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Neurobiological and Functional Outcomes of the Interpersonal Whole-Brain Model of Care in Autism Spectrum Disorder: A Mixed-Methods Study

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Abstract

The Interpersonal Whole-Brain Model of Care (IWBMC™) presents a comprehensive intervention for autism spectrum disorder (ASD) targeting neurobiological frameworks. This mixed-methods study evaluated its efficacy through QEEG connectivity analysis of a longitudinal case study and pre-post outcomes from 61 ASD clients. Results demonstrated normalization of brain connectivity patterns alongside statistically significant improvements with large effect sizes across behavioral regulation (d=1.26), emotional recognition (d=0.98), cognitive functioning (d=0.84), and neurophysiological integration (d=1.52). The concurrent improvement in brain connectivity and functional outcomes suggests that the IWBMC™'s integrated approach effectively addresses both neurological underpinnings and behavioral manifestations of ASD, offering promising pathways for intervention.

Keywords: autism spectrum disorder, neurodevelopment, QEEG, brain connectivity, behavioral outcomes, emotional recognition, primitive reflexes, interhemispheric communication

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1. Introduction

1.1 What Is Autism Spectrum Disorder?

Autism spectrum disorder (ASD) is a developmental disorder that impacts an individual's social interactions, behavior, learning, and communication (Maenner, 2023). Although the presentation can vary greatly, individuals primarily demonstrate challenges in communication abilities, appropriate social interaction, and engagement in restricted or repetitive behaviors. Often, individuals will experience a limited array of interests and can display a wide range of sensory aversions, particularly around activities of daily living such as hair cutting, nail cutting, and tooth brushing. Autism spectrum disorder diagnoses may or may not have an accompanying language or intellectual delay diagnosis or a defined severity level. Physicians screen for autism during well-child visits as early as 18 months; however, for some individuals, indications of challenges are seen before the child is one year old. Therefore, early detection and intervention are critical for individuals diagnosed with ASD (McGlade, Whittingham, Barfoot, Taylor, & Boyd, 2023).

Autism spectrum disorder is divided into three levels of severity based on Social Communication and Restricted, Repetitive Behaviors (American Psychiatric Association, 2013). Table 1 defines the severity levels and related social communication and behavior issues.

Table 1. Severity of Autism and Implications for Social Communication and Behaviors

Severity Level	Social Communication	Restricted, Repetitive Behaviors
Level 1: Requiring support	Without specific support, the individual experiences deficits in social communication, causing noticeable impairments. Additional challenges may include: • Difficulty initiating social interactions • Atypical or unsuccessful responses to social overtures of others • Appears to have decreased interest in social interactions • Challenges with reciprocal conversational abilities • Challenges with making and sustaining friendships	The individual experiences challenges such as: - Inflexible behavior that causes significant interference with functioning in one or more contexts - Difficulty transitioning between activities - Challenges with organization and planning abilities, which interfere with their independence
Level 2: Requiring substantial support	The individual experiences marked deficits in verbal and nonverbal social communication skills. Additional challenges may include: • Social impairments, even with supports in place • Limited initiation of social interactions • Reduced or abnormal responses to social overtures from others • Communication is limited to particular areas of interest • Markedly odd nonverbal communication skills	The individual experiences challenges such as: - Inflexibility of behavior - Difficulty coping with change - Restricted/repetitive behaviors are frequent enough to be evident to the casual observer and interfere with functioning in various contexts - Distress or difficulty changing focus or action
Level 3: Requiring very substantial support	The individual experiences severe deficits in verbal and nonverbal social communication skills that cause significant impairments in functioning. Additional challenges may include: • Significantly limited initiation of social interactions • Minimal response to social overtures from others, such as only approaching or responding when needing their needs met or in straightforward social approaches	The individual experiences challenges such as: - Inflexible behavior - Extreme difficulty coping with change - Restricted/repetitive behaviors that markedly interfere with functioning in all spheres - Great distress/difficulty changing focus or action

1.2 Comorbid Diagnoses

Individuals with a diagnosis of autism spectrum disorder often experience a multitude of diagnoses related to their functional challenges.

Comorbid diagnoses may include intellectual impairment, attention-deficit/hyperactivity disorder (ADHD), anxiety, and developmental coordination disorder. Additionally, individuals may experience medical conditions such as epilepsy, sleep problems, and constipation (Kandel et al., 2000).

1.3 Why Does this Matter?

The United States has the fourth highest rate of ASD diagnoses in the world (following the United Kingdom, Sweden, and Japan), with 1 in 36 children diagnosed with ASD in the United States (Maenner, 2023). Additionally, more than 25% of those diagnosed are classified as having profound autism and will require lifelong care (Hughes et al., 2023). Notably, most of the children diagnosed with profound autism are from ethnic or racial minority groups and tend to be girls from lower-income households. The disparity in diagnosis rates between genders is significant, with ASD diagnoses being four times more common in boys than girls (Maenner, 2023). These statistics highlight the widespread prevalence of ASD in the United States and underscore the importance of comprehensive care models like the IWBMC™.

As stated above, in addition to the rising diagnoses of ASD within the United States and the increase in population, it is well documented that later diagnoses are often comorbid with intellectual disability and other adverse symptomatology. As such, early diagnosis and intervention are critical. Studies show that early intervention is effective in helping autistic individuals achieve more independence, and interventions involving parents are recommended (e.g., Rojas-Torres, Alonso-Esteban, & Alcantud-Marín, 2020). Growing literature also suggests that various interventions, particularly those in natural and developmental settings, are more effective than traditional behavioral interventions (Franz, Goodwin, Rieder, Matheis, & Damiano, 2022). However, the scientific literature emphasizes the need for any intervention strategies that can help neurodivergent individuals lead more independent and healthy lives.

1.4 Autism Spectrum Disorder and the Interpersonal Whole-Brain Model of Care

The Interpersonal Whole-Brain Model of Care (IWBMC™) uniquely addresses the core issues of an autism spectrum disorder diagnosis, including processing incoming sensory information, mood regulation, behavior control, language processing, and language generation. The mission of the IWBMC™ and, more specifically, individuals with an autism spectrum diagnosis is to take an intentional, all-encompassing, and brain-based approach to examine and execute a targeted action plan for clients navigating these difficulties.

1.5 The Nuts and Bolts of the IWBMC™

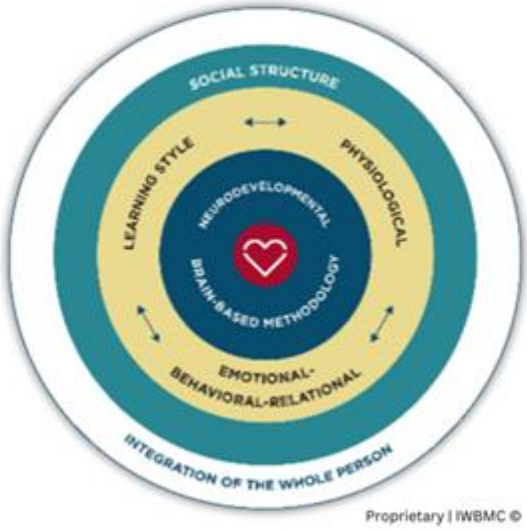

Figure 1. The Elements of the IWBMC™

The Interpersonal Whole Brain Model of Care, or IWBMC™, is a comprehensive and innovative strategy for working with individuals with neurodevelopmental diagnoses, including but not limited to autism spectrum disorders. This model of care aims to develop a unique, highly individualized program for each client through a thorough and multifaceted evaluation. This evaluation encompasses many factors, including the client's motivations, behaviors, physiological and emotional development, neurological functioning, and available social support systems. Considering all these aspects, the IWBMC™ aims to create a holistic understanding of each individual's needs and strengths. The critical elements of the IWBMC™ are visually represented in Figure 1.

Following this comprehensive evaluation process, targeted interventions are planned based on the various components of the IWBMC™. Two of these components are essential to the model's effectiveness. The first is integrating the whole person, which ensures that all aspects of the individual's functioning are considered. The second is the careful attention paid to the social structures and support systems available to the client, recognizing the crucial role that environment and relationships play in an individual's development and well-being.

As emphasized earlier in the discussion, current research suggests that the most effective approaches for autism should incorporate parents and caregivers as active participants in the intervention process. Additionally, these approaches should carefully consider the developmental stages of the individual and the naturalistic environments in which they live, learn, and interact. The IWBMC™ is specifically designed to address these critical factors, ensuring that interventions are tailored to the individual, integrated into their daily life, and supported by their immediate social circle.

It is important to note that the IWBMC™ was not developed in isolation or based on theoretical concepts alone. Instead, it was carefully crafted using evidence-based research, drawing on scientific literature and clinical studies. This grounding in empirical evidence ensures that the model's approaches and interventions have a solid foundation in proven effectiveness while allowing for the flexibility needed to address each client's unique needs.

1.6 How the IWBMC™ Supports the ASD Population

The IWBMC™ provides comprehensive support for the ASD population through individualized program design targeting each student's neurobiological framework. The approach incorporates QEEG brain map analysis to guide treatment intervention plans and measure progress. It focuses on sensory regulation interventions to reorganize maladaptive sensory processing pathways, while implementing a positive interpersonal behavioral model to address behavioral challenges. The program emphasizes frequent cardiovascular and cross-lateral movement activities to promote new neuronal growth and enhance brain communication. Additionally, it works on increasing emotional awareness and understanding the connection between thoughts and behaviors to improve self-regulation abilities. Social and relational challenges are addressed through structured peer interaction, social skills groups, and mentoring opportunities. Finally, the IWBMC™ utilizes a unique Whole-Brain Language Approach to tackle the complex interplay of factors involved in language processing, production, articulation, and functional communication. Data is continuously collected and reviewed as clients progress through the program. All clients undergo periodic re-evaluations to identify areas of growth and mastery and those that still require improvement. This study seeks to answer the following questions:

1) How does the IWBMC™ approach affect neurological connectivity patterns as measured by QEEG, and how do these changes correlate with functional improvements in individuals with ASD?
2) What patterns of improvement across behavioral, emotional, cognitive, and physiological domains emerge from a larger sample (n=61) of ASD clients following IWBMC™ intervention?

2. Methodology

In order to address our research questions, we utilized a mixed-methods approach combining in-depth neurological analysis and comprehensive functional assessment. First, we present a detailed longitudinal case study analyzing QEEG brain maps of a client with ASD who received the IWBMC™ intervention over eight years (2013-2021). This case analysis examines changes in brain connectivity patterns, explicitly focusing on hyper- and hypo-coherence in regions typically affected in ASD.

To complement the neurological findings, we analyzed behavioral, emotional, cognitive, and physical outcomes from a sample of 61 clients diagnosed with autism spectrum disorder (ASD) who received intervention through the Interpersonal Whole-Brain Model of Care (IWBMC™). The sample consisted of 61 clients: 54 males (88.5%) and seven females (11.5%), with 17 participants (27.9%) identifying as non-white and 44 (72.1%) as white. The IWBMC™ aimed to address challenges that impact learning, social connections, and cognitive development by targeting disruptive behaviors that hinder connection, communication, and learning. Since not all clients completed all outcomes tasks, data was adjusted based on the number of completions.

Participants were conveniently sampled from the entire ASD population of a therapeutic school implementing the IWBMC™ approach in a southeastern metropolitan area in the United

States. All participants received a comprehensive individualized intervention based on the IWBMC™ framework for a minimum of 12 months (range = 12-24 months, M = 18.5 months) between 2015 and 2022. Intervention intensity averaged 25 hours weekly of direct therapeutic and educational programming.

2.1 Measures

We collected data across five crucial outcome domains: behavioral, emotional, cognitive, neurological, and physiological functioning. All measures were administered at initial evaluation before intervention implementation and again after approximately one year of intervention during a formal re-evaluation. All assessments were conducted by trained, certified professionals with expertise in neurodevelopmental evaluation. Data collection procedures were standardized across all participants, and evaluators differed from those providing intervention services to minimize potential bias.

Behavioral Measures: Parent questionnaires assessed frequency and severity of negative and disruptive behaviors using a standardized rating scale (0-5, with higher scores indicating more problematic behaviors). Additionally, the percentage of parents reporting specific challenging behaviors was recorded through structured interviews.

Emotional Measures: Emotional recognition abilities were assessed through standardized testing procedures. Clients were asked to identify emotions portrayed in photographs. The number of correctly identified emotions was recorded, and participants were categorized based on their ability to recognize three or more distinct emotions in others.

Cognitive Measures: Academic achievement was assessed using the Wide Range Achievement Test (WRAT-4), providing standard scores and grade equivalencies for mathematics and reading domains. Deductive reasoning abilities were measured using age-appropriate logical reasoning tasks and scored on a standardized scale.

Neurophysiological Measures: Trained clinicians assessed Interhemispheric communication through standardized observations of cross-lateral movements, including belly crawl and creep patterns, on a 0-5 scale. Primitive reflex integration was measured through a standardized protocol assessing the presence and strength of 17 primitive reflexes, with scores ranging from 0 to 50 (higher scores indicating better integration).

2.2 A Key Component of the IWBMC™: Utilization of QEEG Data | Linked-Ears Mapping

In tandem with the Neurodevelopmental Profile component of the IWBMC™ Evaluation, data is collected through a QEEG (Quantitative Electroencephalogram). The QEEG, based on traditional EEG technology, measures the brain's electrical activity; however, it goes a step further and converts the electrical activity to a visual representation. The visual representation indicates areas of the brain with too much or too little electrical activity by comparing the data to a norm-referenced database, including age, gender, and handedness (Thatcher, 2016). The QEEG provides specific measures within the brain wave frequencies of Delta, Theta, Alpha, Beta, and High Beta about the power that is available within the Brodmann areas, or specifically designated brain regions, the balance between waveforms, the communication from site-to-site, and the speed of firing between sites (Prichep, 2005; Wantzen et al., 2022).

The QEEG corroborates the outcomes derived from the IWBMC™ Evaluation by matching the brain's internal state with the external level of functioning. The unique integration of the QEEG to areas of development attests to the holistic nature of the IWBMC™ rather than having separate, isolated viewpoints on the outcomes of functional or metric-based assessments versus diagnostic tools used in clinical settings, the IWBMC™ combines these two complex processes, resulting in a dynamic and comprehensive evaluation of neurological development. Comparative QEEGS are also part of the ongoing re-evaluation process. Shifts in brain frequencies, electrical activity, and connection patterns can substantiate functional changes resulting from therapeutic programming. Further, evidence of foundational shifts correlates to changes within the lower brain frequencies of the brain, allowing the higher frequencies to regulate in time, enabling overall balance to continue emerging.

This component of the holistic assessment focuses on the latest, most innovative neuroscientific principles, which incorporate the software and engineering of the actual measuring equipment. The IWBMC™ utilizes and recommends the software NeuroGuide, created by Dr. Robert Thatcher, Professor of Clinical Neuroscience. Additionally, we partner with Dr. Thatcher to review data analyses produced by the software and support the findings of the IWBMC™ Evaluation. The process begins with a 19-channel EEG recording of resting-state brain activity with an individual's eyes open and consists of using an EEG amplifier to magnify the electrical activity occurring in the brain. All EEG data is then analyzed using a linked-ears montage, and advanced mathematical equations are used to estimate the sources of the electrical activity on the scalp accurately while comparing the individual's data to a normative database. The normative database includes data from 678 individuals aged two months to 82 years (Thatcher, Walker, Biver, North, & Curtin, 2003).

First, the electrical activity from the outer part of the brain, the cerebral cortex, is transferred to a two-dimensional map, and areas of activity are "mapped" to the electrode site. Next, activity is measured by a standard z-score, moving to three or more standard deviations away from the mean, illustrating activity with cool colors, which signify deficient activity, and warm colors, which signify excessive activity. Anatomical brain regions near each electrode are associated with specific Brodmann Areas, validated through diagnostic neuroimaging tools, including functional magnetic resonance imaging (fMRI), electroencephalogram (EEG), magnetoencephalography (MEG), and positron emission tomography (PET) (Thompson & Thompson, 2016). The QEEG then provides specific measurements of five brain wave frequencies (delta, theta, alpha, beta, and high beta) and calculates the electrical activity occurring in each area of the brain, the balance between different waveforms, the communication between brain areas, and the speed of firing between brain areas.

The amount of communication between areas of the brain further supports the need for intervention using the IWBMC™. If areas of the brain are not communicating effectively or are over-communicating, the brain is not operating optimally. Therefore, by looking at the top areas that are under-communicating and over-communicating, we can isolate the functions of these areas and identify a plan to redirect these communication patterns, allowing for improved functioning. Coherence measures derived from the QEEG show activity measured by a standard z-score, with the thickness of the lines indicating deviations away from the mean.

Integrating QEEG data with areas of neurological development substantiates the effectiveness of the Interpersonal Whole-Brain Model of Care® approach. The goal is to identify and correlate areas of brain dysregulation, apply focused interventions, and measure improvement in brain activity levels correlated to identified therapeutic, academic, and quality-of-life measures.

2.2.1 Linked-Ears Mapping

Linked-ears mapping shows a surface-level reading of the electrical activity occurring within the brain. Since medication influences many areas of the brain, the effect of medication is seen in Linked-ears mapping.

2.2.2 QEEG Measurements

Absolute Power measures the amount of power, or resource, available at each site. Absolute power reflects the actual microvolts recorded at each of the sites. The amplitude or voltage the brain produces is measured at each site. Absolute power helps to determine whether an excessive or deficient amount of activity within a particular frequency range is present at each site.

Relative Power is the distributed total amount of power at each electrode site. Measuring relative power aids in determining whether a particular frequency is overpowering other vital brain frequencies. In addition, relative power is essential for understanding the balance of electrical activity in the brain, as it tells us "Who is in charge."

Amplitude Asymmetry measures the balance of the brain waves between various sites. Excessive activity may indicate an over-firing of neuronal intercommunication, while insufficient activity may suggest neuronal communication is not firing sufficiently to maintain proper brain function.

Coherence is the measurement indicating communication flow between various brain regions, giving the value of efficiency and effectiveness of the brain's ability to accomplish a specific task. Excessive coherence indicates that two or more brain areas are "overly connected or locked together." The brain has become overly dependent on those centers and is not efficiently processing and executing information. If areas have low coherence, they are under-communicating and essentially "offline." Coherence patterns represent regional communication, connectivity, and cooperation between brain areas.

Phase Lag measures communication speed, providing a value of the efficiency of timed events between cortical brain sites. The brain cannot perform at peak efficiency when signals arrive too late or too early.

2.2.3 Color-Code Key

Indicated below is a color-coded key for interpreting a QEEG surface reading (See Figure 2). The Absolute Power and Relative Power measurements are based on standard deviations above and below the norm and color-coded accordingly per the chart above. 1-1.5 standard deviations (SD) above the norm is lime green, 1.5-2 SDs above is yellow, 2-2.5 SDs above is orange, and 2.5 SDs or higher is red. Zero is the mean within the white range and represents activity within the normal range. 1-1.5 SDs below the norm is light green, 1.5-2 SDs below is light blue, 2-2.5 SDs below is blue, and 2.5 SD or lower is the darkest blue.

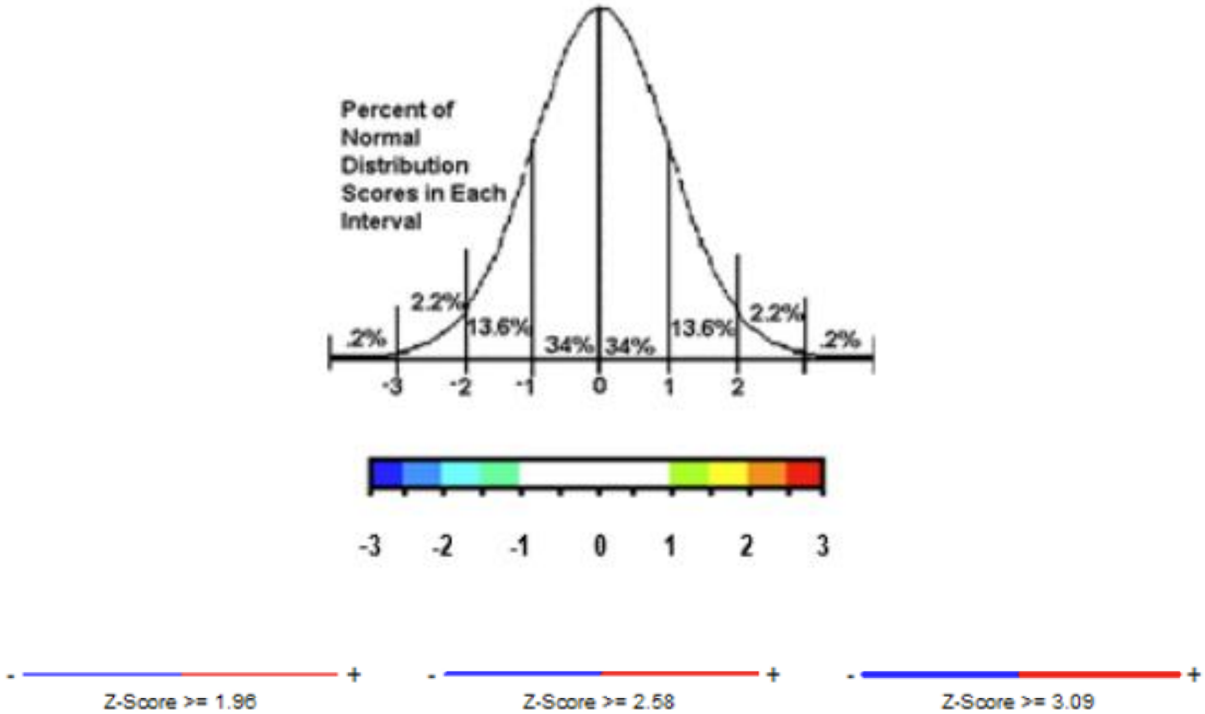

Figure 2. QEEG Surface Reading & Z-Score Key

The Amplitude Asymmetry, Coherence, and Phase Lag measurements are represented as line graphs, with the thinnest lines representing the least significant activity patterns and the thickest lines representing the more substantial activity patterns. Blue lines indicate deficient activity, whereas red lines indicate excessive activity. No lines represent activity within the normal range.

3. Results: Autism Spectrum Disorder & QEEG Data: A Sample Client

For individuals with a diagnosis of autism spectrum disorder, patterns of dysregulation are identified through over and under-connectivity in key areas of the brain, including the Temporal region, Occipital Cortex, Limbic system (specifically the Amygdala and Cingulate Gyrus, Post Central gyrus, Somatosensory Association Cortex, and Prefrontal Association Cortex) (Abi-Dhargam et al., 2023). Often, because of the impact of these connectivity patterns, information cannot flow efficiently between brain regions, hindering the brain's ability to communicate effectively. We also consider how foundational levels of the brain function, as higher-level cognitive skills and functioning depend upon organization within the lower brain regions.

The following image shows a client's QEEG captured at their initial evaluation in 2013 (See Figure 3). The images represent the client's QEEG captured at their 2016, 2019, and 2021 re-evaluations. The client, diagnosed with autism spectrum disorder, completed full-time, intensive programming in the Ladder and Hope School programs at Jacob's Ladder Neurodevelopmental School and Therapy Center in Roswell, Georgia. As part of the programming, the client also completed neurofeedback.

The comparison QEEG findings show improvement in all areas, including electrical activity and communication. Notable improvements are found within absolute power, where excessive activity moved toward the normative range. Further, locked coherence patterns of excessive activity improved, as did amplitude symmetry and phase lag connectivity.

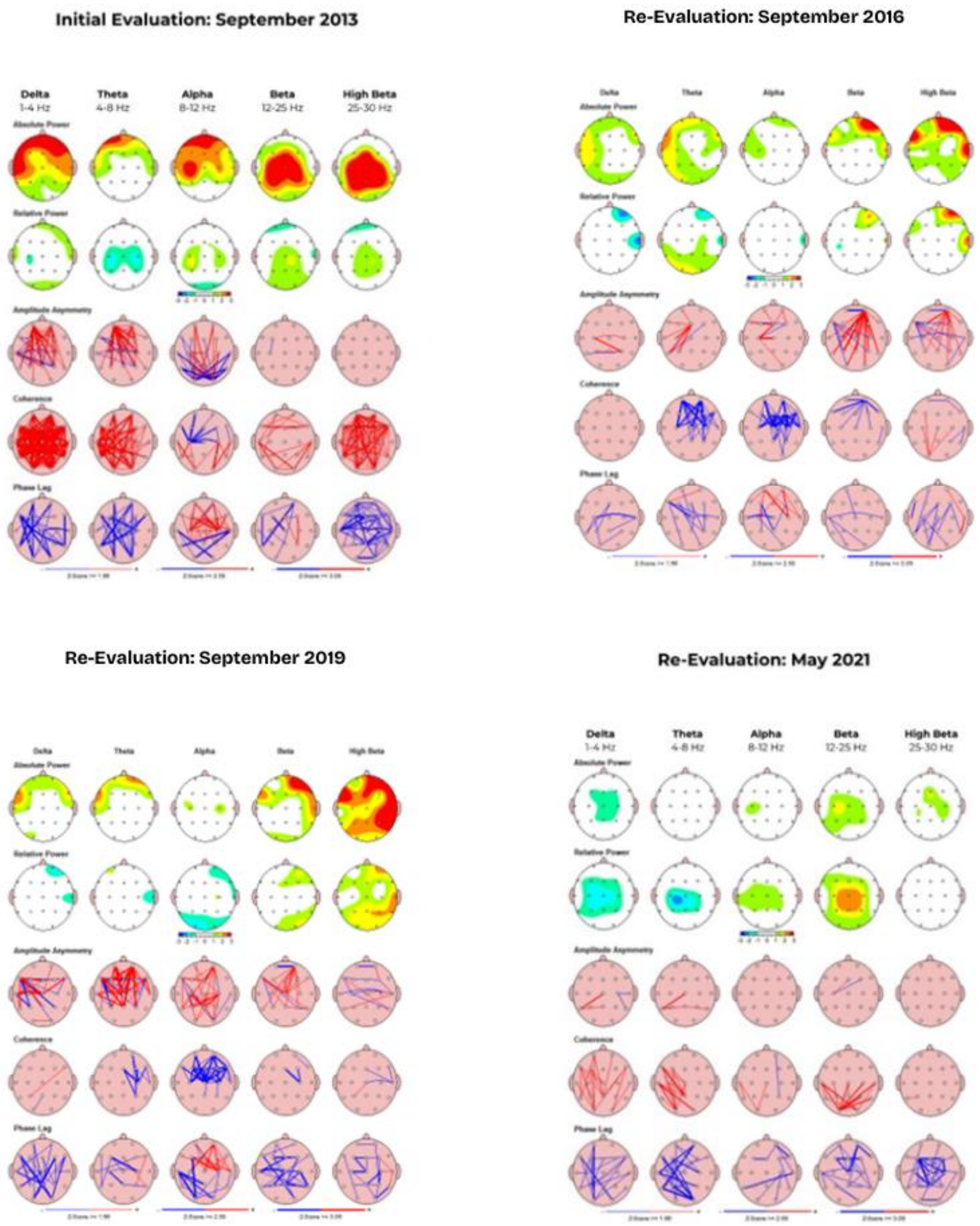

Figure 3. Client's QEEG maps over 8 years of intervention

3.1 QEEG Findings | Top 10 Hyper-Coherence Connections

In addition to images of brain processing, the QEEG can also be used to explore coherence (Thatcher, North, & Biven, 2005). The data below utilizes swLORETA Coherence measures to interpret communication patterns within the brain's deeper structures (Figures 4 and 5). The Top 10 chart provides insight into the most overly connected regions of the brain. The left-hand column indicates the brain regions, followed by the frequency in the next column, and then the comparison data scores at each evaluation point. Finally, the right-hand column shows the z-score change, as noted by scores moving toward the normative score of zero.

Top 10 Hyper-Coherence Connections Comparison
8/19/2013 & 5/10/2021

Channel			Frequency	8/19/2013 z-score	5/10/2021 z-score	Change Toward Normative
Post Central Gyrus - Right Somatosensory Cortex 3R	to	Pre-Frontal Cortex - Right 9R	Alpha 2	6.58	1.39	5.19
Pre Central Gyrus - Right Primary Motor Cortex 4R	to	Pre-Frontal Cortex - Right 9R	Alpha 2	6.44	1.40	5.03
Parahippocampal Gyrus - Right 27R	to	Anterior Cingulate Gyrus - Right 32R	Alpha 2	6.42	1.17	5.25
Anterior Cingulate Gyrus - Right 32R	to	Red Nucleus – Right Brain Stem - Midbrain	Alpha 2	6.29	1.01	5.29
Anterior Cingulate Gyrus - Right 32R	to	Parahippocampal Gyrus - Right Medial Temporal Lobe 35R	Alpha 2	6.28	0.71	5.58
Pre-Frontal Cortex - Right 9R	to	Uncus – Right Superior Temporal Gyrus 34R	Alpha 2	6.26	0.36	5.91
Anterior Cingulate Gyrus - Right 32R	to	Habenula – Right Diencephalon	Alpha 2	6.26	1.09	5.17
Pre Central Gyrus - Right Primary Motor Cortex 4R	to	Anterior Cingulate Gyrus - Right 32R	Alpha 2	6.25	1.34	4.90
Post Central Gyrus - Right Somatosensory Cortex 1R	to	Pre-Frontal Cortex - Right 9R	Alpha 2	6.19	1.43	4.76
Anterior Cingulate Gyrus - Right 32R	to	Uncus – Right Superior Temporal Gyrus 34R	Alpha 2	6.16	0.65	5.51

Figure 4. Top 10 Hyper-Coherence connections historical comparison

Top 10 Hypo-Coherence Connections Comparison
8/19/2013 & 5/10/2021

Channel			Frequency	8/19/2013 z-score	5/10/2021 z-score	Change Toward Normative
Cerebral Crus 2– Right Brain Stem - Midbrain	to	Cerebellum 6 - Right	Alpha 2	-8.41	-1.37	7.04
Occipital Cortex - Right 17R	to	Temporal Lobe - Right 21R	High Beta 2	-6.85	-2.05	4.80
Gustatory Primary Cortex - Left Postcentral and Paracentral Lobule 43L	to	Hippocampus – Left Temporal Lobe	Delta	-6.62	-1.42	5.21
Occipital Cortex - Right 17R	to	Temporal Lobe - Right 22R	High Beta 2	-6.47	-2.14	4.33
Cerebellum 6 - Right	to	Cerebellum 7b - Right	Alpha 2	-6.44	-1.41	5.02
Cerebral Crus 2 – Left Brain Stem - Midbrain	to	Cerebellum 6 - Left	Alpha 1	-6.36	-0.38	5.98
Pre-Frontal Cortex - Right 8R	to	Occipital Cortex - Left 18L	High Beta 2	-6.30	-3.34	2.97
Occipital Cortex - Right 17R	to	Subthalamus – Right Diencephalon	High Beta 2	-6.17	-2.14	4.03
Occipital Cortex - Right 17R	to	Primary Auditory Cortex - Right Inferior Transverse Temporal Gyrus 42R	High Beta 2	-6.15	-2.02	4.13
Vermis 6 - Medial	to	Vermis 7 - Medial	Alpha 2	-5.95	-0.78	5.17

Figure 5. Top 10 Hypo-Coherence connections historical comparison

In the example above of the same client, throughout the time spent working through the IWBMC™ driven interventions, the client's top 10 hyper-coherence (overactive) connections all move from atypical to typical connectivity. Half the connections for the top 10 hypo-coherence (underactive) move to typical connectivity.

4. Results: Autism Sample

4.1 Behavioral Outcomes

Data from 57 clients (50 male, 88.7%; 7 female, 11.3%; 11 non-white, 21.1%; 46 white, 78.9%) demonstrated a significant decrease in reported negative behavior scores from 14.4 pre-intervention to 9.4 post-intervention ($t(56) = 7.83$, $p < .001$, $d = 1.26$). The percentage of parents reporting observed negative behaviors decreased substantially from 56% pre-intervention to only 11% post-intervention ($\chi^2(1) = 25.68$, $p < .001$). These improvements indicate the effectiveness of the IWBMC™ approach in addressing challenging behavioral patterns common in ASD.

4.2 Emotional Development

Analysis of 61 clients showed notable enhancement in emotional recognition capabilities following intervention. The average number of emotions recognized in others increased from 1.5 pre-intervention to 2.3 post-intervention ($t(60) = 6.42$, $p < .001$, $d = 0.98$). The percentage of ASD clients recognizing three or more emotions in others rose from just 9% pre-intervention to 77% post-intervention ($\chi^2(1) = 31.92$, $p < .001$). Notably, 78% of clients could correctly identify two or more emotional expressions, and 27% demonstrated the ability to identify three or more emotions. Given that emotional recognition is considered a fundamental challenge for individuals with ASD, this improvement represents a particularly significant finding.

4.3 Cognitive Functioning

Cognitive assessments of all 61 clients demonstrated meaningful improvements across multiple domains. Deductive reasoning scores almost doubled post-intervention ($t(60) = 5.17$, $p < .001$, $d = 0.84$). Initial receptive word identification scores also showed significant improvement ($t(60) = 4.76$, $p < .001$, $d = 0.74$).

As measured by WRAT-IV grade equivalencies, academic achievement improved significantly in a combined analysis of 43 clients (34 male, 79.1%; 9 female, 20.9%; 9 non-white, 20.9%; 34 white, 79.1%). Math grade equivalents increased from 3.35 to 4.58 ($t(42) = 8.23$, $p < .001$, $d = 1.13$) and reading grade equivalents advanced from 4.86 to 5.21 ($t(42) = 4.76$, $p < .001$, $d = 0.74$). These gains were achieved after just one year of interventions developed through the IWBMC™ programming.

4.4 Neurophysiological Integration

Physiological measurements revealed substantial improvements in neurobiological functioning. Integrated primitive reflexes scores increased from 22.26 pre-intervention to 34.23 post-intervention ($t(60) = 9.48$, $p < .001$, $d = 1.52$). Interhemispheric communication showed marked improvement, with increases in both belly crawl scores (from 2.21 to 3.7; $t(60) = 7.95$, $p < .001$, $d = 1.28$) and creep scores (from 3.14 to 3.95; $t(60) = 6.87$, $p < .001$, $d = 1.05$). These neurophysiological advancements suggest improved neural pathway development and brain integration, fundamental to overall cognitive and behavioral functioning.

These comprehensive results across behavioral, emotional, cognitive, and neurophysiological domains suggest that the IWBMC™ approach effectively addresses the complex needs of individuals with ASD, potentially opening new avenues for connection, communication, and personal growth. By targeting these fundamental areas, the intervention provides clients with tools to navigate their world more effectively and achieve their full potential.

5. Overall Impact and Conclusion

The comprehensive data from 61 ASD clients provides compelling evidence for the effectiveness of the IWBMC™ approach in addressing the complex needs of individuals with autism spectrum disorder. The statistically significant improvements observed across multiple domains—with consistently large effect sizes—demonstrate that targeting fundamental neurobiological frameworks through individualized programming can produce meaningful changes in development and functioning.

The behavioral improvements ($d = 1.26$) reflect a substantial reduction in disruptive behaviors that typically interfere with learning and social engagement. Similarly, the advances in emotional recognition ($d = 0.98$) represent a critical development in an area considered fundamentally challenging for individuals with ASD. The cognitive gains in both deductive reasoning (d = 0.84) and academic achievement (math: d = 1.13; reading: d = 0.74) further support the comprehensive impact of the approach.

Perhaps most notably, the neurophysiological improvements in primitive reflex integration (d = 1.52) and interhemispheric communication (belly crawl: d = 1.28; creep: d = 1.05) provide objective evidence of neurobiological reorganization. These changes in brain functioning likely underpin the behavioral, emotional, and cognitive improvements documented throughout this report.

The IWBMC™'s holistic approach addresses each component of development concurrently, producing a synergistic effect that appears to enhance overall functioning. By identifying and addressing root neurological issues while simultaneously supporting behavioral regulation, emotional development, and cognitive growth, the model creates pathways for lasting improvement. The QEEG case analysis further strengthens these findings by demonstrating concrete shifts in brain connectivity resulting from IWBMC™ interventions.

These outcomes suggest that the IWBMC™ has significant potential to improve quality of life for individuals with ASD and their families, offering practical solutions for challenges previously considered resistant to intervention. While acknowledging the study's limitations, the strength and consistency of these findings across multiple domains provide a solid foundation for continued research and implementation of this promising approach.

5.1 Limitations and the Current Study

While the IWBMC™ approach has demonstrated promising results for individuals with ASD, several limitations should be acknowledged. First, the current data represents a specific client population that received intensive programming at Jacob's Ladder, which may not represent all individuals with ASD across varying severity levels and backgrounds. Second, although improvements were observed across multiple domains, the study did not include a control group, making it difficult to isolate the specific effects of the IWBMC™ from potential confounding variables such as maturation or other interventions the clients may have received concurrently.

While QEEG measurements provide valuable insights into neurological changes, they have inherent limitations in spatial resolution compared to other neuroimaging techniques. Additionally, interpreting QEEG data requires specialized expertise, potentially limiting widespread implementation. Furthermore, while parent reports indicate significant improvements in family functioning and quality of life, standardized measures of these outcomes would strengthen these findings.

5.2 Next Steps for Research and Implementation

Future research should address these limitations through several key initiatives. First, conducting randomized controlled trials comparing the IWBMC™ to other established interventions for ASD would provide more substantial evidence of its efficacy. Expanding the demographic diversity of participants would help determine the generalizability of results across different populations, particularly among underrepresented groups where ASD may be diagnosed later or with greater severity.

Longitudinal studies tracking outcomes over extended periods would be valuable to assess the durability of improvements and potential developmental trajectories. Incorporating additional neuroscientific measurements beyond QEEG, such as functional MRI or DTI, could provide complementary data on structural and functional brain changes associated with behavioral improvements.

From an implementation perspective, developing training protocols for the IWBMC™ approach would facilitate its adoption in diverse settings, including schools, clinics, and home-based programs. Training programs for professionals and accessible resources for families would expand the reach of this promising intervention model. Additionally, exploring telehealth adaptations of specific components could increase accessibility for families in underserved communities.

Finally, investigating the cost-effectiveness of the IWBMC™ compared to traditional interventions would provide important information for policy decisions and insurance coverage. By addressing these next steps, we can build on the promising foundation of the IWBMC™ approach and continue to improve outcomes for individuals with ASD and their families.

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