AAC interventions in children with ASD for better results. Such studies may also provide support for children who do not respond to speech-focused intervention alone, where additional support is required.

Limitation

Due to scarcity of literature available in this area, MBD-MPD with only two RCT was included in this review, reducing the strength of evidence available. Because of the MBD-MPD baseline design, a well-defined pretreatment assessment was not elaborated, although posttreatment was purely based on interobserver agreement but procedural integrity was evident. For building and ensuring greater confidence in the relationship between intervention and outcomes in future research, addressing these concerns is very important.

Author Disclosure

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NeuroRegulation

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Hemodynamic and Pulmonary Safety Profile of the Accelerated Neuroregulation Procedure

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Abstract

Background. Opioid use disorder (OUD) affects an estimated 26.8 million people globally (Strang et al., 2020). In 2020, opioid overdose visits in the United States increased by 28 percent (Harringa, 2021). Opioid-dependent individuals now comprise an internationally and nationally recognized vulnerable population (Harringa, 2021). Effective, proven, and safe treatments for OUD are needed to improve quality of life and life expectancy and to decrease international and national costs of care for this vulnerable population (Florence et al., 2016). Accelerated neuroregulation (ANR) is an internationally recognized protocol for treatment of OUD and has been utilized for over 20 years in hospitals in Israel, Switzerland, Brazil, Georgia, and other countries. **Methods**. This study is a retrospective review conducted by a team of healthcare providers based on the medical record documentation of patients who underwent the ANR procedure and subsequent follow-up care at the ANR clinic located in Florida. Following review of clinical case data, a comparative of patient hemodynamic and pulmonary stability was selected as the criteria to evaluate the procedure's safety. **Results**. The study assessed a sample group of patients treated with the ANR procedure. The sample group consisted of 50 individuals who underwent the ANR procedure between November 2020 and February 2021. All patients treated during this period were included in the sample size, no exclusions were applied. **Conclusion**. The study analysis demonstrates that ANR procedures are a safe and effective treatment for OUD based on the stability of hemodynamic and pulmonary physiological response data.

Keywords: opioid use disorder (OUD); accelerated neuroregulation (ANR); opioid dependency; opioid dependency treatment; opioid dependency treatment safety; ANR safety; ANR physiological response

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In 2017, greater than 47,000 individuals in the United States died from opioid related overdoses (Strang et al., 2020). The continually growing opioid addiction epidemic contributes to poor public health and has serious social and economic implications (American Hospital Association, 2020). Estimates from the Centers for Disease Control and Prevention (CDC) indicate that the costs of healthcare and treatment services, decline in productivity, and involvement with the criminal justice system total over $78 billion a year nationally (Florence et al., 2016). Safe and effective treatment services that correct biochemical imbalances and reduce cravings are critical to help combat this drug crisis impacting increasingly vulnerable populations within the U.S. (Florence et al., 2016).

Accelerated neuroregulation (ANR) is a medical therapy for the treatment of opioid dependency and use disorder, a recognized medical diagnosis (Strang et al., 2020). Developed by Israeli doctor and intensive care specialist Dr. Andre Waismann, the treatment protocol addresses opioid dependency by correcting biochemical imbalances that exist between opioid receptors and endorphins in the central nervous system. The ANR procedure has been successfully applied for over 20 years internationally.

The goal of this retrospective study is to investigate the safety profile of the ANR procedure in a subset of patients from 2020 to 2021. The following data analysis describes the relationships between the ANR procedure and the physiological response to withdrawal (hemodynamic and pulmonary stability).

Background

ANR approaches opioid dependence and addiction from a scientifically based medical perspective. Shah and Hueker (2023) describe the complex nature of neuro-opioid receptors. ANR addresses the following three major key elements responsible for fueling opioid dependence on a neurobiological level:

1. what normal brain function looks like prior to opioid use,
2. the neuroadaptation that occurs from continuously exposing the nervous system to opioids, and
3. how modern medicine can reregulate the endorphin receptor system and return the brain to its pre-drug-dependent state.

The goal of the ANR procedure is to bring the nervous system back into balance by modulating it to decrease receptor production, while allowing the body to resume proper levels of endorphin production. ANR also allows the metabolizing and elimination of unnecessary exogenous opioids from the body. It is in achieving this cellular, neurochemical, and endorphin receptor rebalance that biophysical cravings, which are a hallmark of opioid dependence, are rendered inactive. The ANR procedure method is conducted under deep sedation to avoid the active suffering of opioid withdrawal symptomology, guaranteeing that all patients who undergo the ANR procedure will complete primary treatment and be followed by a period of consolidation treatment orally.

ANR Procedural Intervention

Pretreatment Evaluation. Prospective patients who arrive at the clinic are educated about the safety and effectiveness of the ANR procedure and treatment, including risks and benefits. Clinic staff respond to any questions posed by the patient and provide further clarification as needed. Once the patient consents to ANR treatment, a full medical history is conducted. Inquiries into substance abuse and other medical illnesses, allergies to medications, and anesthesia reactions are documented as noted in Table 1. Patients are screened for social determinants of health, psychosocial concerns, and psychiatric illnesses. Additionally, the patient is assessed for their level of motivation for the treatment and existing support systems.

Based on the patient's medical history, a full physical examination is then completed. If necessary, additional examination may include but is not limited to laboratory studies, electrocardiogram, spirometry, imaging studies, echocardiography, and ultrasonography. This is completed 2 to 3 weeks prior to the ANR procedure. A consultation with an anesthesiologist with critical care medicine expertise is scheduled. The consulting anesthesiologist will then be involved in intubating and administering the anesthetic (moderate to deep sedation) portion of the treatment. At any point in time, additional specialists may be consulted if needed based on the examination and assessment.

Table 1
Potential Risk Factors Associated With ANR Treatment

Type	Risk Factors
Health History	Liver, renal, heart, and lung, and metabolic disorders. Allergies to medications.
Procedural	Prior complications associated with anesthesia. Allergies to anesthesia medications. Complications from the placement of vascular access (thrombophlebitis, Pneumothorax).

Note. ANR = accelerated neuroregulation.

Patients are excluded from treatment if they fall into category IV or V of the American Society of Anesthesiologists (ASA) physical status classification system (ASA, 2020). Patients who fall into category III are also considered for exclusion; however, the decision whether to exclude the patient from ANR treatment is based on anesthesiologist clinical judgment and how well their health has been coordinated by their primary care provider.

If there are no contraindications found in the preevaluations, examinations, assessments, and consultations, then the patient is admitted to the hospital on the day of procedure and prepared per procedural protocol for the ANR intervention. A final consultation is held one day proximal to the hospital admission.

ANR Treatment Protocol Overview. The ANR procedure protocol includes four treatment steps:

1. In the first 5 hours before onset of anesthesia, medications are administered for regulation and stabilization of the autonomic nervous system as noted in Table 2.
2. After preprocedure medications are given, the patient is intubated and anesthesia with propofol is introduced. Naltrexone administration is then started. Patients receive two to three individually titrated doses of naltrexone over 5 to 6 hours via gastric tube. A circulation-stabilizing and sedating concomitant medication prevents heart, circulatory, respiratory, or cerebral reactions.
3. After the blockade, the endorphin system becomes suppressed. Patients are monitored, assessed, and provided intervention(s) with 1:1 care from the intensive care or anesthesia nursing staff. After the anesthesia and extubation are accomplished, the patient remains in the postanesthesia care unit setting for another 2 to 3 hours for monitoring.
4. During the postacute phase, naltrexone is taken in tablet form during 4 to 12 months of consolidation treatment to ensure success as noted in Table 3.

Table 2

Medications Given Prior to Anesthesia

Medication	Purpose
Benzodiazepine	Reduce treatment day anxiety
Histamine H_2 antagonist (H_2 blocker)	Prophylactic prevention of bronchospasms
Alpha-2 Agonist	Lowers blood pressure and heart rate; providing a cardioprotective physiological state
Vitamin C	Acidifies metabolism; facilitates elimination of opioids from system

Table 3

Consolidation Naltrexone Treatment Parameters for ANR Post Procedure

Length of Opioid Dependency	BMI	Dose of Naltrexone	Duration of Naltrexone Regiment
3 years of less	18.5–24.9	25–50mg	Minimum 4 months
3–7 years	25–29.9	25–50mg	6–12 months
Greater than 7 years	30 or greater	50–75mg	Minimum 12 months

Note. ANR = accelerated neuroregulation; mg = milligrams.

Methods

This study is a retrospective review conducted by a team of healthcare providers based on the medical record documentation of patients who underwent the procedure and subsequent follow-up care at the ANR Clinic located in Florida. Following review of clinical case data, a comparative of patient hemodynamic and pulmonary stability was selected as the criteria to evaluate the procedure's safety.

Study Sample

This study investigated a random sample of patients who underwent ANR procedures between 2020 and 2021. The following provides an overview of data collection processes for the sample.

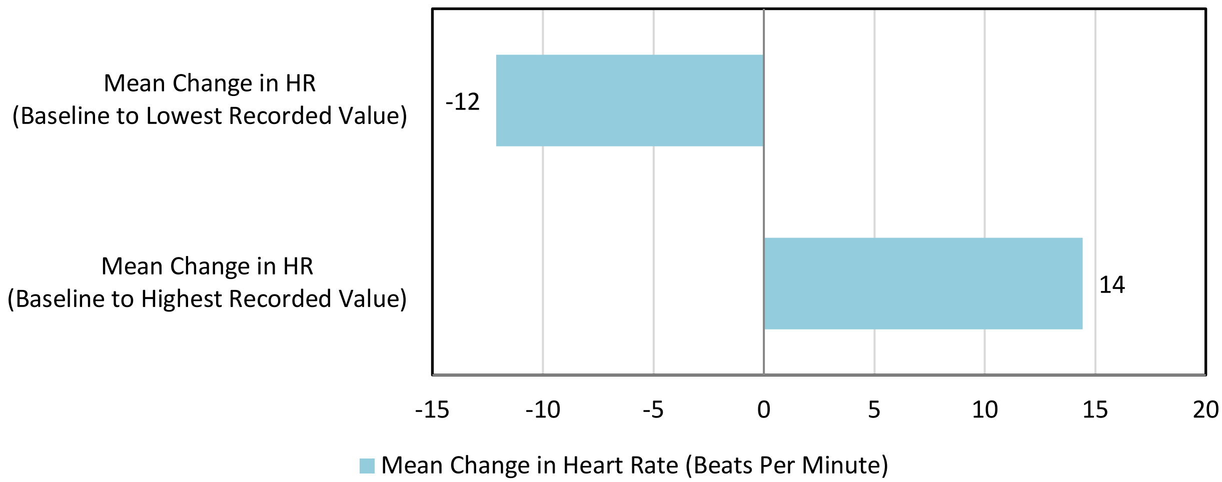
Hemodynamic and pulmonary data were collected on a total of 50 patients who received ANR treatment at the ANR Clinic located in the U.S. in 2020 and 2021. Mean heart rate (HR), systolic and diastolic blood pressure (BP), and oxygen saturation were recorded at baseline, during, and after the ANR procedure. Baseline hemodynamic and pulmonary data were recorded every 15 min upon patient admission to the hospital and prior to induction of anesthesia. At induction of anesthesia, hemodynamic and pulmonary evaluations were recorded every 5 min, and continued until the patient was 30 min postextubation. Once the patient was considered stable, they were transferred to their room for posttreatment care where their hemodynamic and pulmonary data were recorded every 4 hours.

Results and Analysis

Heart Rate Variability During ANR Procedure

To calculate variability, the highest and lowest recorded HR during the ANR procedure for each patient was utilized. Baseline values were subtracted from each of these highest and lowest values and then averaged, respectively, across the sample. Results showed that HR decreased on average by 12 beats per minute (bpm) and increased by 14 bpm from baseline (Figure 1). Since the highest and lowest HR values were used, these averages represent the maximum delta, or change (i.e., upper and lower boundary) from baseline levels. As a result, these data show minimal HR variability during ANR procedure, given that they are still within normal physiological parameters (American Heart Association [AHA], 2021a). Moreover, no adverse events were reported at any interval during or immediately after the procedure and at 1 hour, 2 hours, 4 hours, or 6 hours post-ANR treatment. No variability in hemodynamic and pulmonary data were reported.

Figure 1. *Changes in Mean HR From Baseline During ANR Procedure.*



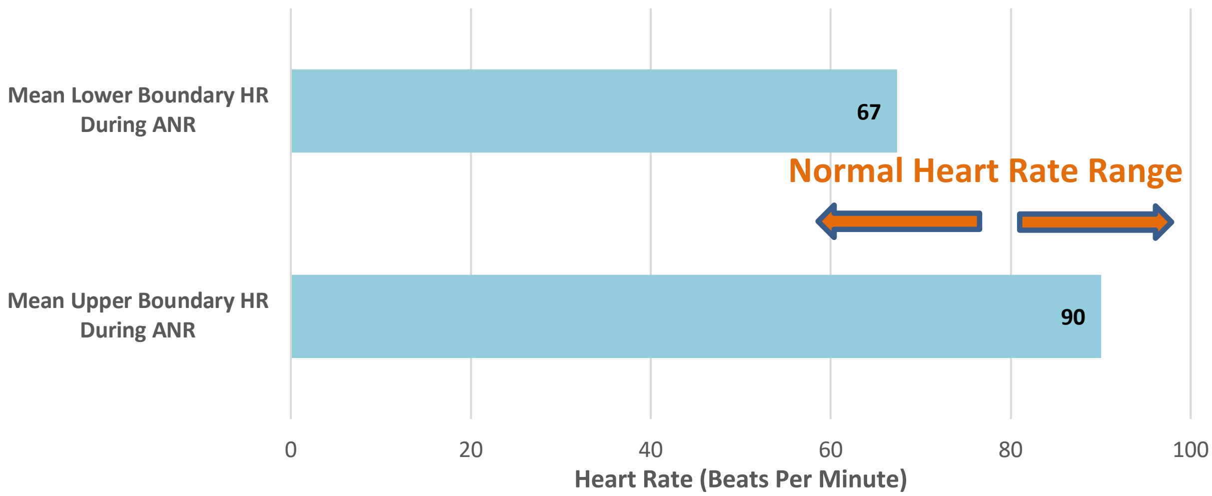
Note. ANR = accelerated neuroregulation; HR = heart rate in beats per minute.

Average lowest and highest HR during the ANR procedures was 67 bpm and 90 bpm, respectively (Figure 2). Additionally, standard deviation for the lowest and highest HR was 12.8 and 10.5, respectively. According to the AHA (2021a), normal HR ranges from 60 to 100 bpm. HR for this sample of patients was within the boundaries of normal parameters (AHA, 2021a). Moreover, incorporating the means associates HR within normal HR parameters. This supports ANR procedure safety as the procedure does not contribute to abnormal HR or reported cardiovascular abnormalities during procedural treatment.

Blood Pressure Variability During ANR Procedure

Similar to HR data, highest and lowest BP values were reviewed for this analysis. Baseline BP was subtracted from each highest and lowest recorded value and then averaged, respectively, across the sample. During ANR procedures, average systolic BP decreased by 26 mm Hg and increased by 13 mm Hg from baseline (Figure 3). Also, average diastolic BP decreased by 18 mm Hg and increased by 9 mm Hg from baseline (Figure 4). Like HR, the mean BP values represent the maximum difference (i.e., upper and lower boundary) from baseline. As a result, these data points also suggest minimal mean systolic and diastolic BP changes during ANR procedures from baseline. Mean upper boundary

Figure 2. *HR Mean During ANR Procedure Compared to Normal Physiologic Range.*

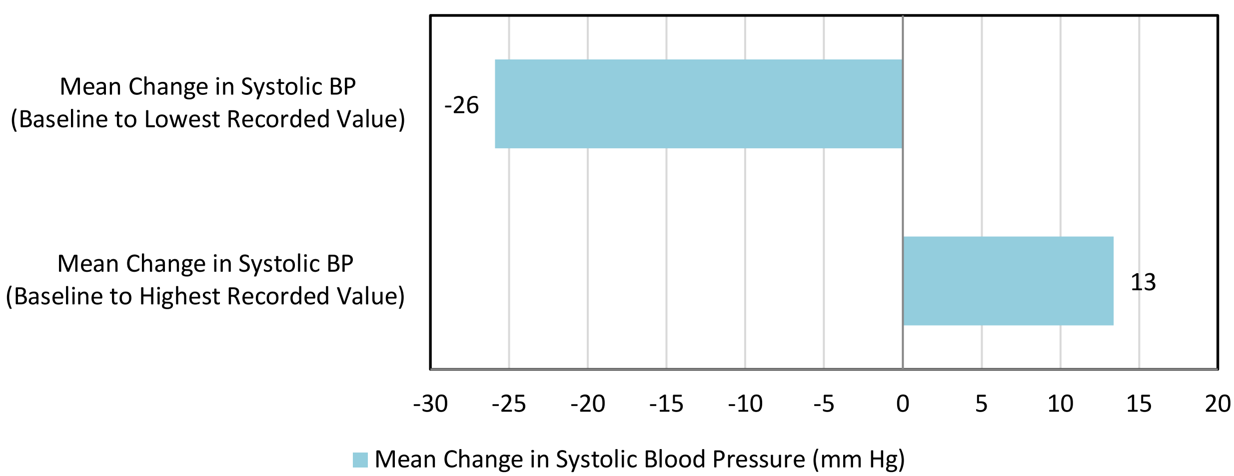


Note. ANR = accelerated neuroregulation; HR = heart rate in beats per minute.

diastolic BP during ANR procedures was within normal range (Figure 5) and BP normalized posttreatment (Figure 5). These data points suggest that while BP increases during treatment, the ANR procedure does not alter long term hemodynamics in any adverse way.

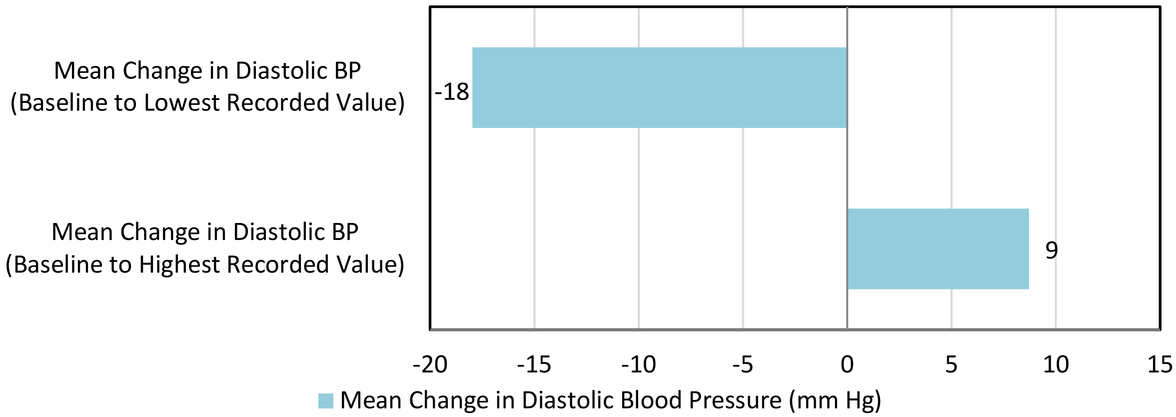
According to the AHA (2021b) and the CDC (2021), normal systolic and diastolic BP are less than 120 mm Hg and 80 mm Hg, respectively. Approximately 60% of the patient sample had elevated systolic BP according to the AHA (2021b) and CDC (2021) guidelines. Mean systolic BP was 128 mm Hg (Figure 6). During ANR, mean lower and upper boundary (i.e., mean maximum and minimum values from baseline) were 103 mm Hg and 139 mm Hg, respectively. Although BP transiently increased during the ANR procedure, this may be attributable to induction of opioid withdrawal which reflects the physiological symptomology response that is associated with a release of catecholamines (Shah & Huecker, 2023).

Figure 3. *Mean Change in Systolic BP During ANR.*



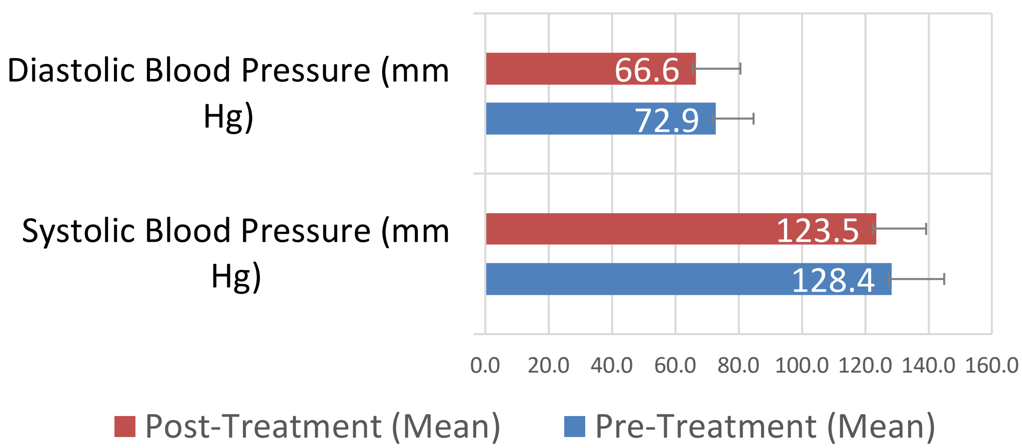
Note. ANR = accelerated neuroregulation; BP = blood pressure; mm Hg = millimeters of mercury.

Figure 4. *Mean Change in Diastolic BP During ANR Procedure.*



Note. ANR = accelerated neuroregulation; BP = blood pressure; mm Hg = millimeters of mercury.

Figure 5. *Mean BP Normalizes After ANR Procedure.*

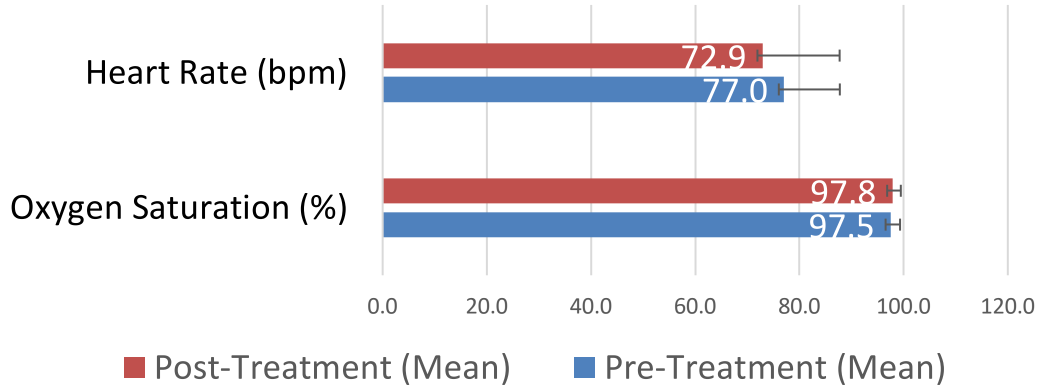


Note. ANR = accelerated neuroregulation; BP = blood pressure; mm Hg = millimeters of mercury.

Oxygen Saturation During ANR Procedure

Highest and lowest oxygen saturation values were recorded during ANR procedures and reviewed for this analysis. These values were then normalized from baseline (i.e., subtracted from each highest and lowest recorded value) and averaged, respectively, across the patient sample. Average lower and upper boundary oxygen saturation levels during treatment were 96.8% and 99.1%, respectively. From pre- to post-ANR procedure, mean oxygen saturation changed approximately 0.3% (Figure 6). As normal physiological oxygen saturation at sea level is between 96% and 99%, this suggests minimal fluctuation during ANR procedure (Shaikh, 2022). No adverse events related to oxygen saturation (i.e., hypoxia or difficulty breathing) were reported during treatment for this sample of patients. As a result, patients demonstrated pulmonary stability during and after ANR procedure.

Figure 6. *Mean Heart Rate and Oxygen Saturation Pre- and Post-ANR Procedure.*



Note. ANR = accelerated neuroregulation; BP = blood pressure.

Conclusion

Results showed no significant variability in cardiovascular or hemodynamic data during any interval of ANR procedure (i.e., intra- or posttreatment). Additionally, no adverse events related to oxygen saturation (i.e., hypoxia or difficulty breathing) were seen during any interval of ANR procedure for this subset of patients. As a result, patients who underwent the ANR procedures demonstrated hemodynamic and pulmonary stability during and after ANR treatment. This preliminary evidence shows that the ANR procedure is a safe and effective procedure with low risks resulting from a structured, evidenced-based protocol and treatment plan.

Advantages of ANR Treatment

Induced withdrawal as a result of ANR procedures reduces the adverse withdrawal symptomology. Non-ANR treatments (rapid detoxification) typically do not rebalance or return opioid receptors back to their original status and result in adverse symptomology and long-term effects for the patient. As a result, patients undergoing these treatments still have cravings and are at increased risk for relapse. The ANR procedure achieves the therapeutic goal of rebalancing the entire endorphin receptor system while providing a safe intervention with few adverse effects.

Author Disclosure

We have no known conflict of interest to disclose.

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Proceedings of the 2023 ISNR Annual Conference: Keynote and Plenary Presentations

Selected Abstracts of Conference Keynote and Plenary Presentations at the 2023 International Society for Neuroregulation and Research (ISNR) 31st Annual Conference, Dallas, Texas, USA

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KEYNOTE PRESENTATIONS

Homeostatic Normalization of Alpha Brain Rhythms Within the Default Mode Network and Reduced Symptoms in PTSD Following a Randomized Controlled Trial of EEG Neurofeedback

Dr. Tomas Ros
University of Geneva, Geneva, Switzerland

Collective research has identified a key electroencephalogram (EEG) signature in patients with posttraumatic stress disorder (PTSD), consisting of abnormally reduced alpha (8–12 Hz) rhythms. We conducted a 20-session, double-blind, randomized controlled trial of alpha-desynchronizing neurofeedback in patients with PTSD over 20 weeks. Our objective was to provide mechanistic evidence underlying potential clinical improvements by examining changes in aberrant PTSD brain rhythms (namely, alpha oscillations) as a function of neurofeedback treatment. We randomly assigned participants with a primary diagnosis of PTSD ($n = 38$) to either an experimental group ($n = 20$) or sham-control group ($n = 18$). In line with our earlier studies, the experimental group received desynchronizing neurofeedback aimed at reducing alpha power (see Kluetsch et al., 2013). A multichannel EEG cap was used to record whole-scalp resting-state activity pre- and postneurofeedback treatment for both the experimental and sham-control PTSD groups. We firstly observed significantly reduced relative alpha source power at baseline in patients with PTSD as compared to an age and sex-matched group of neurotypical healthy controls ($n = 32$), primarily within regions of the anterior default mode network. Posttreatment, we found that only PTSD patients in the experimental NFB group demonstrated significant alpha resynchronization within areas that displayed abnormally low alpha power at baseline. In parallel, we observed significantly decreased PTSD severity scores in the experimental neurofeedback group only, when comparing baseline to posttreatment (Cohen's $d = 0.77$) and 3-month follow-up scores (Cohen's $d = 0.75$), with a remission rate of 60.0% at the 3-month follow-up. Overall, our results indicate that neurofeedback training has the capacity to rescue pathologically reduced alpha rhythmicity, a functional biomarker that has repeatedly been linked to symptoms of hyperarousal and cortical disinhibition in PTSD. This randomized controlled trial provides long-term evidence suggesting that the "alpha rebound effect" (i.e., homeostatic alpha resynchronization) occurs within key regions of the default mode network previously implicated in PTSD.

School Failure, Scientific Correlates (qEEG-HCF) New Contributions of Neurofeedback Treatment

Monica Pistoia
Cognitive Neurosciences Center (CoNoCe), Valencia, Spain

Nowadays, school failure is considered a public health problem with a prevalence of 60% of the world population. Economic, geopolitical, and psychological factors are among the most relevant causes. There are, however, neurobiological causes that are largely overlooked by primary care professionals, as well as unknown to many professionals in the academic field. This particularity leads to the fact that certain neurodevelopmental disorders present late and ineffective therapeutic actions. The scientific literature reports that the population with severe learning disorders show low levels of effectiveness in pharmacological treatments and long periods of time to compensate for the difficulties through specialized didactic programs. In the last decades, thanks to neuroimaging studies in people with learning disabilities, structural and functional abnormalities in brain connectivity have been evidenced, which certify the academic alterations to which between 5% to 15% of the child population is subjected (DSM-5-2014).

The scientific literature of the last decades shows benefits with neurofeedback (NFB) treatments in neurodevelopmental disorders, being conclusive in attention-deficit disorders in its different subtypes. However, in learning disorders, it begins to have more evidence in recent decades. There is evidence suggesting that NFB treatment allows the improvement of learning difficulties presented by this population; training the brain electrical activity, especially with the use of quantitative electroencephalogram (qEEG) studies, which allow personalized protocols.

This lecture will focus on the evidence of the last years in the treatments for NFB in the field of neurodevelopment (ADHD, autism spectrum disorders, specific language disorders, learning disorders, and others), with greater incidence in learning disorders. The presentation will be focused on the explanation of different clinical cases evaluated objectively in their superior cortical functions (FCS) through standardized techniques such as Wisconsin Card Sorting Test, Continuous Performance Test, Rey Complex figure Test, RAVLT, Trail Making Test, and others; as well as quantitative electroencephalograms (qEEG) pre–post NFB treatment.

Hang 'Em High: Neurotoxicology and qEEGs in Tort Evaluation

Gerson Somoger
Smoger and Associates, PC, Dallas, Texas, USA

There is no debate that the diagnosis of mental health disorders has dramatically risen over the past 100+ years. However, it is equally likely that this increase is not merely a result of analytical advances and changing lifestyle but also due to a rapidly increasing exposure to neurotoxic agents. At the same time those economically benefiting from the pervasive use of neurotoxins have sought to minimize this toxicity and create scientific debate about whether the pervasive effects are causative. This debate has often been designed to propagate a balancing test as to what constitutes responsible corporate conduct and who should bear the ultimate responsibility for the costs related to what may be described as abnormal brain function. If those disseminating the toxins are responsible for abnormal brain function as a result of their metallotoxins (most notably lead) and lipophilic toxins, etc., then how does the judicial system allow for recompense based upon that neurotoxicity? Can such necessary proof rely on neuropsychological tools, such as qEEGs?

The Good, the Bad, and the Ugly: Psychology and Human Rights

Gerson Somoger
Smoger and Associates, PC, Dallas, Texas, USA

Psychologists and psychology have played a pivotal role in the evaluation of human rights, both in relation to abuses and analysis and treatment for the ramifications of that abuse. This part of the talk will discuss three aspects of the intersection of human rights with psychology over the last 2 decades.

The first will be what I have termed "the ugly." Psychologists James Mitchell and Bruce Jessen employed the learning and research of the mental health profession to implement an interrogation regime which they described as "enhanced interrogation techniques" and others have described as torture. Should it have been justified? See the U.S. Supreme Court brief I wrote: https://www.supremecourt.gov/DocketPDF/20/20-827/188164/20210820153945725_20-827%20USA%20v%20Zubaydah%20Brief%20of%20Amici%20Curiae%20in%20Support%20of%20Respondents.pdf

The second is what I term "the bad." A purported psychological syndrome, known as "Excited Delirium," has pervaded law enforcement and been routinely diagnosed to justify an extraordinary use of great force on the basis that the condition could impart superhuman strength to individuals when undergoing arrest. While the psychological diagnosis remains in many police manuals, in the past few years it has been disowned as a diagnosis by almost every major medical diagnostic body.

And for "the good"? Throughout the world, and particularly in the global south, there are significant barriers to mental health services, including cost, stigma, a lack of privacy where therapy is offered, and a lack of compassion and sensitivity from poorly trained medical staff. In this gap, Photovoice, a participatory methodology that encourages survivors of sexual violence to reflect on and document their experiences using cameras and recordings has been developed to give the survivors a voice.

PLENARY SESSION PRESENTATIONS

Unlocking Understanding: Helping Novice Practitioners Explain Neurofeedback in Clear and Simple Ways

Dianne Kosto
SYMMETRY Neuro-Pathway Training, Ridgeland, South Carolina, USA

Are you interested in providing neurofeedback but uncertain where to start? In this presentation, we will provide a beginner's guide to brain training and demystify the process of neurofeedback. You don't have to be a neuro guru to use neurofeedback, we'll show you how to make it simple.

We will begin with an overview of neurofeedback, including its history and the ways it creates changes in the brain's white and gray matter. We will also examine the different applications of neurofeedback, including managing symptoms related to stress, improving focus and attention, and better regulating mood and behavior.

Next, we will provide hands-on demonstrations to show you how to conduct a neurofeedback session, including setting up the equipment, applying sensors to the scalp, and interpreting the data.

You will learn to understand the basics of neurofeedback, identify the various types of neurofeedback equipment and technology, and how to conduct a basic neurofeedback session.

Based on the content of this presentation, the participant will be able to interpret the data gathered during a neurofeedback session, incorporate neurofeedback into an existing healthcare or wellness practice, and understand the applications of neurofeedback in brain training.

We will also discuss best practices for integrating neurofeedback into a healthcare or wellness practice, including how to introduce the concept to clients, set up a session, and incorporate it into existing care plans. This presentation will also provide professionals with valuable information on how neurofeedback can benefit current services by working in tandem with traditional modalities of therapy.

Incorporating neurofeedback into your practice can be a game changer for your clients, as it helps the brain learn to better regulate. When the brain is functioning better, hope and relationships are restored, and life is brighter. Don't miss out on the opportunity to add this powerful tool to your practice. Join us for this beginner's guide to neurofeedback.

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Stop the Madness! Towards a Sane Approach to Independent Components Analysis With EEG

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This talk will summarize current status of the uses of independent components analysis (ICA) in EEG and present an alternative approach to using ICA to remove artifacts related to eye and muscle activity. This approach provides automated processing with or without human intervention, consistency of results, and minimization of distortion in the cleaned EEG signals. The method employs an industry-standard ICA algorithm, in combination with well-defined decision-making rules that detect likely artifact components without requiring human judgment and without using artificial intelligence methods.

ICA is a statistical technique that has been adopted in various forms for the processing of biological signals in general, and MEG and EEG data in particular. It offers powerful capabilities in being able to identify component dipoles in the signal, using a blind separation technique. Based on multiple iterative passes, ICA teases out the most powerful single dipole sources and finds the amplitude of each source in each channel. In doing so, the process by definition will detect the effects of volume conduction, effectively reversing the forward projection of potentials from the brain to the scalp.

When using ICA to clean EEG signals, the process consists of computing the ICA and the associated mixing matrix, selecting which components to remove ("zero out"), and then computing the reverse transformation to recover the cleaned EEG signal. Approaches to use of ICA fall along two basic lines.

One is to present the ICA components in a graphical or topographical form and leave it to the user to determine which components are to be rejected. This leads to a process that has to be learned and can lead to errors of the types described. The various positions taken with regard to ICA are:

1. Do not use ICA
2. Use ICA and resort to human judgment to guide component rejection
3. Use ICA and resort to artificial intelligence (e.g. neural networks) to guide component rejection

The approach described here takes a different path. That is, to use ICA and to then use simple, mechanical rules to select components to be rejected, focusing on EOG and EMG-related sources only. The approach is designed to err on the conservative side, which is to retain any components in question, and not remove them from the EEG. This approach is found to provide reliably artifacted EEG signals that may include some artifacts that could be removed but are kept in for the sake of avoiding erroneous rejections ("don't throw out the bathwater with the baby").

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Abnormal Pediatric EEGs and Neuroanatomy: Autism, Learning Disabilities, and Developmental Trauma

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The most common childhood pathologies of dyslexia, dyscalculia, attention-deficit/hyperactivity disorder (ADHD), and autism spectrum disorder (ASD) are those that enter our clinics seeking the silver bullet to change the course of their diagnosis. For this reason, it is paramount that the clinician successfully differentiates pathology for normalcy and identifies those findings that are specific to different disabilities.

The comorbidity of developmental disabilities and developmental trauma (e.g., abuse, neglect, molestation, etc.) is another level of discernment necessary for the clinician; these two sources of developmental creation, genetic and environmental, comingle and can confuse even the most skilled of us.

This lecture will cover: (a) the eight EEG profiles of attention-deficit/hyperactivity disorder (ADHD), as well as the impostor profiles of greater clinical significance that require referring out; (b) the neurobiology and neuroanatomical differences of dyslexia/dyscalculia vs. autism; (c) the EEG findings common in dyslexia and dyscalculia; (d) the EEG findings common in ASD; and (e) the most common findings in cases of childhood abuse and neglect.

The identification of physiology accompanying developmental symptoms, as well as differentiation from normal findings will serve the savvy clinician in protocol selection, montaging, and the targeting of modalities for their clients' success.

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Psychoneurobiological Correlates of Beta Activity

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Chronic stress and anxiety in everyday life can lead to sympathetic hyperactivity. This can be observed as behavioral, chemical, and neurological changes, including increased rumination, anxiety, and depression, and chemical changes in biological markers like homocysteine. There has been increasing evidence that suggests a correlation between resting-state electroencephalography (EEG) activity and anxiety symptoms in patients. Specifically, an increase of beta (13–30 Hz) and a decrease in alpha (8–12 Hz) waves have been associated with higher states of anxiety (Hammond, 2005; Ribas et al., 2018; Tharawadeepimuk & Wongsawat, 2014; Thompson & Thompson, 2007). Furthermore, studies evaluating methods of reducing anxiety have found that a decrease in beta activity is directly correlated with lower anxiety levels (Sherlin et al., 2010; Walker, 2010). These results have been consistently verified across multiple clinical conditions (e.g., PTSD, anxiety spectrum disorders) as well as across diverse anxiety treatment methods such as from neurofeedback therapy to SSRI treatments to mindfulness and meditation, overall, confirming the relationship between beta wave activity and anxiety factors. The Neurocycle (Leaf, 1990, 2021) is a 63-day mind-directed self-help mental health program created by Dr. Caroline Leaf that is implemented in three phases of 21 days for a total of 63 consecutive days. These three phases are administered through the Neurocycle app, in which participants are directed via daily audio and video recordings through the five-step Neurocycle process of gather awareness, reflect, write, recheck, and active reach, which provide a scientifically validated framework for participants to identify, face, process, and manage intrusive toxic thoughts that cause distress, including symptoms of anxiety and depression (Idris, 2020; Leaf, 1997, 2021). The current paper presents a pilot study that assessed the Neurocycle's efficacy as a nonpharmacological mind-management therapy for people who struggle with anxiety and depression. We assessed psychometrics, blood-serum homocysteine levels, and quantitative electroencephalography (qEEG). Efficacy of the Neurocycle was demonstrated by improved psychometric self-assessment over the study. We observed a positive correlation between subject's low beta relative power and homocysteine levels. The findings validate the Neurocycle's efficacy for improving mental health as measured by behavioral, chemical, and neurological measures. Altogether, these findings support low beta's role in stress and anxiety manifestation given that its modulation significantly correlated with stress biomarkers in patients' blood samples and stress and anxiety self-assessments. Future work should expand these findings with larger datasets to confirm the ranges of healthy and maladaptive low beta.

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Literary Review on the Effectiveness of Neurotherapies in the Treatment of Complex Trauma

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In terms of clinical treatment-resistant populations, the most commonly used therapeutic interventions such as cognitive behavioral therapy (CBT) and exposure therapy have not yet been fully effective in the treatment of PTSD, developmental or complex trauma. Therefore, there is a clinical necessity and an ethical duty to find alternative ways to address these devastating lifelong symptoms, which if left untreated can develop not only into other debilitating psychological and medical conditions to the individual, which as per van der Kolk's and colleagues research ensue a significant financial cost to society at large. Recent neuroimaging advancements such as electroencephalography (EEG) neurofeedback therapy and brain/computer interaction (BCI) have contributed to a groundbreaking understanding of brain function, and it may postulate a plausible solution to hard-to-treat clinical cases. However, neuropsychology, psychophysiology, or applied neuroscience are still unavailable from the current clinical psychology program's curriculum for present graduate-level students. Therefore, the aim of this study is to primarily investigate the effectiveness psychophysiological neurotherapies for complex trauma and to raise awareness regarding the prevalence and magnitude of the developmental and complex trauma and to promote and advance interest and further research of neurotherapies for trauma-related issues due to its potential effectiveness in therapeutic settings.

Study Design. This research was conducted with Pepperdine University library resources, more specifically, focusing on peer-reviewed journal articles from psychological databases such as PsycINFO and EBSCO Publishing online from 2016 to 2022, including the following keywords: ("neurofeedback" OR "neurofeedback therapy") AND ("trauma") AND ("PTSD" OR "post-traumatic stress disorder"). Twenty-four articles were considered for the study. Out of the preselected articles, 14 studies were excluded. Exclusion parameters consisted of eliminating those involving other comorbidities, unrelated treatments and techniques, or any non-trauma-related neurofeedback studies.

Discussion. Despite all the existing discrepancies in methodologies, procedures, and protocols in neurofeedback therapies, all studies included in this review have shown positive therapeutical results in treatment-resistant trauma patients diagnosed with complex trauma, PTSD, and/or developmental trauma.

Conclusion. In sum, all included studies show consistent results in favor of EEG-NF. One of these four reviewed studies reported significantly improved level of executive functioning and another study showed a reduction in the use of psychotropic medication for complex PTSD treatment-resistant participants. All the aforementioned studies suggest that treatment with EEG-based NF may improve PTSD symptoms in adult patients with PTSD and complex trauma.

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Fueling the Fire of Fight-or-Flight: Addressing the Psycho-Neuroimmunological Effects of Chronic and Traumatic Stress

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The immune system is a highly intelligent network of cells and organs from various body systems, all of which work together to fight illness and disease, as well as maintain internal homeostasis (Dantzer, 2018). Immunocompetent cells in the brain, called microglia, play a key role in these interactions. Microglia are involved in a wide variety of neurological processes, including nurturing and structurally remodeling neurons, monitoring the environmental conditions surrounding neurons, and protecting the brain against outside invaders (Macht & Reagan, 2018).

Chronic and traumatic stress tend to activate the immune system in a maladaptive manner, causing microglia to release inflammatory cytokines and triggering a cascade of chronic inflammation throughout the brain and body (Picard et al., 2021). This creates a cumulative allostatic burden, leading to impaired neurological processes, altered neurotransmitter metabolism, and physiological imbalances. Such alterations contribute to the pathogenesis of various mental health challenges, including chronic PTSD and other stress-related disorders (Ravi et al., 2021). Epidemiological studies have also verified comorbidities between these psychiatric disorders and inflammation-related illness, as well as elevated proinflammatory markers in the bloodstream (Hori & Kim, 2019). The molecular consequences of this stress-perpetuating cycle further amplify systemic inflammation, thus continuing the feedback loop (Miller et al., 2018).

In this session, we will review important connections between the brain and immune system, as well as potential underlying roots, mechanisms, and consequences of inflammation. We will explore how stress plays a role in the manifestation of inflammation, as well as how inflammation can contribute to and exacerbate stress-related disorders. As part of this discussion, we will cover the basic science of psychoneuroimmunology, as well as specific factors, such as the cell danger response, microglial activation, oxidative stress, mast cell activation, mitochondrial dysfunction, and chronic inflammatory response syndrome. Furthermore, we will examine both neuroimaging research and clinical findings to identify neurophysiological patterns associated with inflammation. We will also discuss other forms of testing to evaluate immune dysregulation as well as identify underlying roots and consequences.

Lastly, we will explore a variety of interventions to reduce inflammation and rebalance the immune system. This will include various forms of neuromodulation (e.g., neurofeedback, neurostimulation, photobiomodulation, etc.) as well as biofeedback training, nutritional support, supplementation, neuropeptide therapy, lifestyle interventions, and integrative psychotherapeutic methods. Such an integrative approach is important for optimizing therapeutic outcomes in individuals who have endured chronic or traumatic stress.

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Special Weapons and Tactics: Examining Collected qEEGs for the Assessment and Mental Health Implications of SWAT Personnel

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Members of law enforcement working in the community encounter a variety of trauma-related experiences (Bishopp et al., 2019). Known as occupational stressors, these events range from conflict resolution between community members to crime and violence (Eddy et al., 2021; Soomro & Yanos, 2018). Study findings continue to illustrate that occupational stressors increase the onset of physical and psychological consequences (Wild et al., 2016). If left unattended, law enforcement workers experience the negative symptoms of stress (Bishopp et al., 2019) and an overall decrease in health (Rajaratnam et al., 2011). Special weapons and tactics (SWAT) teams function as a more niche group within law enforcement and navigate situations mandating more trained and focused care such as hostage negotiations and other high-risk encounters (Avdija, 2014). Engaging in events that not only require heightened vigilance (Callaway et al., 2011) but perpetuate the exposure to harmful outcomes may exacerbate the onset of negative mental health symptoms (Papazoglou & Tuttle, 2018).

Quantitative electroencephalogram (qEEG) is a computerized process that synthesizes and analyzes raw EEG data. Researchers advocate that qEEGs are useful in recognizing diagnoses including depression (Olbrich & Arns, 2013), posttraumatic stress disorder (PTSD), and anxiety (Bandelow et al., 2017). For instance, van der Kolk (2014) states that individuals with a PTSD diagnosis typically demonstrate a combination of excessive activity in the right temporal lobe combined with frontal slow-wave activity (p. 325). This biomarker suggests that mental functioning is inhibited due to hyperarousal of the fear center of the brain.

Mental health professionals who utilize qEEG recordings are uniquely positioned to assist with the law enforcement population. By considering both engrained cultural safeguards surrounding mental health and integrating qEEG-guided interventions (e.g., neurofeedback) can help populations subjected to traumatic and difficult events. This presentation will articulate common barriers faced by law enforcement personnel seeking out mental health services, as well as provide preliminary evidence findings of qEEG recordings performed on members of a SWAT team. The purpose of this presentation is to continue the ongoing dialogue discussing interventions that address the psychological needs of law enforcement individuals.

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LORETA Neurofeedback in the Educational Setting: A Standard Protocol to Improve Learning and Self-Regulation as a Method for Student Success in Post-Covid Recovery

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Learning is the most important process for human development. In the educational setting, numerous problems have been emphasized because of policies and procedures related to the COVID disruptions, including significant disruptions to traditional modes of learning, with many students struggling to adapt to online or remote learning environments. Studies have found that students have experienced learning loss during the pandemic, with lower achievement scores in subjects such as math and reading (Hanushek et al., 2021; Kuhfeld et al., 2021); negative impacts on the mental health of students, with increased levels of anxiety, depression, and stress reported (Loades et al., 2020; Zhou et al., 2021). This is particularly true for students who were already struggling with mental health issues before the pandemic; reduced socialization for many students can impact their social and emotional development. Studies have found that students have experienced increased feelings of loneliness and isolation during the pandemic (Marques de Miranda et al., 2020; Stickley & Koyanagi, 2021). LORETA neurofeedback at precuneus (Cannon et al., 2014; Cannon et al., 2018) was employed in a high school setting with 20 students (15 female) with mean age 16.00, *SD* = 1.37, selected by administration and counseling staff to complete 20 sessions on 20 consecutive school days. Logistical parameters were coordinated by administrative, counseling and teaching staff. The Conners CPT-3 and adolescent version of the Personality Assessment Inventory (PAI-A) were utilized as pre–post outcome measures. Repeated measures analysis of variance showed significant reductions on the scales of the PAI-A and improvements on the CPT-3. Standardized LORETA (sLORETA) showed significant shifts in alpha current source density levels in posterior cingulate, precuneus, and parahippocampal regions, primarily favoring midline and left hemisphere. It is feasible to include neurofeedback in the school setting to aid in student success and reduce problematic stress and associated experiences to improve the educational environment for both students and staff.

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A Useable Guide to Medication and the EEG

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The number of people taking psychiatric medication in the United States has been on the rise year over year and was only exacerbated by the COVID-19 pandemic. According to the CDC, the number of people taking psychiatric medication increased from 15.8% in 2019 up to 24% in 2020. While numbers vary state to state, some states saw an increase in psychiatric medication use of 17% during that time. While it is hard to measure, this number has likely gone up in the 3 years since. As neurofeedback practitioners, we typically work in the intersection of neurological function and mental health. As such, we often find ourselves trying to interpret functional neurological data that may be impacted by one or more common psychiatric medications. This can make interpreting the EEG and helping the client to regain mental and neurological health, a tricky endeavor. With so many people taking psychiatric medications now, we are sometimes forced to interact with aspects of healthcare that are beyond our scope of practice. Building on the work of Kaiser, Gunkelman, Swatzyna, and so many other great minds in our field, our goal is to create and present an easy-to-reference practical guide that will help neurofeedback practitioners recognize common medication effects, use EEG data and phenotypes to inform decisions regarding medications, and stay within their scope of practice. We will cover common EEG phenotypes and how to recognize them, and then discuss how they respond to various medication choices, citing both published research and clinical experience. The data will be broken down by medication class, citing common medications, their EEG effects, noted side effects, and half-life. We will also include an easy-to-reference guide to understanding how medication affects the EEG, and how to interpret results when medication is present. Finally, we will provide guidance on how to ethically stay within scope of practice and how best to approach the subject of medication when it is outside your scope.

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LORETA Neurofeedback at Precuneus: Self-Regulation as a Tool for Reducing Recidivism in a Population of Inmates With Substance Use Problems

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Introduction. The rate of recidivism for drug and alcohol offenders is estimated at 25% within 3 years of release, with half of all incarcerated individuals projected to meet criteria for a substance use disorder (Chandler et al., 2009). The data presented are from an ongoing 3-year effort to address self-regulation via brain computer interface to aid in the reduction in recidivism with inmates with substance use issues. LORETA neurofeedback at precuneus was implemented for improving psychological status in inmates in the Newaygo County, Michigan Jail for substance abuse related offenses (Cannon et al., 2009; Cannon et al., 2014). It has been proposed that one in five incarcerations are drug related offenses.

Methods. This group data consists of 30 participants (16 female) with mean age 35.34, *SD* = 9.36. Participants completed initial screening and informed consent prior to inclusion in the learning paradigm. Participants were administered the personality assessment inventory (PAI) and self-perception/experiential schemata assessments pre training and completed 5-min eyes-closed (ECB) and eyes-opened (EOB) baselines with EEG education and training prior to beginning the LNFB protocol. Sessions were conducted five times per week across 20 consecutive weekdays. Each session consisted of six 5-min training rounds and required approximately 50 min to complete. The PAI was administered at session 19 for pre–post comparison. A repeated measures ANOVA was conducted for PAI scores and paired contrasts were conducted on EEG spectral data and LORETA current sources.

Results. There were significant overall effects for reductions in nearly all scales on the PAI with the repeated measures ANOVA with Greenhouse-Geiser correction. Brain areas showing significant differences in alpha current source density posttraining included Brodmann Areas 9, 10, 24, 20, 21, 22, 32, and 36. Reductions in posttraining arrest are significant with 73% not returning to the facility postneurofeedback.

Discussion. The current program is focused on improving self-regulation using LORETA neurofeedback standard procedures in the local jail at Newaygo County, Michigan, to reduce recidivism rates. There have been research studies that have shown small to uncertain effects in prison and jail populations (Perry et al., 2019). Alternatively, other authors propose treatment models during incarceration have offered some level of efficacy (Peters et al., 2017) with initial treatment and longer term monitoring. These type of studies and active interventions in county jails may aid in the reduction of recidivism as well as decrease the rates of overdose related deaths shortly after release (Becker et al., 2020; Davis et al., 2020; Kim & Yang, 2020; Oluwoye et al., 2020; Rushovich et al., 2020). Current results do show relative success in improving the recidivism rates among this population in Michigan.

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Neurotypical Pediatric EEGs and Developmental Neuroanatomy

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Analyzing adult EEGs is a more familiar practice to the general clinician than analyzing children's EEGs. Yet many cases that most desperately need the services of neurotherapy clinicians are those of learning disabilities, developmental traumas, autism spectrum disorders, and the like. It is paramount that we can differentiate normal findings in healthy pediatric EEGs from abnormal, in order to target and customize protocol selection for the best interests of our children clients and their parents.

This lecture covers the findings in the normal EEGs of children from in utero to adolescence, in a chronological fashion. From the strategic encoding of DNA that established the resting-state networks early in the womb to the fundamental networks and their interactions, this talk will impart information on the aperiodic noise under the brain's rhythms (brown and pink noise in the human EEG), the bases of paralinguistics, nonverbal, and declarative language development, as well as neuroanatomical areas of import in healthy early attachment.

The healthy child's psychological milestones, behaviors, and oddities will discussed in connection with the EEG findings that—while abnormal in a mature EEG—are normal in a child's EEG (e.g., spikes, mu rhythm, slow content, etc.). Finally, this lecture will identify false positives, areas of anomaly that are often misinterpreted as normal. This lecture will serve the beginner and advanced clinician alike.

This lecture is part one of a two-part lecture, the other being on abnormal pediatric EEGs: autism, learning disabilities, and developmental trauma. While it is not imperative that clinicians attend both lectures, the contrast between heathy and abnormal EEG and anatomical structures is subtle and meaningful.

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Heart Rate Variability Biofeedback (HRV-BFB) for Reducing Special Education Teachers' Work-Related Stress

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The Individuals with Disabilities Education Act (IDEA, 2004) guarantees an appropriate and individualized education program for all students with disabilities. However, an insufficient supply of fully qualified special education teachers threatens this promise. Special education teacher shortages have increased since 2012 to 6.8%, leaving approximately 23,000 positions in special education without a qualified teacher (Dewey et al., 2017). This number is expected to grow in the aftermath of the COVID-19 pandemic, which resulted in 38.4% of special education teachers meeting the criteria for generalized anxiety disorder. This is a rate 12.4 times greater than the U.S. population, and 37.6% of special education teachers meeting the criteria for major depressive disorder, a rate of 5.6 times greater than the U.S. population (Cormier et al., 2022). Special education teachers have identified that work-related stressors have an adverse effect on their overall quality of life, and this has contributed to feelings of burnout and decisions to leave the field (Hester et al., 2020). An intervention with promising results for reducing stress and anxiety is heart rate variability biofeedback (HRV-BFB), which has received increasing attention among clinicians and researchers (Chung et al., 2021; Lehrer & Gevirtz, 2014).

Therefore, our IRB-approved study will use a mixed methods approach for examining the influence of HRV-BFB for stress reduction and self-regulation utilizing both subjective and objective indicators during special education teachers' practicum semester. We will recruit the teachers before they begin their practicum semester with an ideal sample size of five. Participants will receive HRV-BFB by a trained clinician using the Neurobit Optima+ device, BioExplorer software with visual/audio feedback, and forearm sensors to record electrocardiogram data. Additionally, our study incorporates a multiple-baseline, single-case experimental design (SCED). The dependent variable (i.e., HRV) will be measured systematically after each biofeedback session by collecting HRV data averages. Participants will be asked to visit our university counseling clinic for all their sessions, including the baseline data collection of HRV (i.e., no training) and their intervention HRV-BFB sessions (i.e., biofeedback training). Participants will have from three to six baseline sessions and three to seven training sessions. The baseline sessions will include feedback but no set training protocols. Each participant's HRV session averages will be compared using percentage of nonoverlapping data (PND). Utilizing SCED allows participants to serve as their own baseline, respecting their individual changes and unique physiological functioning. At the conclusion of the HRV sessions, we will use a posttest interview to obtain qualitative data. This standardized interview protocol consists of 11 questions developed to elicit teachers' perceptions stressors encountered in the classroom, the mental and physical impact of those stressors, and perceptions regarding additional resources and support needed to reduce stress (Haydon et al., 2018).

Our study and presentation will explore the use of HRV-BFB for reducing stress and improving self-regulation alongside unveiling insights into stressors using qualitative interviews. The application of a mixed methods study offers the production of new knowledge while simultaneously testing the effectiveness of an intervention and attending to the concerns and insights of the persons involved. outcomes include increased skill without exhaustive training at asking about metabolic issues and explaining basic options to patients that may affect brain chemistry and clinical outcomes.

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Data-Driven Neurofeedback Enhances Spatial Cognition in Healthy Adults

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Background. The efficacy of neurofeedback in modulating cognitive outcomes varies between users resulting in some users not to benefit from neurofeedback (Alkoby et al., 2018). To explain this variability, most studies investigated how to learn (e.g., factors predicting changes in neurofeedback related brain activity; Alkoby et al., 2018), and only a few investigated what to learn (e.g., the targeted feature for neurofeedback; Gruzelier, 2014b). To enhance spatial cognition, most studies designed the neurofeedback training to alter alpha waves in the electrocortical activity (Gruzelier, 2014a). Recently, identifying person-specific brain networks expanded our understanding of how our brains perform complex cognitive processes (Porter et al., 2023). In this study we investigated the efficacy of personalized neurofeedback using a randomized, double-blind, sham-control design.

Methods. We recruited 40 healthy participants. After giving their written and informed consent, participants completed a socio-demographic questionnaire. Additionally, they then carried out a mental rotation task (Ganis & Kievit, 2015) and the trail making task (TMT; Bowie & Harvey, 2006) before and after a 30-min neurofeedback training session. While the experimental group received their personalized feedback, the sham group received the same prerecorded feedback from another person. We recorded the electroencephalography (EEG) signal using a BrainAmp system (Brain Products, Gilching, Germany). For the personalization, we applied a machine learning approach and individually trained a ridge regression to predict the mental rotation task performance based on task-related electrocortical activity. Prior to estimating the regression parameters, we preprocessed the EEG signal including bandpass filtering and spatial filtering via Source Power Comodulation (Dähne et al., 2014).

Results. We analyzed our data with (generalized) linear mixed models and a priori defined contrasts. In the mental rotation task, the experimental group did not reduce their reaction time in trials with correct responses more than the sham group (z = 1.28, p = .90). However, the experimental group increased their accuracy more than the sham group (z = 1.67, p < .05). Further analyses revealed that the experimental group processed more difficult trials than the sham group after neurofeedback (z = −2.78, 95% CI = [−4.19, −1.05]). Comparisons in the TMT performance did not reveal any significant difference between the groups (part A: $t(74)$ = 1.08, p = .86; part B: $t(72)$ = 0.20, p = .58).

Conclusion. Our results suggest that data-driven, individually tailored target specification for EEG neurofeedback increases mental rotation task performance more than sham feedback in healthy adults. Furthermore, the training effect was specific to spatial cognition involved in mental rotation and did not yield changes in cognitive flexibility measured with the TMT. One limitation of our study is that we cannot clearly distinguish between accuracy and reaction time due to the per trial time constraint in our implementation of the mental rotation task. Future studies should investigate if such personalized neurofeedback designs outperform classical approaches where all participants share the same target feature.

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Proficiency Modulates Effects of Embodiment Learning on Word Learning in Typical and Dyslexic Readers: Evidence From Event Related Potentials

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Sensorimotor experience in the form of learning to print and write letters allows the interplay between motor production and visual perception to broaden the stored representation of letters. Handwriting movement, as a manual sensorimotor skill, has direct influences on how words are recognized and acquired in the brain. Writing words with hands facilitates the acquisition and processing of the words—the handwriting effect. Previous studies have established the handwriting effect as one of the most fundamental demonstrations of language embodiment, but little is known as to how language proficiency, as in the case of bilingualism, might affect embodied learning of words in the second language (L2).

Here we report how language proficiency modulates the hand movement effects (integration of sensorimotor experience through hand movement) on word reading processing as indexed by different ERP components. Forty typical and nontypical readers participated in the behavioral and ERP experiments. They were subdivided into two groups (typical vs. nontypical) according to their Chinese L2 proficiency. We designed three learning conditions: viewing, handwriting, and drawing followed by word recognition in Chinese. We compared three conditions between two groups to unfold how effective sensorimotor experience variance across groups. Behavioral results showed reduced reaction times and error rates in both handwriting and drawing condition as compared to the viewing condition for high proficient L2 Chinese learners, but no evidence for such an embodied learning effect was found in low proficient L2 Chinese learners. However, event-related potentials (ERPs) showed modulations of N170, P200, and N400 as an effect of hand movements (i.e., handwriting and drawing) on character recognition in both groups of participants. Our results suggest a significant role of L2 proficiency in embodied language learning: high proficient L2 learners could benefit from the sensorimotor experience associated with hand movements at both behavioral and electrophysiological levels; low proficient L2 learners failed to show such an embodied learning effect behaviorally, but ERPs revealed that both handwriting and drawing facilitated early processing of visual form information of Chinese characters.

In this study, an innovative finding is that handwriting also facilitates word recognition for typical learners. The behavioral and neural correlates also suggested a strong embodiment trace leads to a strengthen word memorial trace. The results suggest a linguistic universally stratified behavioral and neuroprocessing performance in word reading for typical and nontypically developed (e.g., dyslexic) learners.

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Adolescents With Complex Childhood Trauma From Residential Homes in Romania: Searching for Neuromarkers and Neurofeedback Protocol

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Adolescents in residential homes are one of the most disadvantaged populations. They were removed from their biological families and suffer from childhood complex trauma, which compromises the development of the frontal lobes that peaks during adolescence. The adolescents in Romanian residential homes have little chance to get adopted, as they do not receive treatment to improve their functionality, and their education level is low. All these adolescents have complex childhood trauma (also named developmental trauma) which should be considered when treating them.

Although research has shown that neurofeedback significantly reduces PTSD symptoms and improves executive functioning in adults and children (Gapen et al., 2016; Hong & Park, 2022; Rogel et al., 2020; van der Kolk et al., 2016), results show that symptoms are reduced and not eliminated. Besides, to our knowledge, there is a lack of controlled studies to investigate the efficacy of neurofeedback in adolescents in general and in those in residential homes specifically.

This study is a first step in developing a comprehensive approach for these adolescents by (1) raising awareness that their complex childhood trauma is associated with their current situation and proposing a treatment modality to directly address the neurological development, (2) proposing the most effective neurofeedback (NF) protocol as a treatment for enhancing their executive functioning and reducing their PTSD symptoms, and (3) identifying neurological objective measurements and neuromarkers to develop the most effective NF treatment and to assess the impact of NF treatment.

We propose a two-stage study:

- (S1) Stage 1: exploratory, with the aim of finding markers (EEG, qEEG, ERP, physiological, and behavioral) for adolescents with complex childhood trauma.
- (S2) Stage 2: a three-group random-control, assessor-blinded, clinical trial. Forty-eight adolescents (12–17 years old) will be randomized to either NF-S (standard T4-P4), individual NF (qEEG based) or WL (waitlist, control) group, and will complete four assessments (including follow-up).

Following the study, identified markers (neural, physiological, and behavioral) will be proposed to the research community to further testing in association with complex childhood trauma. Also, the study's results may help to guide the recommended NF protocol for adolescents who are currently in complex childhood trauma programs. In addition, follow-up assessments would inform about the stability of the significant achievements. Based on the obtained results, an intervention program will be recommended in the residential homes. Guidelines and recommendations for personnel and people preparing to adopt will be produced. Given that there are no resources allocated in Romania for the treatment of children in residential homes, there is a big need for support interventions aiming at raising their functionality and reducing their vulnerability.

The comparison of standard protocols with individual protocols (i.e., qEEG-guided) can bring valuable insights into the most beneficial NF approach to complex childhood trauma. The research will thus contribute in the long term to (1) the development of a treatment framework for adolescents with complex childhood trauma and (2) the international efforts of developing a discipline of childhood trauma.

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Development of Student Neurofeedback Learning Competencies for Counseling Programs

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Advances in neuroscience continue to impact the counseling profession (Beeson & Field, 2017). It informs clinical skills and the facilitation of client development (Ivey et al., 2018). Due to increased interest in the counseling community, organizations such as the American Counseling Association (ACA) and the Association for Counselor Education and Supervision (ACES) created neuroscience interest networks (Beeson & Aideyan, 2016; Chapin, 2016). Similarly, accrediting bodies like the Council for the Accreditation of Counseling and Related Educational Programs (CACREP) include curricular standards for programs to cover biological, neurological, and physiological aspects of mental health in entry-level counseling curriculum (CACREP, 2015). The term neurocounseling was soon adopted, signifying the incorporation of the two fields.

Neurocounseling, which integrates empirical knowledge of neuroscience with the traditional wellness values of counseling, is a growing topic of discussion among the counseling profession (Crockett et al., 2017). The term serves as an avenue in exploring brain-based understanding within a counseling framework including the validation of preexisting and new therapeutic techniques and theories (Beeson & Field, 2017). As neurocounseling continues to grow, clinicians, therapists, and universities seek to add neuro-based elements into their scopes of practice (Chapin, 2016; Duenyas & Luke, 2019; Myers & Young, 2012). Neurofeedback is one such modality. As an intervention that falls under neurocounseling, neurofeedback conditions brainwave activity by monitoring and relaying real-time wave amplitude back to the client (Demos, 2019). It is tool used in treating various mental health concerns such as symptoms relating to anxiety (Gregory et al., 2020), depression (Hammond, 2005), and posttraumatic stress disorder (van der Kolk, 2016).

This poster proposal will examine what experts in both neurofeedback and professional counseling regard as required learning competencies for counseling graduate students enrolled in either a neurofeedback training course or certification program. Findings presented in this presentation may offer insight or a framework for counseling programs interested in integrating neurocounseling into their curriculum and coursework.

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Dynamics of Diffusion Indicators of the Brain White Matter Tractography After a Course of the Brain Secondary Motor Cortical Zones fMRI Neurofeedback in Stroke Patients

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Introduction. Tractography is a method of diffusion-weighted magnetic resonance imaging (DW-MRI), which allows to reconstruct and study the structure of the conductive pathways of the brain white matter by measuring the direction of water diffusion (DH) in each voxel of the image. Neurofeedback (NFB) technology allows training aimed to control the activity of certain brain areas by fMRI signal. The purpose of the current study was to examine the effect of fMRI NFB on the dynamics of DH of the white matter of the brain in patients after stroke.

Materials and Methods. Ten patients (45 to 70 years old, 4 to 24 weeks postischemic stroke) underwent a course of standard rehabilitation. Five of them were assigned to the fMRI neurofeedback, while five served as a control group. The fMRI group additionally underwent six sessions of fMRI NFB of secondary motor cortical zones in the lesional hemisphere. Before (T1), after the course of treatment (T2) and after 6 months (T3), DW-MRI was performed; diffusion characteristics (DX) were studied in the lesional (IP) and contralateral (CP) cortices, as well as in the second and third segments of the corpus callosum (MT). Following variables were studied: fractional, kurtosis fractional, quantitative anisotropy (FA, kFA, QA), average diffusion capacity (MD), and axial and radial diffusion coefficients (AD and RD). The prognostic index of rehabilitation is the asymmetry of fractional anisotropy (aFA), calculated as the difference in FA values to the contra- and ipsilateral hemispheres.

Results. All patients had changes in the diffusion measures of both hemispheres in T1, T2, and T3. There was found a significant difference between the groups ($p < .001$) in the change of kFA indicators between T2 and T3 in the two MT segments studied: the experimental fMRI NFB group showed an increase in indicators, while the control group showed a decrease. The values of MD and AD diffusion in T1 and T3 in the second segment of MT significantly differ in two groups ($p < .001$) showing a decrease in indicators for the experimental group and their increase for the control group. The reconstruction of the tracts showed a slight increase in kFA values between T1 and T2 and their decrease between T2 and T3, a significant decrease in kFA in IP and KP between T1 and T2 ($p < .05$), T1 and T3 ($p < .05$). Similarly, MD, AD, RD in IP increased from T1 to T2 and from T2 to T3, reliably for MD between T1 and T2 ($p < .05$), T2 and T3 ($p < .001$), T1 and T3 ($p < .05$); AD between T1 and T3 ($p < .001$), T2 and T3 ($p < .05$); RD from T1 to T2 ($p < .05$), T1 to T3 ($p < .001$).

Conclusion. Stroke provokes structural changes in both hemispheres, and the reorganization of the tracts continues for more than 6 months after the stroke. To determine the contribution of the fMRI neurofeedback of affected hemisphere additional motor cortical zones to the process of such restructuring, a larger number of observations is required.

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Loreta Neurofeedback for Brain and Behavioral Dysregulation in a Stroke Patient: A Case Study

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Epidemiological data has positioned stroke as the second leading cause of death worldwide. Of 15 million people that suffer from a stroke yearly, approximately 6 million die and 5 million become chronically disabled. Stroke is the fifth leading cause of death and the first cause of long-term disability in Puerto Rico. Cognitive and motor impairments are highly prevalent and persistent in stroke survivors. Network disruptions caused by a stroke event on brain regions implicated in the different aspects of motor function and cognition can significantly impact quality of life. Targeting both focal cortical tissue damage and nonfocal global changes in brain function should be considered when developing therapeutic strategies to improve brain responses, recovery rate, and the quality of life of brain injury survivors. In this regard, using qEEG-guided low-resolution electromagnetic tomography analysis (LORETA) *Z*-Score neurofeedback (NFB) is a promising approach that has been reported to be effective for stroke and TBI rehabilitation as it targets dysregulation in networks in deep cortical locations. Being able to train these deeper structures in the brain is a major leap forward in brain mapping as connections between networks or regions can be trained, increasing the efficiency of brain networks specifically related to a patient's symptoms. The main goal of this study was to explore the effects of qEEG-guided *Z*-score LORETA NFB (LZLNB) in the optimization of behavioral performance and brain electrophysiological activity in a 57-year-old male who suffered a stroke in the central/right part of the parietal lobe (severe speech difficulties due to apraxia, left hemiparesis, and intense headaches were presented). The study used a preexperimental design with pre–post comparison. To this end, LZNFB was applied to affected brain areas for 25 sessions. Baseline and posttreatment measurements were made on qEEG metrics, event-related potentials at Pz (oddball paradigm), attention, memory, executive function, reaction time, and cognitive flexibility. Behavioral improvements were found in executive function, cognitive flexibility, processing speed, and reaction time after 25 sessions of LZNFB on computerized tasks (at the postmeasurement, the patient could complete the tasks with both hands). Significant changes were found on lower frequencies and connectivity variables across all brain areas, as observed in the qEEG *Z*-score maps. Greater discrimination and less latency for auditory stimulus were also found on P300 ERP component analysis at Pz after the intervention (prelatency= 430 ms, postlatency = 360 ms). In addition, significantly improved speech, mood, and motor function were also observed in session #6. These findings suggest the potential effectiveness of LZNFB on cognitive performance improvement among stroke sufferers. Further studies with a larger number of patients and control groups may be required to evaluate the full potential of this type of training in stroke patients.

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Language, Emotion, and Cognitive Congruence: Does Appropriated Racism Detoxify the N-Words for African American Males Using Neurophysiological Measures?

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It is well documented that racial oppression, known as racism, is linked to mental (e.g., stress-related conditions such as depression, anxiety, and PTSD) and physical health challenges (e.g., stress-related illnesses such as diabetes, high blood pressure, and obesity) in African Americans (AAs). In 2020, the American Medical Association, American Psychological Association, and the American Psychiatric Association declared racism as toxic stress and therefore a public health threat. One example of racial oppression is the creation and use of the words *n*gger* and *n*gga* by whites during slavery. These words are still used to identify and classify AAs.

As part of the complex process of resistance to oppression, known as internalized racial oppression, some AAs have appropriated n*gga both as a means of desensitization and to take back the power of the word. They insist that there is a difference between n*gger and n*gga (proponents). Others are adamant that regardless of the form it takes and/or who uses it, it is injurious to the health of AAs (opponents).

To the best of our knowledge, there is a lack of empirical documentation of the neurophysiological responses of internalized racial oppression by and between in-group members. In-group use of n*gger and n*gga permeates AA culture in entertainment and daily language. The intent of the study is to provide empirical data to further discussion and inform neuropsychological, medical, liberation, social justice, and ethical studies. Therefore, the research question is "Does appropriated racial oppression emotionally detoxify n*gger/n*gga among African American males using neurophysiological measures?"

The hypotheses to investigate are (1) The relationship between affective position and emotional response to the word in either form, (2) the difference between proponents' and opponents' mean emotional response to 'n*gger', (3) the difference between proponents' and opponents' mean emotional response to 'n*gga', and (4) the difference between target and control group means based on cognitive position.

The study is investigative ex post facto with a control group. Participants are adult AA male volunteers from the Minneapolis area. For the design, both active and control groups hear an audio ERP paradigm of neutral words. In addition to the neutral words, the active group hears the target words n*gger and n*gga. All the ERP words are prerecorded in neutral prosody. The ERP paradigm consists of three trials of 10 randomized culturally-specific words, 10 times each at 3-s intervals. EEG will capture ROIs at AF3, F4, FC6, at N400 or P3 latencies. Heart rate, skin conductance, and temperature will be recorded. Pearson's R will be used to analyze the relationship hypothesis; factorial ANOVA will be run to examine differences between categorical and independent variables.

The words n*gger and n*gga are pervasive in AA culture, which is globally consumed. The results of this study can have far-reaching implications for views on entertainment, emulation, communication, cultural exchanges, and social interactions. AAs may be more likely to consider the impact of using n*gger and n*gga as innocuous forms of resistance, entertainment, and communication.

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Attention-Deficit Disorder: A Path to Diagnosis

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Attention-deficit disorder (ADD) is often undiagnosed and misdiagnosed in children, adults, and the geriatric population. ADD is most likely a multifactorial etiology and shares symptoms with multiple other mental disorders making it challenging to diagnose.

ADD is a complex neuropsychiatric condition with a multifactorial etiological basis involving genetic and environmental determinants. The presentation emphasizes the importance of a multidisciplinary approach to the diagnosis and treatment of ADD.

The presentation highlights the significance of comorbidities and symptom similarities in making diagnosis difficult for ADD. The author stresses the importance of recognizing differences in symptoms for different age groups and obtaining an accurate diagnosis due to the overuse of prescription medications.

Method. This poster draws on recent work that is available from multiple sources, including published journal articles, systematic reviews, and clinical trials focusing on differential diagnosis, diagnostic screening tools, single photon emission computed tomography (SPECT), functional MRI (fMRI), advanced assessment, and quantitative electroencephalogram (qEEG). It highlights the effects on individuals and society when patients are misdiagnosed or undiagnosed. The author draws on expertise from years of experience as a registered nurse, and current training in psychiatric mental health nurse practitioners master’s program.

Results. The specific cause of ADD remains unknown. There is growing evidence to suggest that genetics contribute to ADD, and several genes have been linked to the disorder. There is evidence of anatomical differences in the brains of children with ADD in comparison to other children without the condition (American Psychiatric Association, 2013), and changes in theta/beta brainwaves (Lee et al., 2022). A combination of tools should be used in the diagnosis of ADD.

Conclusion. Mental health practitioners need to be aware of the diagnostic tools available. Because ADD shares some of the same symptoms as depression, addiction, anxiety, autism, and other psychiatric disorders, diagnosis is imperative to develop a treatment plan. This overlap of symptoms increases the risk of false diagnoses.

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Brain Shifts Through the Triangle of Neurology

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This study is designed to assess the hypothesis that stimulation of the visual, oculomotor, and vestibular systems in a novel way can promote profound, positive neuroplasticity in those suffering from general anxiety disorder.

The “Triangle of Neurology” connects the vestibular system and the eyes known as the vestibular ocular reflex, where the eyes and ears are yoked through the superior and inferior colliculus, and the ears and the vestibular system are yoked through the vestibulocochlear nerve. The Symmetron chair provides gentle elliptical movement around three axes of motion. While experiencing this gentle motion the patient is looking at a nonstimulating moving video of colors and shapes. Brain-based music is playing through bone conduction headphones.

This case study invited a female patient, 65 years of age, who presented to the office previously diagnosed with generalized anxiety disorder (GAD). The patient was given a thorough neurological examination identifying limitations in cortical function. The patient was found to have faulty eye movement patterns via RightEye Technologies (Figure 1).

Deficiencies were noted with both pursuits and saccades when matched to gender and age demographics. In addition, the patient noted sound sensitivities in her history. Many research articles have been published supporting vestibular stimulation for reducing stress and improving focus (Kumar, 2016). Pasquier et al. (2019), found a significant reduction in anxiety symptoms after 38 min of vestibular stimulation. Visual mismatch has been improved through vestibular stimulation (Wibble et al., 2020). The auditory and vestibular systems work together to process sound and movement (Oh et al., 2018). Modern work in aiding those with GAD may involve eye movement, such as with EMDR, but few have integrated focus with these three key components of the nervous system.

To monitor progress, the patient received three brain maps over a 30-day period. For this case study, the highlights of the sLORETTA summary from each qEEG map are used where the brain waves were beyond 2–3 standard deviations from typical. The Initial brain map (Figure 2): Eyes closed (EC) increased delta in the superior frontal gyrus, increased beta in the medial frontal gyrus, increased gamma in the superior frontal gyrus. Eyes open (EO) increased beta in the medial frontal gyrus.

The second brain map (Figure 3): EC increased delta in the middle occipital gyrus. EO increased delta in the anterior cingulate, increased beta in the inferior temporal gyrus, increased hi beta in the inferior temporal gyrus. The third brain map (Figure 4): EC increased hi beta inferior parietal lobe. EO increased hi beta superior parietal lobe, decreased gamma in the posterior cingulate.

Following a 10-hour treatment plan the patient displayed drastic changes in her brain maps, as well as ocular-motor function (Figure 1). Dysregulated vestibular responses coupled with GAD can propel a constellation of dysregulated autonomic symptoms which can be explained through an imbalance of the autonomic nervous system. The triangle of neurology is a path inward to promote balance to the brain, its perception and overall function of the nervous system.

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