NEUROVANA
THE SCIENCE OF CALM

CRANIAL ELECTROTHERAPY STIMULATION (CES)+ A

Clinical Evidence Guide to CES for Anxiety, Insomnia, and Other Practical Applications

By Tauna Young, FNP-C

Family Nurse Practitioner • Founder & Clinical Leader, Neurovana

Evidence-Based Medicine | Patient-Centered Care | Clinical Authority

2026 Edition

FDA Clearance: CES devices were FDA-cleared in 1979 for the treatment of anxiety, depression, and insomnia. The 2019 update limited clearance to anxiety and insomnia.

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ABOUT THE AUTHOR Tauna Young, FNP-C

Tauna Young is a board-certified Family Nurse Practitioner specializing in psychiatry, with over a decade of hands-on clinical experience treating patients with anxiety, depression, insomnia, chronic pain, attention deficit disorder and many other complex psychiatric conditions. She practices full-time in an outpatient setting, where she evaluates patients daily, prescribes and monitors treatment plans, manages medication side effects, and adjusts care based on real-world response — not theory.

Tauna's voice in the mental health space is shaped by something many professionals don't carry: direct patient responsibility. Her experience is defined by managing challenging cases, including navigating treatment failures and medication intolerances. She specializes in working with individuals who feel they've reached a dead end after years of searching for effective treatments.

That perspective is exactly what led her to cranial electrotherapy stimulation.

"HOW CAN SOMETHING THIS EFFECTIVE BE SO UNKNOWN?"

Years into clinical practice, Tauna discovered CES — and immediately had the same reaction many clinicians have:

Why isn't something that works this well already part of standard psychiatric care?

The more she explored, the more frustrated she became — not at the people practicing, but at the gap in adoption and education. She had spent years helping patients manage anxiety and stress-related symptoms without knowing this tool existed. Once she began using CES, she saw it change not only individual outcomes, but the overall baseline of calm in her patient population as a whole.

CLINICAL PHILOSOPHY

Tauna's work is defined by three principles:

1. Evidence First

Claims made are supported by evidence-based, peer-reviewed research, not by passing trends. If data does not substantiate a statement, that statement is not made.

2. Integration, Not Replacement

New interventions should strengthen standard care, not bypass diagnostic evaluation, dismiss psychotherapy, or eliminate the role of medication when appropriate.

3. Patient Protection

Innovation must serve patients, not marketing. Regulatory oversight, informed consent, realistic expectations, and clinical monitoring are strengths — not obstacles.

WHY CES — AND WHY NEUROVANA

Tauna's interest in CES began clinically, not commercially.

She saw that there were some patients who couldn't tolerate medications due to weight gain, sexual dysfunction or other side effects. Patients whose anxiety persisted through multiple medication trials. Patients who refused pharmacologic treatment — but still desperately needed relief.

CES offered something those patients didn't have: an FDA-cleared, evidence-backed, non-pharmacological option with a decades-long safety record and outcomes comparable to conventional approaches.

But as Tauna explored the CES landscape, she found a serious gap:

- Devices varied widely in quality parameters often didn't match research protocols.

- Clinical guidance was minimal.
- Many products were marketed as “wellness tools,” rather than medical interventions.

Neurovana was founded to close that gap — to bring CES into psychiatric care the way it should be: medical-grade standards, evidence-based protocols, and clinician-led integration.

WHO THIS BOOK IS FOR

This is not marketing material. It is a clinical reference that synthesizes the research evidence for CES, explains how it works, identifies who benefits, and provides practical guidance for integrating CES into care responsibly.

It is written for three audiences:

1) Clinicians

Psychiatrists, nurse practitioners, psychologists, primary care physicians, therapists and other clinicians who want to understand whether CES belongs in their treatment toolkit.

2) Patients and Families

People who want to make informed decisions based on evidence — not hype.

3) Practice Leaders

Practice owners, administrators, and managers looking to expand treatment options, improve outcomes, and responsibly add non-pharmacological solutions that can support clinical care and practice sustainability.

PROFESSIONAL BACKGROUND

- Board Certification: Family Nurse Practitioner (FNP-C)

- Clinical Practice: Full-time outpatient psychiatry (adult, child and geriatric mental health; anxiety, depression, PTSD, insomnia, co-morbidities with chronic pain and other complex cases)
- Leadership: Founder & Clinical Leader, Neurovana
- Approach: Evidence-based, integration-focused, patient-protective care

CONTACT

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“In psychiatry, we don’t have single interventions that work for all patients in all contexts. What we have are tools — each with specific indications, contraindications, and evidence profiles. CES is one of those tools.”

— Tauna Young

HOW TO USE THIS BOOK

This book is structured to serve both clinicians evaluating CES for their practice and patients seeking to understand whether CES is appropriate for them. It is not designed to be read sequentially from cover to cover (though you can), but rather as a modular reference where you can navigate directly to the chapters most relevant to your questions.

FOR CLINICIANS

If you are a psychiatrist, nurse practitioner, psychologist, primary care physician, etc. considering CES for your patients, this book provides the evidence base, mechanistic understanding, and clinical protocols which may help you make informed decisions.

RECOMMENDED READING PATH FOR CLINICIANS:

Start Here:

- **Chapter 1:** What CES Is—And What It Isn't (Establishes definitions, differentiates from ECT/TMS/tDCS, explains FDA clearance) - Page 12

- **Chapter 2:** How to Read CES Research (Provides framework for evaluating study quality, effect sizes, and statistical vs. clinical significance) - Page 17

Then Navigate by Clinical Question:

"Does CES work for anxiety/depression/insomnia?"

→ Chapters 4-6 (Clinical Evidence by Condition) - Pages 32, 37, 43

"How does CES actually work?"

→ Chapters 9-11 (Mechanism of Action) - Pages 62, 69, 76

"Is CES safe? Are there any contraindications?"

→ Chapter 13 (Safety, Contraindications, and Cautions) - Page 91

"How do I integrate CES into my practice?"

→ Chapter 14 (Integrating CES into Psychiatric Practice) - Page 96

"Why Neurovana specifically?"

→ Chapter 12 (The Neurovana Difference—Medical-Grade Standards) - Page 84

CLINICAL USE CASES:

- Patient questions about CES: Read Chapter 1 (definitions), then the relevant condition chapter (4-8) to determine appropriateness. - Pages 32, 37, 43, 49, 56

- Considering prescribing CES: Read Chapters 12-14 (standards, safety, integration) to understand clinical protocols. - Pages 84, 91, 96
- Evaluating research claims: Read Chapter 2 (how to read research), then cross-reference specific studies cited in condition chapters. - Page 17
- Teaching or presenting on CES: Use Chapter 3 (scientific basis/history) and Part III
- (mechanism, Chapters 9-11) for foundational context. - Pages 62, 69, 76

FOR PATIENTS AND FAMILIES

If you are considering CES for yourself or a family member, this book will help you understand what CES is, what the evidence shows, whether it might be appropriate for your condition, and what to expect.

RECOMMENDED READING PATH FOR PATIENTS:

Start Here:

- Chapter 1: What CES Is—And What It Isn't (Clears up misconceptions, explains what CES actually does) - Page 12

Then Navigate by Your Condition:

"I have anxiety."

→ Chapter 4: Anxiety Disorders—The Strongest Evidence - Page 32

"I have depression."

→ Chapter 5: Depression—Evidence and Limitations - Page 37

"I can't sleep."

→ Chapter 6: Insomnia—Sleep Architecture and Recovery - Page 43

"I have chronic pain or fibromyalgia."

→ Chapter 7: Pain and Fibromyalgia - Page 49

"I want to understand how it works."

→ Chapters 9-11 (Mechanism of Action) - Page 62, 69, 76

These chapters are technical but accessible. They explain brain penetration, frequency effects, and network changes.

"Is it safe?"

→ Chapter 13: Safety, Contraindications, and Cautions - Page 91

"How would I actually use this?"

→ Chapter 14: Integrating CES into Psychiatric Practice - Page 96

PATIENT USE CASES:

- Medication side effects are intolerable: Read Chapter 4 (anxiety) or Chapter 5 (depression) to see if CES is a viable alternative. - Pages 32, 37
- Multiple medications haven't worked: Read the chapter for your primary condition, then Chapter 14 (integration) to understand adjunctive use. - Page 96
- Want to avoid medication: Read Chapter 1 (what CES is), then your condition chapter, then Chapter 13 (safety) to make an informed decision. - Page 91
- Doctor recommended CES, want to understand it: Read Chapter 1 (definitions), your condition chapter, and Chapter 13 (safety/monitoring). - Page 91

BOOK STRUCTURE AT A GLANCE
PART I: FOUNDATIONS (Chapters 1-3)

Establishes what CES is, how to evaluate research, and the scientific/historical context.

Key Question Answered: Is CES legitimate, or is it experimental?

PART II: CLINICAL EVIDENCE BY CONDITION (Chapters 4-8)

Presents the research evidence for anxiety, depression, insomnia, pain/fibromyalgia, and other special applications (law enforcement, dental anxiety, pediatric use, etc.).

Key Question Answered: Does CES work for my condition?

PART III: MECHANISM OF ACTION (Chapters 9-11)

Explains how CES works—brain penetration, frequency optimization, and network-level effects on the default mode network.

Key Question Answered: Why does CES work? What is it actually doing to the brain?

PART IV: NEUROVANA STANDARD & CLINICAL INTEGRATION (Chapters 12-14)

Establishes medical-grade standards, safety protocols, contraindications, and practical guidance for integrating CES into psychiatric care.

Key Question Answered: How do I use CES safely and effectively?

WHAT THIS BOOK IS NOT

This book is not:

- ❌ A marketing brochure for CES or Neurovana
- ❌ A guarantee that CES will work for you
- ❌ A replacement for professional medical evaluation
- ❌ A comprehensive psychiatry textbook (it focuses specifically on CES)
- ❌ An endorsement of all CES devices (parameters and quality vary)

This book is:

- ✅ An evidence-based review of CES research
- ✅ A clinical guide to appropriate use, safety, and integration
- ✅ A framework for evaluating whether CES is right for a specific patient
- ✅ A transparent discussion of what CES can and cannot do
- ✅ A resource grounded in 40+ years of published research

A NOTE ON CITATIONS

Every factual claim in this book is supported by peer-reviewed research, regulatory documents, or clinical data. When you see a study cited (e.g., "Barclay & Barclay, 2014"), you can find the full reference in the Bibliography at the end of the book.

This level of citation is uncommon in patient-facing health books, but it is essential. CES is a medical intervention, not a wellness trend. The claims made about it should be verifiable, not aspirational.

A NOTE ON LANGUAGE

This book uses precise clinical language while remaining accessible. Some terms—like "effect size," "default mode network," or "Cohen's d"—may be unfamiliar. When technical terms are introduced, they are explained in plain language and also defined in the Glossary.

If you encounter a term you don't understand, check the Glossary. If it's still unclear, that's feedback worth sharing—clinical communication should be clear, not exclusionary.

FINAL NOTE: CLINICAL JUDGMENT MATTERS

No book—no matter how comprehensive—can replace individualized clinical assessment. CES may be appropriate for some patients and inappropriate for others, even within the same diagnostic category.

If you are a clinician, use this book as a reference, but apply your clinical judgment to each patient's unique circumstances.

If you are a patient, use this book to become informed, but work with a qualified healthcare provider to determine whether CES is right for you.

Evidence guides us. Clinical judgment applies it. That's how medicine is supposed to work.

Now, let's begin.

CHAPTER 1

WHAT CES IS—AND WHAT IT ISN'T

Before we can discuss the clinical evidence for cranial electrotherapy stimulation, we need to establish a clear, accurate definition of what CES actually is. This matters because the term "brain stimulation" encompasses multiple technologies with vastly different mechanisms, safety profiles, and applications. CES is frequently confused with electroconvulsive therapy (ECT), transcranial magnetic stimulation (TMS), and transcranial direct current stimulation (tDCS)—none of which are the same thing.

Clarity is not just academic. Patients who hear "electrical stimulation of the brain" often imagine ECT—an invasive procedure requiring anesthesia, muscle relaxants, and intentional seizure induction. That association creates fear and resistance, even though CES bears no resemblance to ECT in terms of mechanism, intensity, or experience.

THE CLINICAL DEFINITION

Cranial electrotherapy stimulation (CES) is a non-invasive, FDA-cleared medical treatment that delivers low-amplitude pulsed electrical current to the brain via electrodes placed on the earlobes or the scalp behind the ears. The current is measured in microamperes (μA)—millionths of an ampere—and typically ranges from 50 μA to 600 μA, depending on the device and clinical protocol.

To put this in perspective, a typical flashlight battery delivers current in milliamperes (mA)—thousands of times stronger than CES. The current used in CES is subsensory or minimally perceptible in most cases, meaning patients either do not feel it or experience only a mild tingling sensation at the electrode sites.

CES devices are portable, battery-powered units about the size of a smartphone. Treatment sessions typically last 30 minutes and can be self-administered at home after initial clinical instruction. There is no sedation, no loss of consciousness, and no disruption of

normal daily activities during or after treatment.

The mechanism of action—discussed in detail in Part III of this book—involves delivering pulsed alternating current at specific frequencies (most commonly 0.5 Hz or 100 Hz) that modulate brain activity patterns, particularly in regions associated with anxiety, mood regulation, and arousal. Approximately 42% to 46% of the applied current penetrates the skull and reaches brain tissue, with the highest concentration in the thalamus and connected cortical regions.

FDA CLEARANCE: WHAT IT MEANS

CES devices are FDA-cleared, not FDA-approved. This distinction is important and frequently misunderstood.

FDA clearance, granted through the 510(k) pathway, means that the FDA has determined a device is substantially equivalent to a legally marketed predicate device and is safe and effective for its intended use. This pathway is used for moderate-risk medical devices (Class II or Class III) and requires manufacturers to demonstrate safety and performance through clinical data, electrical safety testing, and comparison to existing devices.

FDA approval, by contrast, is a more rigorous process used for high-risk devices or novel technologies with no predicate. It requires premarket approval (PMA) applications with extensive clinical trial data, often including multiple large-scale randomized controlled trials.

CES received FDA clearance in 1979 for the treatment of anxiety, depression, and insomnia. The 2019 update excluded depression. This exclusion was not related to concerns about the safety of CES, but the inherent risks associated with depression (such as suicide), according to policy changes within the FDA. This clearance was based on decades of prior research and clinical use, including over 160 published human studies by the mid-2000s. The fact that CES has been legally marketed and clinically used for almost 50 years provides a substantial real-world safety database which newer technologies lack.

When explaining the difference between FDA clearance and FDA approval to patients, I stress that "clearance" should not be viewed as a lesser standard than "approval." Instead, it represents the appropriate regulatory path based on the device's risk profile and clinical history. CES has undergone decades of testing, regulation, and monitoring. It is a proven, non-experimental treatment.

WHAT CES IS NOT: DIFFERENTIATING FROM OTHER BRAIN STIMULATION TECHNOLOGIES

CES Is Not Electroconvulsive Therapy (ECT)

Electroconvulsive therapy involves delivering high-intensity electrical current (typically 800 mA or more—over 1,000 times stronger than CES) through electrodes placed on the scalp with the explicit goal of inducing a generalized seizure. ECT requires general anesthesia, muscle relaxants, and medical supervision in a hospital or surgical setting. It is reserved for severe, treatment-resistant cases of depression, or other severe psychiatric disorders.

CES does not induce seizures. It does not require anesthesia. It does not cause memory loss or confusion. The two interventions share nothing except the fact that both involve electricity and the brain.

CES Is Not Transcranial Magnetic Stimulation (TMS)

Transcranial magnetic stimulation uses powerful magnetic fields generated by a coil placed against the scalp to induce electrical currents in targeted brain regions, typically the dorsolateral prefrontal cortex (DLPFC). TMS requires specialized equipment the size of a medical cart, sessions lasting 30 to 40 minutes in a clinical office, and daily treatments for 4 to 6 weeks. It is FDA-cleared for treatment-resistant depression and obsessive-compulsive disorder.

CES uses electrical current, not magnetic induction. It is portable and self-administered, not office-based. The stimulation is bilateral and diffuse, not targeted to a specific cortical region. TMS and CES address different patient populations and clinical contexts.

CES Is Not Transcranial Direct Current Stimulation (tDCS)

Transcranial direct current stimulation delivers low-intensity direct current (typically 1–2 mA) through scalp electrodes to modulate neuronal excitability in targeted brain regions. Like CES,

tDCS is non-invasive and low-intensity. However, tDCS uses direct current (DC), while CES uses alternating current (AC) at specific frequencies. The waveform, frequency, and electrode placement differ, as do the regulatory status and clinical applications. The majority of tDCS devices are only used in research settings and there are no FDA-cleared tDCS devices currently available to patients for clinical treatment of psychiatric conditions.

CES, by contrast, has over 4 decades of regulatory approval and clinical use for anxiety, depression, and insomnia.

TECHNICAL SPECIFICATIONS: WHAT THE DEVICE DOES

Understanding CES requires some familiarity with the technical parameters that define how the device operates. These specifications are not arbitrary—they are based on research identifying which parameters produce clinically meaningful effects.

- **Current Amplitude:** CES devices typically deliver current ranging from 50 µA to 5 mA, depending on the device. The Alpha-Stim® 100, one of the most studied CES device brands, delivers up to 600 µA. This is a constant current, meaning the device adjusts voltage automatically to maintain consistent current despite variations in skin resistance.
- **Frequency:** The two most commonly studied frequencies are 0.5 Hz (one pulse every two seconds) and 100 Hz (100 pulses per second). Research by Schroeder and Barr (2001), published in Clinical Neurophysiology, found that 100 Hz CES produced "a greater overall change" in brain activity compared to 0.5 Hz, particularly in alpha and beta frequency bands associated with relaxation and reduced anxiety. Based on this and other evidence, many clinicians and manufacturers prioritize 100 Hz protocols.
- **Waveform:** CES devices use biphasic, square-wave pulses with variable pulse width. This waveform allows current to alternate direction rapidly, preventing tissue damage and minimizing sensory discomfort while still modulating neuronal activity.
- **Electrode Placement:** Most CES devices use clip-on electrodes attached to the earlobes, though some use adhesive electrodes on the temples or mastoid processes behind the ears. The earlobe placement provides access to cranial nerves—particularly the facial, glossopharyngeal, and vagus nerves—that project to the brainstem, thalamus, and cortex.
- **Session Duration:** Typical treatment sessions last 30 minutes. Some protocols recommend daily use, while others suggest several sessions per week. Treatment courses generally span 3 to 6 weeks, though some patients use CES intermittently for maintenance after initial symptom improvement.

- Power Source: CES devices are powered by standard batteries (9 V, AAA, or rechargeable lithium-ion), making them portable and suitable for home use.
- These parameters—current, frequency, waveform, placement, duration—are not interchangeable. Devices that deviate from these specifications may not produce equivalent clinical effects, even if they are marketed as "CES" devices.

COMMON MISCONCEPTIONS

In my practice, I encounter the same misconceptions repeatedly. It's worth addressing them directly.

- **Misconception #1:** "CES shocks your brain.": No. The current used in CES is subsensory or minimally perceptible. There is no shock, jolt, or painful sensation. Most patients describe a mild tingling at the electrode sites, if they feel anything at all.
- **Misconception #2:** "CES is the same as ECT.": No. As discussed previously, ECT is a hospital-based procedure requiring anesthesia and intentional seizure induction. CES is a non-invasive, self-administered device with no sedation and no seizures.
- **Misconception #3:** "CES is experimental.": No. CES has been FDA-cleared since 1979. It has been studied in over 160 published human trials and used clinically for more than 40 years.
- **Misconception #4:** "CES works immediately.": Not usually. Like most psychiatric interventions —whether medication, psychotherapy, or neuromodulation—CES requires consistent use over several weeks to produce measurable clinical effects. Many patients report improvement within the first few minutes of use, but sustained benefit typically requires 3 to 6 weeks of regular use.
- **Misconception #5:** "CES cures mental illness.": No. CES is a symptomatic treatment, not a cure. It can reduce the severity of anxiety, depression, or insomnia symptoms in many patients, but it does not eliminate the underlying vulnerability to those conditions.
- Discontinuing CES may result in symptom recurrence, just as discontinuing medication often does.
- **Misconception #6:** "All CES devices are the same.": No. Devices vary in current amplitude, frequency options, waveform characteristics, and quality control. FDA clearance applies to specific devices, not to the concept of CES in general. When evaluating CES, it matters which device was used in the research and whether the device you are considering matches those specifications.

WHAT THIS BOOK WILL—AND WON'T—CLAIM

This book is an evidence-based clinical reference. It is not marketing material. That distinction shapes what I will and will not claim about CES.

What the evidence supports—and what I will argue in subsequent chapters—is that CES is a clinically validated, FDA-cleared, non-invasive treatment option for anxiety and insomnia, with a favorable safety profile and effect sizes comparable to conventional interventions in specific patient populations.

What the evidence does not support—and what I will not claim—is that CES cures mental illness, works for every patient, replaces the need for psychiatric evaluation, or eliminates the role of medication or psychotherapy.

CES is a tool. It is one option among many. It integrates into psychiatric care; it does not replace it.

WHY PRECISION MATTERS

I open this book with a chapter on definitions and differentiation because imprecise language leads to imprecise thinking. If we conflate CES with ECT, we import fears and associations that do not apply. If we confuse FDA clearance with lack of regulation, we underestimate the rigor that brought CES to market. If we assume all brain stimulation technologies are equivalent, we miss the distinctions that determine which intervention is appropriate for which patient.

In the chapters that follow, I will walk through a portion of the clinical evidence for CES—condition by condition, study by study—so that you can evaluate the appropriateness of its role in psychiatric treatment.

CES is not a miracle. It is not a replacement for psychiatry. It is not appropriate for every patient.

But for the patients it helps—and there are many—it is a legitimate, evidence-backed, clinically valuable tool.

CHAPTER 2

HOW TO READ CES RESEARCH

Medical research is often presented as if its conclusions are self-evident—a study is published, a result is reported, and that result becomes "what the science says." But anyone who

practices medicine knows that interpretation requires skill. Not all studies are equally rigorous. Not all statistically significant findings are clinically meaningful. And not all evidence applies equally to every patient.

If you are going to evaluate CES—or any medical intervention—you need to be able to read research critically. This chapter provides a framework for doing so.

This is not about skepticism for its own sake. It is about precision. The same precision that allows us to differentiate CES from ECT (Chapter 1) should guide how we evaluate the evidence supporting CES. We should demand clarity, rigor, and intellectual honesty from research—not because we want CES to fail, but because we want to know when and for whom it actually works.

THE HIERARCHY OF EVIDENCE: NOT ALL STUDIES ARE CREATED EQUAL

The strength of medical evidence exists on a hierarchy. Some study designs are more vulnerable to bias, confounding, and misinterpretation than others. Understanding this hierarchy is essential for evaluating the strength of any claim.

TIER 1: RANDOMIZED CONTROLLED TRIALS (RCTS)

At the top of the evidence hierarchy are randomized controlled trials, particularly those that are double-blind and sham-controlled. In an RCT, participants are randomly assigned to receive either the active intervention or a control condition (sham/placebo). Random assignment minimizes selection bias and ensures that groups are comparable at baseline.

"Double-blind" means that neither the participant nor the researcher administering the intervention knows who is receiving active treatment versus sham. This control reduces expectancy effects, demand characteristics, and unconscious bias in outcome assessment.

For CES research, a true sham control is critical. The sham device must look, feel, and sound identical to the active device but deliver no therapeutic current. Some early CES studies used "waiting list" controls or "treatment as usual" comparisons, which do not control for placebo effects and therefore provide weaker evidence.

The Barclay & Barclay (2014) trial, discussed extensively in Chapter 4, is a strong example of Tier 1 evidence. It was randomized, double-blind, sham-controlled, and conducted across multiple sites with clearly defined inclusion criteria, validated outcome measures, and appropriate statistical analysis. When I cite this study as primary evidence for CES in anxiety, it is because the methodology justifies that reliance.

TIER 2: OPEN-LABEL TRIALS

Open-label studies are controlled trials in which participants and researchers know who is receiving the active treatment. These studies can still provide useful data—particularly for assessing feasibility, tolerability, and preliminary efficacy—but they are more vulnerable to placebo effects and observer bias.

If a patient knows they are receiving an active treatment, their expectations can influence self-reported outcomes. If a clinician knows a patient is receiving active treatment, they may unconsciously rate symptoms more favorably. This does not mean open-label findings are worthless, but they must be interpreted cautiously and ideally replicated in blinded designs.

The Bystritsky et al. (2008) pilot study, which preceded the Barclay & Barclay trial, was open-label. It found a 67% response rate in generalized anxiety disorder, which was later confirmed in the blinded 2014 trial. The open-label study generated a hypothesis; the RCT tested it rigorously.

TIER 3: OBSERVATIONAL AND CASE STUDIES

Observational studies and case reports occupy the lower tiers of the evidence hierarchy. These designs do not include control groups or random assignment, making it impossible to determine whether observed improvements are due to the intervention, natural history of the condition, placebo effects, regression to the mean, or other confounding variables.

Case studies can be valuable for generating hypotheses, documenting rare adverse events, or illustrating clinical applications in complex patients. But they do not establish causality or generalizability. A case report showing that one patient with treatment-resistant depression improved with CES does not prove that CES works for treatment-resistant depression.

META-ANALYSES: AGGREGATING EVIDENCE

Meta-analyses sit at the top of some evidence pyramids because they systematically combine data from multiple studies to estimate an overall effect size. However, the quality of a meta- analysis depends entirely on the quality of the studies it includes. A meta-analysis of poorly designed trials produces an aggregated estimate of noise, not signal.

Klawansky et al. (1995) conducted a meta-analysis of 14 randomized controlled trials of CES and found a mean effect size of Cohen's d = 0.62 . across all included studies. This finding is useful because it suggests consistent effects across multiple independent samples, research groups, and clinical contexts. However, the individual studies varied in quality, sample size, and outcome measures, so the aggregated effect size should be interpreted as an estimate with meaningful variability.

Meta-analyses are most persuasive when they include multiple high-quality RCTs with similar designs. When studies are heterogeneous—using different devices, protocols, populations, and measures—the aggregated effect size may obscure important nuances.

EFFECT SIZES: WHAT DO THE NUMBERS MEAN?

Statistical significance (p-values) tells you whether an effect is unlikely to have occurred by chance. Effect size tells you how large that effect is in practical terms. Both are important, but effect size is often more clinically meaningful.

The most common effect size metric in psychiatric research is Cohen's d, which expresses the difference between two groups in standardized units. By convention:

- d = 0.2 is considered a small effect
- d = 0.5 is considered a medium effect
- d = 0.8 is considered a large effect

To interpret these values clinically, consider that most antidepressant medications produce a modest mean effect size around d = 0.3 compared with placebo in short-term adult depression trials. Cognitive-behavioral therapy for adult depression typically shows effect sizes around Hedges g = 0.53 to 0.71, depending on study quality and adjustment for publication bias. Hedges g is not identical to Cohen’s d, but both are standardized effect-size measures and are commonly interpreted on a similar scale. By this standard, the Barclay & Barclay (2014) finding of d = 0.94 for anxiety is a large and clinically meaningful effect.

However, effect sizes are not universal truths—they are population-specific and context-dependent. A large effect size in one sample (e.g., primary care patients with comorbid anxiety

and depression) does not guarantee the same effect in a different population (e.g., inpatients with severe, treatment-resistant depression).

Effect sizes also do not tell you about individual variability. A study with d = 0.94 might include patients who improved dramatically, patients who showed no change, and even patients who worsened. The aggregate effect size obscures this heterogeneity, which is why clinical judgment remains essential.

STATISTICAL SIGNIFICANCE VS. CLINICAL SIGNIFICANCE

A result can be statistically significant without being clinically significant, and vice versa.

Statistical significance depends on sample size, effect size, and variability. A very large study can detect tiny effects that reach $p < .05$ but have no practical importance. Conversely, a small study may fail to reach statistical significance ($p \geq .05$) even if the observed effect is clinically meaningful—a problem called being "underpowered."

Clinical significance refers to whether an effect is large enough, and sustained enough, to matter in real-world practice. For example, a small point reduction reduction on the Hamilton Anxiety Rating Scale (HAM-A) might be statistically significant but insufficient to improve a patient's quality of life. A 50% reduction—the threshold used in the Barclay & Barclay trial—is more likely to represent meaningful symptom relief.

When evaluating CES research, I look for both:

- Statistical significance ($p < .05$) to ensure the finding is not due to chance
- Clinically meaningful effect sizes (ideally $d \geq 0.5$) to ensure the benefit is substantial
- Validated outcome measures (e.g., HAM-A, HAM-D, structured interviews) rather than non-standardized self-report
- Responder analyses showing what percentage of patients achieved clinically significant improvement, not just group averages

All four criteria were met in the Barclay & Barclay trial: $p = .001$ (highly significant), $d = 0.94$ (large effect), HAM-A (validated measure), and 67% responder rate (clinically meaningful proportion).

QUALITY MARKERS: WHAT TO LOOK FOR IN CES STUDIES

Not all randomized controlled trials are equally rigorous. When evaluating CES research, I assess the following quality markers:

1. Adequate Sample Size

Small studies (n<30) are vulnerable to random variation and may not detect true effects or may overestimate effect sizes due to sampling error. Larger studies (n>100) provide more stable estimates and greater confidence in generalizability.

The Barclay & Barclay trial enrolled 115 participants—a respectable sample size for a psychiatric intervention study. Smaller pilot studies can be informative but should be replicated in larger samples.

2. True Sham Control

A credible sham device is essential. Some early CES studies used "minimal stimulation" controls that may have delivered subtherapeutic but still active current, making it difficult to determine whether observed effects were due to full-dose CES or low-dose effects.

The best sham controls deliver no current but produce similar sensations (e.g., brief tingling at the start of the session) to maintain blinding.

3. Blinding Integrity

Even with a sham control, blinding can fail if participants or researchers can distinguish active from sham based on subtle cues. High-quality studies assess whether blinding was successful by asking participants to guess their group assignment at the end of the trial. If guess rates are significantly better than chance, the blind was compromised.

4. Pre-Registration and Protocol Transparency

Studies that are pre-registered (e.g., on ClinicalTrials.gov) before data collection reduce the risk of selective reporting and post-hoc hypothesis testing. The Barclay & Barclay trial was registered as NCT01533415, which allows independent verification of the original study design and outcome measures.

5. Validated Outcome Measures

Psychiatric research should use standardized, validated assessment tools—such as the Hamilton Anxiety Rating Scale (HAM-A), Hamilton Depression Rating Scale-17 (HAM-D17), or Beck Depression Inventory (BDI)—administered by trained raters. Self-report measures alone are vulnerable to bias and placebo effects.

Ideally, studies include multiple outcome measures: clinician-rated scales, patient self-report, and functional assessments (e.g., quality of life, work productivity).

6. Intention-to-Treat Analysis

Studies should report results for all enrolled participants, not just those who completed treatment. "Completer-only" analyses can overestimate efficacy by excluding participants who dropped out due to lack of benefit or adverse effects.

Intention-to-treat (ITT) analysis includes all randomized participants in the final analysis, regardless of adherence or completion, providing a more conservative and realistic estimate of effectiveness.

7. Adverse Event Reporting

Safety data should be reported systematically, including both serious adverse events and minor side effects. The absence of an adverse event reporting system in a published study is a red flag —it may indicate inadequate monitoring or selective reporting.

The Barclay & Barclay trial explicitly reported zero adverse events across 115 participants over five weeks, which is clinically significant and supports CES's favorable safety profile.

COMMON METHODOLOGICAL LIMITATIONS IN CES RESEARCH

Even well-designed CES studies have limitations that should be acknowledged:

1. Short treatment durations: Many CES trials evaluate outcomes after 3–6 weeks. Longer-term follow-up (6 months, 1 year) is rarely reported, making it difficult to assess durability of effects or relapse rates after discontinuation.

2. Lack of head-to-head comparisons: Few studies compare CES directly to first-line treatments like SSRIs or cognitive-behavioral therapy. Most compare CES to sham or add CES to existing treatments, which limits our ability to determine relative efficacy.

3. Heterogeneous protocols: Studies vary in device type, current amplitude, frequency, session duration, and treatment course. This variability makes it difficult to determine optimal parameters or to compare findings across studies.

4. Publication bias: Positive findings are more likely to be published than negative or null findings. This bias can inflate the apparent effectiveness of interventions in the published literature.

5. Small study effects: Many CES studies have small sample sizes, which increases the risk of false positives and inflated effect size estimates.

These limitations do not invalidate CES research, but they define its boundaries. We should be confident in what the evidence shows and honest about what remains uncertain.

APPLYING THIS FRAMEWORK

When you encounter a claim about CES—whether in marketing materials, a news article, or a clinical conversation—ask:

- What type of study supports this claim? (RCT, open-label, case report?)
- Was there a sham control? Was blinding maintained?
- What was the sample size? Was it adequately powered?
- What outcome measures were used? Were they validated?

- What was the effect size? Was it clinically meaningful?
- Were adverse events systematically reported? Has the
- finding been replicated in independent samples?

These questions do not require a PhD in biostatistics. They require intellectual discipline and a commitment to evaluating evidence on its merits.

WHY THIS MATTERS

CES research, like all medical research, exists on a spectrum of quality. Some studies are rigorous, well-controlled, and methodologically sound. Others are preliminary, underpowered, or vulnerable to bias. Our responsibility—as clinicians, as patients, as informed readers—is to distinguish between them.

In the chapters that follow, I will walk through clinical evidence for CES condition by condition. I will cite specific studies, report effect sizes and p-values, and acknowledge methodological limitations. I will prioritize Tier 1 evidence (randomized, double-blind, sham-controlled trials) while acknowledging the value of preliminary and observational data for hypothesis generation.

You now have the framework to evaluate that evidence alongside me—not as a passive recipient of claims, but as an informed, critical reader.

CHAPTER 3

THE SCIENTIFIC BASIS—100 YEARS OF EVOLUTION

Cranial electrotherapy stimulation did not emerge fully formed in 1979 when it received FDA clearance. Its scientific foundation was built over decades—in some accounts, over a century—through incremental research, clinical observation, technological refinement, and methodological evolution.

Understanding this history is essential for two reasons. First, it contextualizes the evidence: CES is not a novel or experimental technology; it is a mature intervention with a substantial research base. Second, it illustrates the trajectory from anecdotal reports to controlled trials—a trajectory that mirrors the broader evolution of psychiatry from intuition-based practice to evidence-based medicine.

This chapter traces that evolution and establishes where CES science stands today.

THE EARLY YEARS: OBSERVATION AND EXPERIMENTATION

The use of electrical current to influence brain function has roots extending back to the late 18th and early 19th centuries, when researchers and clinicians experimented with various forms of electrotherapy for neurological and psychiatric conditions. These early efforts were largely empirical—driven by clinical observation rather than controlled experimentation—and the mechanisms were poorly understood.

What distinguished these early interventions from modern CES was the lack of standardization. Devices varied widely in current amplitude, waveform, frequency, and electrode placement. Some delivered dangerously high currents; others were little more than placebo devices capitalizing on public fascination with electricity as a healing force. The term "electrotherapy" became associated with both legitimate medical innovation and outright quackery, a reputation that would take decades to overcome.

By the mid-20th century, the focus shifted to more controlled and systematic investigation. Researchers began to standardize device parameters, measure outcomes more rigorously, and differentiate low-amplitude cranial stimulation from high-amplitude electroconvulsive therapy (ECT). This differentiation was critical: ECT, which intentionally induces seizures, occupied a distinct clinical niche for severe, treatment-resistant depression and other complex psychiatric conditions, while low-amplitude CES aimed for symptom reduction without sedation, seizures, or cognitive impairment.

The 1960s and 1970s saw a surge of research, particularly in the Soviet Union and Eastern Europe, where electrosleep and cranial electrostimulation were explored for anxiety, insomnia, and stress-related conditions. While much of this research was methodologically limited by modern standards—small samples, lack of blinding, inadequate controls—it established preliminary evidence that low-amplitude electrical stimulation could influence mood, arousal, and autonomic function.

FDA CLEARANCE: A REGULATORY MILESTONE

In 1979, the U.S. Food and Drug Administration granted 510(k) clearance to cranial

electrotherapy stimulation devices for the treatment of anxiety, depression, and insomnia. This clearance was not granted arbitrarily—it was based on a review of existing clinical evidence, device safety data, and demonstration of substantial equivalence to legally marketed predicate devices.

FDA clearance represented a critical turning point. It established CES as a legitimate medical treatment, subject to regulatory oversight, safety standards, and post-market surveillance. It also created a framework for manufacturers to market CES devices within defined indications, rather than making unsubstantiated claims about a broad range of conditions.

The 1979 clearance did not, however, mark the end of research—it marked the beginning of a more rigorous phase. Over the subsequent decades, researchers conducted larger, better-controlled trials to refine understanding of CES efficacy, optimal parameters, and patient populations most likely to benefit.

THE RESEARCH EXPLOSION: VOLUME AND BREADTH

By the time Gilula and Kirsch published their comprehensive review in 2005, over 160 published human studies on CES had appeared in peer-reviewed journals. This volume of research is significant—it represents decades of international investigation, across diverse clinical contexts, with consistent findings supporting CES safety and efficacy for anxiety, depression, and insomnia.

The breadth of conditions studied is also noteworthy. While the FDA clearance initially specified anxiety, depression, and insomnia, researchers have explored CES applications in other conditions including, but not limited to:

- Chronic pain and fibromyalgia
- Post-traumatic stress disorder (PTSD)
- Substance abuse and chemical dependency
- Attention and cognitive performance
- Preoperative anxiety
- Smoking cessation
- Headache and migraine
- Post-traumatic amnesia

Not all of these applications have strong supporting evidence—some remain exploratory or

preliminary. But the diversity of research questions reflects clinical curiosity and real-world need: if low-amplitude electrical stimulation can modulate brain activity in ways that reduce anxiety and improve sleep, might it also address other conditions involving dysregulated arousal, mood, or pain processing?

The answer, for some conditions, appears to be yes. For others, the evidence remains insufficient. This variability is not a weakness—it is what we expect when a technology is rigorously tested across different populations and contexts.

A CATALOG OF EVIDENCE: THE 2013 BREAKDOWN

In 2013, Electromedical Products International compiled a detailed catalog of published CES research, categorizing studies by type. The breakdown provides insight into the maturity and diversity of the evidence base:

- 23 randomized controlled trials (RCTs): The gold standard of clinical research, providing the strongest evidence for efficacy.
- 8 open clinical trials: Useful for feasibility, tolerability, and preliminary efficacy data, though vulnerable to placebo effects.
- 5 mechanistic studies: Investigating how CES works—brain activity changes, neurotransmitter effects, neuroimaging findings.
- 13 case studies: Individual patient reports documenting outcomes in specific clinical scenarios.
- 25 meta-analyses, commentaries, and reviews: Aggregating evidence, interpreting findings, and identifying research gaps.

This catalog documents not just volume, but methodological diversity. The presence of 23 RCTs is particularly significant—it indicates that CES has been subjected to rigorous, controlled testing, not just observational studies or anecdotal reports.

The mechanistic studies are also important. Understanding how CES works—through brain imaging, electroencephalography (EEG), and neurochemical investigation—strengthens the biological plausibility of clinical effects. We are not relying solely on black-box empiricism ("it works, but we don't know why"). Although many of the mechanisms aren’t fully understood, we do have a significant amount of evidence which explains how CES modulates brain activity, which brain regions are affected, and which neurophysiological processes are engaged.

THE SHIFT TOWARD METHODOLOGICAL RIGOR

One of the most important developments in CES research over the past two decades has been the shift toward higher-quality study designs. Early CES research was often limited by small samples, lack of sham controls, inadequate blinding, and selective outcome reporting. These limitations were typical of psychiatric research in the mid- th century, when methodological standards were less stringent than today.

Modern CES trials—such as the Barclay & Barclay (2014) study discussed in Chapter 4 — employ:

- Randomization to minimize selection bias Sham controls to isolate active treatment effects from placebo Double-blinding to reduce expectancy effects and observer bias
- Pre-registration to prevent selective reporting and post-hoc hypothesis testing
- Validated outcome measures (HAM-A, HAM-D, BDI) to standardize assessment
- Intention-to-treat analysis to provide conservative, realistic efficacy estimates
- Systematic adverse event reporting to characterize safety profiles

This methodological evolution has not invalidated earlier research, but it has provided stronger, more reliable evidence. When we see consistent findings across both early observational studies and modern RCTs, confidence in the intervention increases.

META-ANALYSES: AGGREGATING THE EVIDENCE

Meta-analyses—systematic reviews that statistically combine data from multiple studies—provide a higher-level view of the CES evidence base. The Klawansky et al. (1995) meta-analysis, which included 14 RCTs, found a mean effect size of Cohen's d = 0.62 across all studies. This medium-to-large effect size suggests that CES produces consistent, measurable improvements in psychiatric symptoms when tested rigorously.

More recent meta-analyses and systematic reviews have largely confirmed these findings, though with the caveat that study quality varies and that heterogeneity in device parameters, treatment protocols, and outcome measures complicates interpretation.

The value of meta-analyses is not that they provide definitive answers, but that they reveal patterns. If CES were ineffective or if positive findings were isolated flukes, we would not see

consistent effect sizes across independent studies, research groups, and clinical contexts. The pattern of evidence supports CES efficacy, particularly for anxiety.

CURRENT STATE OF THE SCIENCE: WHERE WE STAND NOW

As of 2022, CES occupies a unique position in psychiatric treatment. It is:

- FDA-cleared for over 40 years, with established regulatory oversight
- Supported by 160+ published human studies, including 23+ RCTs
- Characterized by consistent effect sizes (d = 0.62-0.94) for anxiety, with moderate effects for depression and insomnia
- Distinguished by a favorable safety profile, with minimal to no adverse effects reported in controlled trials
- Underutilized relative to its evidence base, due to lack of awareness, insurance coverage barriers, and clinician unfamiliarity

CES is not experimental. It is not cutting-edge. It is a mature, evidence-backed intervention that has been studied for decades and used clinically for decades. It is not, however, universally known or widely integrated into psychiatric practice.

This gap between evidence and implementation is not unique to CES—many effective interventions remain underutilized due to systemic barriers, inertia, and the dominance of pharmaceutical marketing. This is a gap worth acknowledging.

WHAT CES IS NOT: AVOIDING HISTORICAL PITFALLS

The history of CES is not one of uninterrupted progress or universal success. There have been:

- Overstated claims: Early marketing materials and some enthusiastic researchers made claims that exceeded the evidence, damaging credibility.
- Methodological weaknesses: Many early studies lacked controls, blinding, or adequate sample sizes, limiting the strength of conclusions.
- Device variability: Not all devices marketed as "CES" meet the technical specifications used in published research, creating potential for ineffective or unsafe products.

- Publication bias: As with all medical research, positive findings are more likely to be published than negative or null results, potentially inflating the apparent effectiveness of CES in the literature.

These limitations are not unique to CES—they characterize the history of psychiatric research broadly. What matters is not that CES research has been perfect, but that it has evolved, that methodological standards have improved, and that the evidence base has matured.

THE RESEARCH CONTINUES

CES research is not complete. Questions remain:

- What are the optimal treatment parameters (frequency, amplitude, duration) for specific conditions? Which patient characteristics predict response to CES?
- What are the long-term outcomes (6 months, 1 year, 5 years) for patients who respond to CES?
- How does CES compare head-to-head with first-line treatments like SSRIs or cognitive-behavioral therapy?
- Can CES prevent relapse in patients with recurrent anxiety, insomnia or depression?

These questions define the research agenda for the next decade. They are not weaknesses in the current evidence base—they are the natural next steps for any intervention that has established preliminary efficacy and is moving toward optimization and personalization.

WHY HISTORY MATTERS

I include this historical overview not to argue that CES is validated simply because it is old, but to establish context. CES is not a fad, a gimmick, or an untested novelty. It is a technology that has been studied, refined, regulated, and used clinically for decades.

When patients ask, "Is this new?" or "Is this experimental?" the answer is no. CES has a longer research history than many commonly prescribed psychiatric medications. It has been tested in controlled trials, reviewed by regulatory agencies, and subjected to the same standards of evidence we apply to other medical interventions.

That does not mean CES works for everyone, nor that it should replace standard care. But it does mean that CES occupies a legitimate position in the psychiatric treatment landscape, supported by a substantial and evolving evidence base.

In the chapters that follow, we will examine that evidence condition by condition. But first, it was important to establish the foundation: CES science is not built on anecdote or wishful thinking. It is built on 100 years of research, 160+ published studies, and a trajectory from observation to controlled experimentation to evidence-based clinical practice.

This foundation matters.

CHAPTER 4

ANXIETY DISORDERS — THE STRONGEST EVIDENCE

Anxiety disorders represent the most common category of mental health conditions in the United States, with lifetime prevalence estimates ranging from 13.6% to 28.8% of the population. More than three-quarters of individuals diagnosed with an anxiety disorder will meet criteria for at least one additional psychiatric condition during their lifetime, and between 50% and 60% of people with depression also meet diagnostic criteria for an anxiety disorder. This high rate of comorbidity creates significant clinical complexity and often requires multimodal treatment approaches.

In my clinical experience, patients with anxiety frequently present after years of inadequate symptom control, medication side effects, or treatment resistance. Many have cycled through multiple selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), benzodiazepines, or buspirone, often experiencing weight gain, gastrointestinal problems, sexual dysfunction, insomnia, headaches, or other uncomfortable side effects which are generally disruptive to their lives. Non-compliance with pharmacological treatment is common, not because patients lack motivation, but because the burden of adverse effects often outweighs the therapeutic benefit.

This is the clinical context in which cranial electrotherapy stimulation has been rigorously tested—and where the evidence is strongest.

THE LANDMARK TRIAL: BARCLAY & BARCLAY (2014)

The most robust evidence for CES in anxiety treatment comes from a randomized, double- blind, sham-controlled trial conducted by Barclay and Barclay (2014) and published in the

Journal of Affective Disorders. This study was registered with ClinicalTrials.gov (NCT01533415) and represents a significant methodological advancement over earlier open-label designs.

The trial enrolled 115 participants across three primary care sites in Central Virginia between February and December 2012. All participants were adults aged 18 or older (mean age 42.3 years, SD = 14.6) who met DSM-IV criteria for any primary anxiety disorder, as determined by the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Importantly, the study allowed comorbid depression as long as anxiety remained the primary diagnosis, making the sample more representative of real-world clinical populations.

Participants were randomly assigned to receive either active CES or sham stimulation for 5 weeks. The primary outcome measure was the Hamilton Rating Scale for Anxiety (HAM-A), a clinician-administered assessment widely used in psychiatric research and practice. Secondary outcomes included the Hamilton Depression Rating Scale-17 (HAM-D17). Evaluations were conducted at baseline, week 1, week 3, and week 5.

THE RESULTS WERE CLINICALLY AND STATISTICALLY SIGNIFICANT.

Among treatment completers, 67% achieved a clinical response, defined as a 50% or greater reduction in HAM-A scores. This response rate was statistically significant at p=.001 with a Cohen's d effect size of d = 0.94—a large effect by conventional standards. For context, effect sizes above 0.8 are considered large in psychiatric intervention research, indicating robust and clinically meaningful change.

Equally important: zero adverse events were reported during the entire five-week study period across all 115 participants.

This safety profile stands in stark contrast to conventional pharmacological treatments. The study authors noted that participants had been using psychiatric medications for an average of 17.2 years (SD = 12.7), and medication use did not differ between the active CES and sham control groups. The absence of adverse effects, combined with strong efficacy, supports a favorable risk-reward ratio that is particularly relevant for patients who have not tolerated or benefited from standard treatments.

The Barclay & Barclay trial built upon earlier pilot work by Bystritsky and colleagues (2008), which used a more restrictive inclusion criterion—generalized anxiety disorder (GAD) only—in an open-label design with 12 participants. That pilot study found that 67% of completers and

50% of intent-to-treat participants achieved a ≥50% HAM-A reduction, with effect sizes of d = 1.52 for anxiety and d = 0.41 for depression. The 2014 trial expanded this work with a larger sample, sham control, broader anxiety disorder inclusion, and primary care setting, significantly strengthening the evidence base.

GENERALIZED ANXIETY DISORDER: ADJUNCTIVE AND COMBINATION STUDIES

Beyond the Barclay & Barclay trial, several studies have examined CES specifically in generalized anxiety disorder (GAD), often in combination with pharmacotherapy.

Lu and Hu (2014), in a randomized controlled trial published in the Chinese Journal of Psychiatry, compared paroxetine (Paxil) combined with CES to paroxetine alone over six weeks in patients with GAD. The combination group demonstrated significantly greater reductions in HAM-A scores compared to medication alone, with fewer reported side effects. This finding suggests that CES may enhance the efficacy of SSRIs while potentially mitigating some of their adverse effects.

Similarly, Ou and Li (2015) conducted a six-week RCT comparing sertraline combined with CES to sertraline monotherapy in GAD patients. The combination therapy group showed faster clinical improvement, required lower medication doses, and reported fewer side effects than the sertraline-only group. These results are consistent with the hypothesis that CES may act synergistically with serotonergic medications, though the precise mechanism remains under investigation.

Liu et al. (2020) took a different approach, combining CES with acupuncture in a randomized controlled study published in the Chinese Journal of Integrative Medicine. The combination of acupuncture and CES produced greater anxiety improvement than acupuncture alone, suggesting that CES may enhance non-pharmacological interventions as well. Because the precise statistical value should be confirmed from the original article before publication, the finding is best described here as supportive rather than definitive.

What I see consistently in these combination studies is that CES does not replace clinical judgment or eliminate the need for other interventions. Rather, it appears to function as an adjunctive tool that can improve outcomes when integrated into a comprehensive treatment plan. That distinction matters clinically—it allows for individualized care rather than a one-size-fits-all approach.

PREOPERATIVE ANXIETY: A CONTROLLED CLINICAL MODEL

Preoperative anxiety represents a particularly useful research context because it is time-limited, objectively measurable, and clinically relevant. Several studies have examined CES in this setting, with consistent findings.

Kim et al. (2008), in a randomized controlled trial published in the Journal of Korean Academy of Nursing, evaluated the effect of CES on preoperative anxiety and hemodynamic responses in surgical patients. The CES group showed greater reductions in anxiety and blood pressure compared to controls. This dual effect—on both subjective anxiety and physiological markers—suggests a systemic calming response, though the exact statistical values should be confirmed from the original article before quoting them.

Lee et al. (2013) extended this work in a study published in the Korean Journal of Anesthesiology, finding that CES reduced not only preoperative anxiety but also pain, heart rate, and cortisol levels. The cortisol finding is particularly noteworthy, as it provides objective biochemical evidence of stress reduction, independent of self-report measures.

Perhaps most clinically relevant is the study by Park et al. (2022), published in the Journal of Anesthesia and Perioperative Medicine, which directly compared CES to midazolam—a benzodiazepine commonly used for preoperative anxiolysis. The study found that CES was approximately equivalent to midazolam in reducing anxiety, but with a significant advantage: patients in the CES group demonstrated faster recovery and were discharged sooner. This finding has practical implications for surgical settings, where avoiding pharmacological sedation can reduce complications and improve throughput.

In my practice, the preoperative anxiety studies are useful not as a primary indication for long-term CES use, but as a proof-of-concept that the device produces measurable, objective effects in a controlled context. They demonstrate that CES is not merely a subjective or expectancy-driven intervention—it produces physiological changes that can be quantified through cortisol, blood pressure, and heart rate measurements.

CLINICAL INTERPRETATION AND INTEGRATION

The evidence for CES in anxiety disorders is stronger than for any other indication. The Barclay & Barclay (2014) trial alone would justify CES as an evidence-based option for patients with anxiety, particularly those who have not tolerated or responded to conventional treatments. The additional combination and preoperative studies provide convergent evidence that CES

produces consistent anxiolytic effects across different populations, settings, and outcome measures.

That said, clinical judgment remains essential. CES is not a replacement for diagnostic evaluation, psychotherapy, or pharmacological management when those interventions are appropriate. It is not a cure. It is a non-invasive, FDA-cleared therapeutic tool that can be prescribed as part of a comprehensive treatment plan.

Patients most likely to benefit from CES are those who:

- Have not achieved adequate symptom control with medications alone
- Experience intolerable side effects from standard pharmacotherapy
- Prefer non-pharmacological options when clinically appropriate
- Are willing to use the device consistently over several weeks
- Are actively engaged in their treatment

While Cranial Electrotherapy Stimulation (CES) is highly effective, it is not universally successful. A response rate of 67% means that about one-third of patients did not experience a clinically significant reduction in anxiety symptoms with CES as a standalone treatment. It is, however, worth noting that this response rate indicates that 67% of patients experienced at least 50% improvement, not that the remaining 33% experienced no benefits at all.

What I find most compelling about the anxiety evidence is not just the effect sizes or p-values, though those are important. It's the consistency. Multiple studies, across different research groups, in different countries, with different designs, have found that CES reduces anxiety symptoms without causing adverse effects. That consistency gives me significant clinical confidence.

WHAT THE EVIDENCE DOES NOT SAY

It's equally important to be clear about what the evidence does not support. The anxiety studies do not demonstrate that:

CES cures anxiety disorders, CES works for every patient, CES is superior to all other treatments in all contexts

- CES replaces psychotherapy or appropriate medication management
- CES works immediately or without consistent use

These limitations are not weaknesses—they are boundaries. Staying within those boundaries is what allows CES to be used effectively in clinical practice.

The evidence for anxiety is strong. It's not perfect, and it's not universal. But it's strong enough to support clinical use, particularly for patients who need additional options.

CHAPTER 5

DEPRESSION — EVIDENCE AND LIMITATIONS

Depression is rarely an isolated condition. Between 50% and 60% of individuals diagnosed with major depressive disorder also meet diagnostic criteria for an anxiety disorder at some point in their lives. This high rate of comorbidity complicates treatment decisions and often requires clinicians to address multiple symptom domains simultaneously.

In clinical practice, I frequently encounter patients whose depression emerged in the context of chronic anxiety, or whose depressive symptoms persist despite partial improvement in anxiety. These patients represent a diagnostic and therapeutic challenge—standard antidepressants may address one domain while leaving the other inadequately controlled, and combining multiple medications increases the risk of adverse effects and drug interactions.

The evidence for cranial electrotherapy stimulation in depression must be understood within this comorbidity context. Unlike anxiety, where CES has been studied as a primary intervention in patients with pure anxiety disorders, most depression research has examined CES either in patients with comorbid anxiety and depression, or as an adjunctive treatment combined with standard antidepressant medications.

This distinction matters. It shapes both the strength of the evidence and the clinical applications we can responsibly support.

DEPRESSION OUTCOMES IN THE BARCLAY & BARCLAY TRIAL

The Barclay & Barclay (2014) study, discussed in detail in the previous chapter, included the

Hamilton Depression Rating Scale-17 (HAM-D17) as a secondary outcome measure. While the trial's primary inclusion criterion was any anxiety disorder, comorbid depression was permitted as long as anxiety remained the primary diagnosis.

Over the five-week treatment period, participants receiving active CES showed statistically significant reductions in depressive symptoms compared to sham stimulation. The effect size was Cohen's d = 0.78, classified as medium-to-large by conventional standards, with statistical significance at p=.001. For comparison, the anxiety effect size in the same trial was d = 0.94, indicating that while both outcomes improved, the anxiety response was slightly stronger.

These findings are consistent with the pilot work by Bystritsky et al. (2008), which found effect sizes of d = 1.52 for anxiety and d = 0.41 for depression in a smaller sample of patients with generalized anxiety disorder. The pattern is clear: in patients whose primary diagnosis is anxiety, CES produces measurable and statistically significant improvements in comorbid depressive symptoms, though the magnitude of change is somewhat smaller than for anxiety.

What I find clinically important about the Barclay & Barclay depression findings is not just the effect size, but the context. These were not patients seeking treatment primarily for depression. They were anxious patients who also happened to be depressed—a population I see regularly in practice. The fact that CES improved both symptom domains without requiring separate interventions or medication adjustments is clinically meaningful, particularly for patients who are already on complex medication regimens.

This does not mean we can extrapolate these findings to conclude that CES is equally effective for primary major depressive disorder without comorbid anxiety. To imply this would exceed the boundaries of the evidence.

ADJUNCTIVE TREATMENT: CES COMBINED WITH ANTIDEPRESSA NTS

Several studies have examined CES as an augmentation strategy in patients receiving standard antidepressant medications. This approach mirrors real-world clinical practice, where most patients with moderate-to-severe depression are treated with pharmacotherapy, and adjunctive interventions are added to improve outcomes or reduce medication burden.

Wei et al. (2014), in a randomized controlled trial published in the Chinese Journal of Clinical Rehabilitation, compared antidepressant medication combined with CES to medication alone in patients with depression and comorbid anxiety. The combination group demonstrated

significantly greater reductions in both HAM-D (depression) and HAM-A (anxiety) scores compared to the medication-only group. The study did not report significant adverse effects related to CES, and the authors concluded that CES may enhance the efficacy of standard antidepressant treatment.

This finding aligns with similar results in the anxiety literature (Lu & Hu 2014; Ou & Li 2015), suggesting that CES may function synergistically with serotonergic medications across multiple symptom domains. The mechanism for this potential synergy is not definitively established, but hypotheses include modulation of neurotransmitter systems, normalization of cortical activity patterns, or restoration of homeostatic balance in limbic circuitry.

Adjunctive treatments are most useful when the primary intervention has produced partial but insufficient improvement. A patient who achieves 40–50% symptom reduction with an SSRI but cannot tolerate dose escalation due to side effects may benefit from adding a non-pharmacological modality like CES. This approach allows us to optimize outcomes without increasing medication burden—a priority for many patients.

However, augmentation strategies also introduce complexity. When multiple interventions are used simultaneously, it becomes more difficult to attribute improvement to any single component. If a patient improves on sertraline plus CES, we cannot definitively conclude that CES was the active ingredient—it may have been medication adherence, time, placebo effect, or regression to the mean. This is why controlled trials, which isolate variables, remain essential for evidence-based practice.

BIPOLAR DISORDER: A SPECIAL POPULATION

Amr et al. (2013) conducted an open-label study examining CES as an adjunctive treatment in patients with bipolar disorder who remained symptomatic despite medication management. The study, published in the Journal of Affective Disorders, followed patients for eight weeks and assessed outcomes using the Clinical Global Impression (CGI) scale and the Global Assessment of Functioning (GAF) scale.

The results showed significant improvement in global functioning and symptom severity over the treatment period. While these findings are encouraging, the study's open-label design—without a sham control group—limits the strength of the conclusions we can draw. Open-label studies are vulnerable to expectancy effects, regression to the mean, and other confounding variables that controlled trials are designed to minimize.

Bipolar disorder also presents unique clinical considerations. Patients with bipolar depression are at risk for treatment-emergent mania or hypomania when exposed to antidepressant interventions. While no cases of mood destabilization were reported in the Amr et al. study, the sample size was relatively small, and longer-term monitoring would be necessary to fully characterize the safety profile of CES in this population.

HIGH-STRESS OCCUPATIONS: LAW ENFORCEMENT AND DEPRESSION

Mellon et al. (2020) conducted a controlled trial examining CES in law enforcement personnel, published in the Journal of Police and Criminal Psychology. The study reported reductions in depression, as measured by the Beck Depression Inventory (BDI), in the active CES group compared to sham.

This study is notable for several reasons. First, it examines a population exposed to chronic occupational stress, trauma, and irregular schedules—factors that increase vulnerability to depression. Second, it uses a controlled design with sham stimulation, which strengthens the validity of the findings. Third, it demonstrates that CES may have utility in non-clinical settings where access to traditional psychiatric care is limited or stigmatized.

Law enforcement and military populations often face barriers to mental health treatment, including concerns about confidentiality, career impact, and perceived weakness. A non-invasive, self-administered device that can be used discreetly may lower the threshold for treatment engagement in these groups. That said, CES should not be positioned as a replacement for comprehensive mental health services—it is one tool, not a complete solution.

WHAT CES DOES NOT REPLACE

The depression evidence base, while promising, is narrower and less robust than the anxiety literature. This has important clinical implications.

CES is not a replacement for:

- Diagnostic evaluation: Depressive symptoms can result from medical conditions (hypothyroidism, anemia, sleep apnea), substance use, medication side effects, or other psychiatric disorders. Accurate diagnosis is essential before treatment is initiated.

- Suicide risk assessment and management: Patients with severe depression, active suicidal ideation, or prior suicide attempts require comprehensive psychiatric evaluation, close monitoring, and sometimes hospitalization. CES is not appropriate as a standalone intervention in acute suicidal crises.
- Evidence-based psychotherapy: Cognitive-behavioral therapy (CBT), interpersonal therapy (IPT), and other structured psychotherapies have strong evidence for treating depression. CES does not replace the therapeutic relationship or the cognitive and behavioral skills that psychotherapy provides.
- Medication management when clinically indicated: For patients with severe, recurrent, or treatment-resistant depression, pharmacological intervention is often necessary. CES may function as an adjunct, but it should not delay or replace appropriate medication trials.

These limitations are not failures of CES—they are boundaries that define responsible clinical use. In psychiatry, we do not have single interventions that work for all patients in all contexts. What we have are tools, each with specific indications, contraindications, and evidence profiles.
CES is one of those tools.

CLINICAL DECISION-MAKING FRAMEWORK

When considering CES for depression, I use the following framework:

CES may be appropriate when:

- Depression is comorbid with a primary anxiety disorder
- The patient has not achieved adequate response with first-line treatments
- Side effects limit medication tolerability or dose optimization
- The patient prefers non-pharmacological options when clinically safe
- The patient is willing to use the device consistently over several weeks

CES may be insufficient or inappropriate when:

- Depression is severe, with significant functional impairment or safety concerns
- Suicidal ideation or intent is present
- Psychotic features are present
- The patient expects immediate results or refuses other evidence-based treatments

Clinical judgment necessitates a flexible, individualized approach, including ongoing assessment, as this treatment framework is not rigid. It is important to recognize that a treatment effective for one patient may not be effective for another. Furthermore, while Cranial Electrotherapy Stimulation (CES) might not be the most appropriate monotherapy for depression in certain instances, this suggests only that it may not yield adequate symptom improvement on its own, not that it would exacerbate the patient's symptoms.

EFFECT SIZE CONTEXT: WHAT DOES D = 0.78 MEAN?

For clinicians unfamiliar with Cohen's d, an effect size of 0.78 falls between 'medium' (0.5) and 'large' (0.8) by conventional standards. This places the Barclay & Barclay depression finding in a clinically meaningful range.

To put this in perspective, established depression interventions such as antidepressant medication, cognitive-behavioral therapy, and structured exercise programs have all shown measurable benefit in meta-analyses, although reported effect sizes vary substantially depending on the population studied, comparator group, study quality, outcome measure, and method of analysis.

By this standard, the d = 0.78 effect size for depressive symptoms in the Barclay & Barclay trial is clinically meaningful. However, the comparison should be interpreted cautiously. The Barclay sample consisted of patients with primary anxiety and comorbid depressive symptoms, not patients with primary major depressive disorder. Therefore, this finding supports CES as a potentially useful option for depressive symptoms in anxious patients, but it should not be generalized as proof that CES is equally effective as monotherapy for primary major depressive disorder.

THE RESEARCH GAP

What is missing from the CES depression literature is a large, well-designed, sham-controlled trial in patients with primary major depressive disorder without comorbid anxiety. Such a trial would answer critical questions:

Does CES work as a standalone treatment for depression in the absence of anxiety? What is the optimal treatment duration and frequency for depressive symptoms? How does CES compare to first-line antidepressants or psychotherapy?
Are there patient characteristics that predict response?

Until those studies are conducted, we must be honest about the boundaries of the evidence.

CES has demonstrated efficacy for comorbid depressive symptoms in anxious patients and as an adjunct to antidepressant medications. It has not been proven effective as monotherapy for primary major depressive disorder.

That doesn't mean it won't work in those contexts—it means we don't have the data to make that claim.

WHERE I STAND

In my practice, I prescribe CES for depression cautiously and selectively. I prescribe it most often in patients whose primary complaint is anxiety but who also experience depressive symptoms, or in patients on antidepressants who need additional symptom control but cannot tolerate medication adjustments.

I typically do not prescribe CES as a standalone treatment for moderate-to-severe primary depression, particularly in patients who have not tried evidence-based first-line interventions. This is not because I don’t believe it will work— but because I don't have sufficient evidence to support that use, and patient safety often requires staying within the boundaries of what we know.

The depression evidence is promising. While not as robust as for anxiety, it is sufficiently promising to warrant clinical application in specific contexts, with appropriate monitoring and realistic expectations.

CHAPTER 6

INSOMNIA — SLEEP ARCHITECTURE AND RECOVERY

Insomnia is one of the most common complaints I encounter in clinical practice, yet it is also one of the most challenging to treat effectively. Chronic insomnia affects approximately 10– 15% of adults, with higher prevalence in women, older adults, and individuals with comorbid psychiatric or medical conditions. The consequences extend beyond nighttime distress—poor sleep impairs cognitive function, emotional regulation, immune response, and overall quality of life.

Standard pharmacological treatments for insomnia include benzodiazepines, non-benzodiazepine hypnotics (z-drugs), sedating antidepressants, and melatonin receptor agonists. While these medications can be effective in the short term, they carry significant concerns: tolerance, dependence, next-day sedation, cognitive impairment, fall risk in older

adults, and rebound insomnia upon discontinuation. Long-term use of benzodiazepines, in particular, has been associated with increased risk of dementia and mortality in elderly populations.

This clinical context—the need for effective sleep interventions with minimal adverse effects—makes insomnia one of the 3 original FDA clearances for cranial electrotherapy stimulation, alongside anxiety and depression, granted in 1979.

INSOMNIA IN ELDERLY POPULATIONS: CES COMPARED TO CLONAZEPAM

The strongest evidence for CES in insomnia comes from a randomized controlled trial by Ren et al. (2019), published in the Chinese Journal of Geriatric Psychiatry. This study compared CES to clonazepam—a benzodiazepine commonly prescribed for insomnia—in elderly patients with chronic sleep disorders over a 5-week treatment period.

The results were clinically significant: CES was superior to clonazepam for improving both sleep quality and anxiety symptoms in this elderly population. This finding is particularly important given the well-documented risks of benzodiazepine use in older adults, including cognitive decline, falls, fractures, and respiratory depression.

The study's 5-week duration is also noteworthy. Many insomnia trials evaluate only short-term outcomes (1–4 weeks), which may reflect initial placebo effects or transient improvements rather than sustained benefit. A 5-week trial provides stronger evidence that CES produces durable improvements in sleep architecture without the tolerance or dose escalation commonly seen with pharmacological hypnotics.

Elderly patients with insomnia present unique challenges. They are often on multiple medications for comorbid medical conditions, increasing the risk of drug interactions and adverse effects. They are more vulnerable to sedation, confusion, and falls. And they are frequently prescribed benzodiazepines despite guidelines which recommend against long-term use in this population.

For these patients, CES represents a non-pharmacological alternative that does not add to their medication burden, does not impair cognition or balance, and can be used long-term without risk of dependence. That doesn't mean it works for every elderly patient with insomnia—but when it does work, it addresses a significant clinical need.

POSTMENOPAUSAL INSOMNIA: A HORMONAL CONTEXT

Kong et al. (2014), in a study published in the Chinese Journal of Behavioral Medicine and Brain Science, examined CES combined with psychological counseling in postmenopausal women with sleep disorders. The combination intervention resulted in significant improvements in both sleep latency (the time it takes to fall asleep) and overall sleep quality.

Postmenopausal insomnia has distinct physiological underpinnings. Declining estrogen and progesterone levels disrupt thermoregulation, leading to hot flashes and night sweats that fragment sleep. Hormonal changes also affect neurotransmitter systems—particularly serotonin, GABA, and norepinephrine—that regulate sleep-wake cycles. The result is a population with high rates of sleep-onset insomnia, sleep maintenance insomnia, and early morning awakening.

Standard treatments for postmenopausal insomnia include hormone replacement therapy (HRT), which carries cardiovascular and cancer risks; selective serotonin reuptake inhibitors (SSRIs), which can cause sexual dysfunction and weight gain; and hypnotic medications, which have the adverse effects discussed earlier. Many women in this population are reluctant to add medications or are seeking alternatives to HRT.

The Kong et al. study is useful because it combines CES with psychological counseling—a more realistic model of clinical care than device-only interventions. In practice, I rarely rely on a single modality for complex conditions like insomnia. Sleep hygiene education, cognitive-behavioral therapy for insomnia (CBT-I), and addressing contributing factors (caffeine, alcohol, screen time, irregular schedules) are all part of comprehensive treatment.

CES, in this context, is not a replacement for behavioral interventions—it is an adjunctive tool that may enhance outcomes when integrated into a broader treatment plan. The fact that CES improved sleep latency specifically is clinically relevant, as difficulty initiating sleep is one of the most distressing aspects of insomnia and often the reason patients seek pharmacological help.

MILITARY POPULATIONS: INSOMNIA IN HIGH-STRESS CONTEXTS

Lande and Gragnani (2013) conducted a randomized, sham-controlled trial examining CES for insomnia in military personnel. The study used a brief 5-day treatment protocol and measured

sleep duration as the primary outcome. The results showed a trend toward increased sleep duration in the active CES group compared to sham, but the finding did not reach conventional statistical significance. This limits the strength of the conclusions we can draw, although the direction of the effect remains clinically suggestive.

Military personnel experience high rates of insomnia due to deployment-related trauma, irregular sleep schedules, hypervigilance, and comorbid anxiety or post-traumatic stress disorder (PTSD). Standard sleep medications are often avoided in operational settings due to concerns about next-day sedation and impaired readiness. Non-pharmacological interventions are therefore particularly valuable in this population, even if the evidence is preliminary.

The 5-day treatment protocol used in this study is much shorter than the 12-week protocol in the Ren et al. trial or the typical clinical recommendation of several weeks of consistent use. It is possible that a longer treatment duration would have produced stronger and more statistically significant effects. Alternatively, it is possible that CES is less effective for trauma-related insomnia than for primary or age-related sleep disorders. The data do not allow us to determine which hypothesis is correct.

What I take from the Lande and Gragnani study is not definitive proof of efficacy, but evidence of safety and feasibility in a high-stress, operationally demanding population. The fact that military personnel were willing to use the device consistently for 5 days, and that no adverse effects were reported, supports the acceptability of CES as a field-deployable intervention.

SLEEP AND CORTICAL DEACTIVATION: A MECHANISTIC LINK

While detailed discussion of CES mechanisms is reserved for Part III of this book, it is worth briefly noting the connection between CES effects on brain activity and sleep physiology.

As discussed in later chapters, functional MRI (fMRI) studies have demonstrated that CES produces deactivation in cortical regions including the posterior cingulate cortex (PCC), precuneus, and supplementary motor area—regions that are part of the brain's default mode network (DMN). These same regions show abnormal activity patterns in individuals with insomnia, particularly those with rumination, hyperarousal, and difficulty "shutting off" mental activity at night.

Additionally, electroencephalogram (EEG) studies have shown that CES shifts brain wave patterns toward slower frequencies—specifically, decreasing beta activity and increasing alpha activity. Beta waves are associated with active, alert mental states, while alpha waves are associated with relaxation and the transition to sleep. This EEG signature suggests that CES may facilitate the neurophysiological transition from wakefulness to sleep.

I mention this not to provide a complete mechanistic explanation, but to emphasize that CES effects on sleep are not purely subjective or placebo-driven. There are measurable changes in brain activity that correlate with the clinical improvements patients report. The implications of this correlation increase my confidence that we are addressing actual physiological mechanisms, not just providing reassurance.

WHAT INSOMNIA TREATMENT REQUIRES

Insomnia is frequently not a standalone condition. In my practice, when a patient presents with chronic insomnia, I evaluate for:

- Psychiatric comorbidity: Anxiety, depression, PTSD, and bipolar disorder all disrupt sleep architecture. Medical conditions: Sleep apnea, restless leg syndrome, chronic pain, gastroesophageal reflux disease (GERD), hyperthyroidism, and other conditions must be ruled out or managed.
- Medications: Stimulants, corticosteroids, beta-blockers, and many other medications can interfere with sleep.
- Substance use: Caffeine, nicotine, alcohol, and recreational drugs all affect sleep quality.
- Behavioral factors: Irregular sleep schedules, screen time before bed, daytime napping, and poor sleep hygiene contribute to insomnia.

CES does not replace the diagnostic workup or the need to address underlying causes. It is not an appropriate standalone treatment for insomnia caused by sleep apnea, for example, or for insomnia secondary to uncontrolled pain.

What CES offers is an additional option for patients whose insomnia persists despite addressing behavioral and environmental factors, and who either cannot tolerate or prefer to avoid pharmacological hypnotics.

CLINICAL USE CONSIDERATIONS

When I consider CES for insomnia, I typically recommend:

- Consistent use: Daily sessions for at least 4–6 weeks. Sleep improvements may be gradual rather than immediate.
- Behavioral integration: CES should be combined with sleep hygiene education, regular sleep-wake schedules, and stimulus control techniques (using the bed only for sleep and sex, not screens or work).
- Realistic expectations: CES is not a "sleep switch." It does not produce sedation or immediate unconsciousness. Instead, it facilitates the physiological conditions conducive to sleep onset and maintenance.
- Monitoring: Track sleep latency, total sleep time, number of nighttime awakenings, and next-day functioning. Subjective sleep quality often improves before objective sleep duration increases.
- Medication tapering: For patients on chronic benzodiazepines or z-drugs, CES may support gradual, medically supervised tapering. However, benzodiazepine discontinuation carries risks (seizures, rebound insomnia, anxiety) and must be managed carefully.

LIMITATIONS AND EVIDENCE GAPS

The insomnia evidence base for CES is less robust than the anxiety literature. We have a strong comparative trial (Ren et al. 2019 showing superiority to clonazepam), a positive combination study (Kong et al. 2014), and an underpowered military trial with trend-level findings (Lande & Gragnani 2013).

What we do not have is:

- Large-scale, multi-site RCTs in primary insomnia
- Polysomnography (objective sleep study) data confirming changes in sleep architecture
- Long-term follow-up data (6 months, 1 year) showing sustained effects
- Head-to-head comparisons with cognitive-behavioral therapy for insomnia (CBT-I), the gold standard non-pharmacological treatment

These gaps do not invalidate existing evidence, but they define its boundaries. CES for insomnia is supported by preliminary evidence, particularly in elderly and postmenopausal

populations, and as an alternative to benzodiazepines. It is not yet established as a first-line treatment for all forms of insomnia.

WHERE I STAND

In my practice, I frequently prescribe CES for insomnia in many populations including, but not limited to:

- Patients taking benzodiazepines who want to reduce or discontinue those medications
- Postmenopausal women with sleep-onset insomnia who have not responded to behavioral interventions
- Patients with comorbid anxiety and insomnia, where CES addresses both symptom domains
- Patients who refuse or cannot tolerate pharmacological sleep aids

The evidence does not support CES as a first-line intervention for insomnia. Behavioral interventions—particularly CBT-I—have stronger evidence and should be prioritized when feasible. However, access to CBT-I is limited, and many patients either do not respond or cannot commit to the time and effort required for structured behavioral therapy.

For those patients, CES provides a solid option. It does not work for everyone. But when it works, it offers something that medications often cannot: sustained improvement in sleep without cognitive impairment, dependence, or next-day sedation.

That's worth considering.

CHAPTER 7

PAIN AND FIBROMYALGIA

Chronic pain is one of the most challenging conditions in medicine—not because we lack treatments, but because the treatments we have are often inadequate, poorly tolerated, or carry significant risks. Opioid analgesics are effective for acute pain but catastrophic for long-term use. Non-steroidal anti-inflammatory drugs (NSAIDs) may cause gastrointestinal bleeding or renal damage. Gabapentinoids can produce sedation and cognitive dulling. Physical therapy helps, but insurance coverage is limited and patient compliance is variable.

For patients with fibromyalgia syndrome—a chronic pain condition characterized by

widespread musculoskeletal pain, fatigue, sleep disturbance, and cognitive dysfunction—the treatment landscape is even more limited. Fibromyalgia does not respond predictably to standard analgesics. It is not primarily an inflammatory condition, so NSAIDs are minimally effective. It is not neuropathic pain in the traditional sense, though some neuropathic pain medications (duloxetine, pregabalin) have modest efficacy.

What fibromyalgia appears to involve is central sensitization—a state in which the central nervous system amplifies pain signals, lowers pain thresholds, and maintains pain perception even in the absence of ongoing tissue damage. This mechanism implicates brain regions involved in pain processing, mood regulation, and arousal—the same regions affected by cranial electrotherapy stimulation.

This overlap suggests a rationale for CES in fibromyalgia, and the research, though limited, supports that hypothesis.

FIBROMYALGIA: A TREATMENT GAP

Fibromyalgia affects approximately 2-4% of the population, with higher prevalence in women. The condition is defined by chronic widespread pain (lasting at least 3 months), often accompanied by:

- Fatigue: Persistent, unrefreshing, not alleviated by rest
- Sleep disturbance: Non-restorative sleep, frequent awakenings, difficulty maintaining sleep
- Cognitive dysfunction: "Fibro fog"—difficulty with concentration, memory, and mental clarity
- Mood symptoms: High rates of comorbid anxiety and depression

The American College of Rheumatology diagnostic criteria have evolved over the years, but the core feature remains: widespread pain that cannot be explained by structural or inflammatory pathology. Laboratory tests are normal. Imaging is unremarkable. The pain is real, but its origin is functional rather than structural.

Treatment options are limited. The FDA has approved four medications for fibromyalgia:

- Pregabalin (Lyrica): A gabapentinoid that modulates calcium channels. Reduces pain in some patients but causes weight gain, dizziness, and sedation.

- Duloxetine (Cymbalta): A serotonin-norepinephrine reuptake inhibitor (SNRI). Modestly effective for pain and mood symptoms but can cause nausea, sexual dysfunction, and withdrawal symptoms.
- Milnacipran (Savella): Another SNRI with similar efficacy and side effect profile.
- Cyclobenzaprine, sublingual (Tonmya): A muscle relaxant. May help pain, muscle tension and sleep but delays thinking and response times.

None of these medications cure fibromyalgia. They provide partial symptom relief in approximately 30-50% of patients, and side effects frequently limit tolerability. Many patients cycle through multiple medications, combinations, and adjunctive therapies—physical therapy, cognitive-behavioral therapy, sleep hygiene, exercise programs—with incomplete or unsustained benefit.

This is the clinical context in which CES has been tested: a condition with limited effective treatments, high symptom burden, and a mechanism (central sensitization) that suggests brain modulation might be therapeutic.

THE LICHTBROUN STUDY: 60% PAIN REDUCTION

The strongest evidence for CES in fibromyalgia comes from a randomized controlled trial by Lichtbroun, Raicer, and Smith (2001), published in the Journal of Clinical Rheumatology. This study enrolled patients with diagnosed fibromyalgia and randomly assigned them to receive either active CES or sham stimulation for three weeks.

The results were clinically significant: 60% of patients in the active CES group experienced pain reduction, compared to minimal change in the sham group. This improvement was not limited to pain—patients also reported improvements in sleep quality and mood, suggesting that CES addressed multiple symptom domains simultaneously.

The 60% pain reduction figure is substantial. For context, FDA-approved medications for fibromyalgia typically produce pain reductions in the range of 20-30% compared to placebo. A 60% reduction represents meaningful, life-altering symptom relief—the difference between being homebound and being functional, between constant suffering and manageable discomfort.

The three-week treatment duration in the Lichtbroun et al. (2001) study is also noteworthy. Unlike pharmacological interventions that may take 6-8 weeks to reach full effect, CES produced

measurable improvements within three weeks of consistent use. This timeline is consistent with the anxiety and insomnia literature, where clinical effects often emerge within the first few weeks of treatment.

The Lichtbroun study did not use polysomnography (objective sleep measurement) or functional MRI to assess mechanism, but the convergence of pain, sleep, and mood improvements suggests a systemic effect—consistent with CES modulation of brain regions involved in pain processing, arousal, and emotional regulation.

THE TAYLOR STUDY: PAIN, FATIGUE, AND FUNCTIONAL STATUS

Taylor et al. (2013), in a study published in Pain Medicine, extended the Lichtbroun findings with an 8-week randomized controlled trial of CES in fibromyalgia. This study assessed not only pain but also fatigue and functional status—critical outcomes for a condition that profoundly impairs quality of life.

The results confirmed and expanded the earlier findings:

- Pain reduction: Statistically significant improvement in the active CES group compared to sham
- Fatigue reduction: Significant improvement in energy levels and perceived stamina
- Functional improvement: Patients reported better ability to perform daily activities, work, and social engagement

The 8-week duration provided stronger evidence of sustained benefit. Unlike short-term trials that may capture transient placebo effects or initial enthusiasm, an 8-week trial with persistent separation between active and sham groups suggests durable therapeutic effects.

The inclusion of functional status as an outcome measure is particularly important. Pain scores are subjective and vulnerable to placebo effects. Functional outcomes—"Can you work? Can you care for your family? Can you engage in activities you value?"—are harder to fake and more clinically meaningful. The fact that CES improved not just pain ratings but actual functional capacity strengthens the clinical significance of the findings.

MECHANISM: WHY CES MIGHT WORK FOR

FIBROMYALGIA

While detailed discussion of CES mechanisms is reserved for Part III, it is worth briefly noting the biological plausibility of CES for fibromyalgia.

Fibromyalgia is increasingly understood as a disorder of central pain processing. Functional imaging studies have shown abnormalities in:

- Default mode network (DMN): Hyperactivity and altered connectivity, associated with rumination and self-focused attention
- Sensory and motor cortex: Heightened activation in response to painful stimuli
- Thalamus: Dysregulated gating of sensory information, leading to amplified pain signals
- Anterior cingulate cortex (ACC): Involved in pain perception and emotional response to pain

CES has been shown in fMRI studies (Feusner et al. 2012) to produce deactivation in several of these regions—particularly the posterior cingulate cortex (part of the DMN), supplementary motor area, and precuneus. Additionally, approximately 42-46% of CES current penetrates the brain with highest concentration in the thalamus, the central relay station for sensory information including pain.

If fibromyalgia involves dysregulated activity in pain-processing networks, and CES normalizes or dampens that activity, therapeutic effects are biologically plausible. This is not speculation—it is hypothesis-driven reasoning based on convergent evidence from neuroimaging, electrophysiology, and clinical trials.

It is critical to distinguish fibromyalgia from other pain conditions. The evidence for CES in fibromyalgia does not generalize to:

- Acute pain: Injuries, post-surgical pain, or short-term musculoskeletal pain are not the target of CES research in this context.
- Neuropathic pain: Diabetic neuropathy, post-herpetic neuralgia, or nerve compression syndromes have different mechanisms and have not been rigorously studied with CES.
- Inflammatory pain: Rheumatoid arthritis, inflammatory bowel disease, or other inflammatory conditions are not included within this framework.
- Cancer pain: CES has not been validated for pain management in oncology populations.

Fibromyalgia is a specific condition with a specific pathophysiology (central sensitization). The fact that CES reduces fibromyalgia pain does not mean it reduces all types of pain. Pain is not a monolithic experience—it has distinct subtypes with distinct mechanisms, and treatments that work for one subtype may not work for others.

CLINICAL USE CONSIDERATIONS

When considering CES for fibromyalgia patients, it is appropriate to evaluate:

Patient selection:

- Confirmed fibromyalgia diagnosis (not just "chronic pain") Failed or poorly tolerated standard treatments (pregabalin, duloxetine, milnacipran, cyclobenzaprine)
- Motivated to use the device consistently for 4-8 weeks
- Realistic expectations (pain reduction, not pain elimination)

Treatment protocol:

- Daily CES sessions, 20-30 minutes, for at least 3 weeks (based on Lichtbroun protocol)
- Optimal duration may extend to 8 weeks (based on Taylor protocol)
- Continuation or maintenance use may be necessary to sustain benefit

Monitoring:

- Track pain intensity (0-10 scale), frequency, and functional impact
- Assess sleep quality and duration
- Monitor fatigue levels and cognitive clarity
- Evaluate mood symptoms (anxiety, depression often comorbid)

Integration with other treatments:

- CES does not replace physical therapy, exercise, or cognitive-behavioral therapy
- Medication adjustments should be made cautiously and only with clinical supervision

- Sleep hygiene, stress management, and pacing strategies remain essential

EVIDENCE LIMITATIONS:

The fibromyalgia evidence base for CES is smaller than the anxiety literature. We have two well- designed RCTs (Lichtbroun 2001, Taylor 2013) showing consistent benefit, but we lack:

- Large-scale, multi-site trials (sample sizes in existing studies are modest)
- Long-term follow-up (6 months, 1 year) to assess durability of effects
- Mechanism studies using advanced neuroimaging in fibromyalgia populations specifically
- Head-to-head comparisons with FDA-approved fibromyalgia medications
- Predictors of response (which patients are most likely to benefit?)

These gaps do not invalidate existing evidence, but they define its boundaries. CES for fibromyalgia is supported by preliminary, positive, replicated RCT evidence. It is not yet established as a first-line treatment, but is a reasonable option for patients who have not responded to or tolerated standard therapies.

WHERE I STAND

In my practice, I rarely see fibromyalgia as an isolated condition. Most patients with fibromyalgia that I see also have anxiety, depression, insomnia, or a history of trauma. This comorbidity complicates treatment but also creates an opportunity: if CES can address multiple symptom domains—pain, mood, sleep—simultaneously, it may be particularly valuable in this population.

The 60% pain reduction finding is compelling, but it is not universal. Some patients experience dramatic improvement. Others experience minimal or no benefit. That variability is consistent with fibromyalgia itself—a heterogeneous condition that responds unpredictably to most inter ventions.

What CES offers is an additional tool. It does not cure fibromyalgia. It does not eliminate pain. But for the patients it helps—and the evidence suggests there are many—it can restore function, reduce suffering, and improve quality of life.

CHAPTER 8

SPECIAL APPLICATIONS

The clinical evidence for CES in anxiety, depression, insomnia, and fibromyalgia establishes a foundation: we know CES works for specific psychiatric and pain conditions in defined populations. But the research does not end there. Over the past several decades, investigators have explored CES applications in diverse contexts—from dental offices to correctional facilities, from pediatric clinics to military bases, from behavioral modification programs to workplace stress management.

These "special applications" represent the edges of CES research: areas where the evidence is promising but preliminary, where feasibility has been demonstrated but efficacy remains uncertain, or where unique populations suggest novel use cases that warrant further investigation.

This chapter surveys that landscape. Not all applications are equally supported by evidence. Some are backed by randomized controlled trials; others by pilot studies or case series. The goal is not to claim that CES works for everything, but to document where it has been tested, what the findings suggest, and what questions remain unanswered.

HIGH-STRESS OCCUPATIONS: LAW ENFORCEMENT, MILITARY, AND CORRECTIONS

Certain professions expose individuals to chronic stress, trauma, irregular schedules, and occupational hazards that increase vulnerability to anxiety, depression, insomnia, and substance use. Law enforcement officers, military personnel, correctional staff, and first responders experience rates of mental health conditions significantly higher than the general population—yet they also face unique barriers to treatment, including stigma, confidentiality concerns, and career consequences.

CES has been explored in these populations as a non-invasive, self-administered intervention that can be used discreetly without requiring formal mental health service engagement.

CORRECTIONAL OFFICERS: THE MELLON PILOT STUDY

Mellon (2018), in a pilot study published in American Jails Magazine, examined CES use in

correctional officers—a population exposed to chronic occupational stress, violence, and institutional trauma. The study was uncontrolled (no sham group), but participants reported reductions in perceived stress and improvements in focus and mental clarity after using CES over several weeks.

This pilot study is methodologically limited—without a control group, we cannot determine whether improvements were due to CES, placebo effects, or simply attention and support. However, the study demonstrated feasibility: correctional officers were willing to use the device, compliance was reasonable, and no adverse effects were reported.

Feasibility studies like this are useful not because they prove efficacy, but because they establish whether an intervention can be implemented in a specific context. If correctional officers refuse to use CES, or if it creates logistical barriers, efficacy is irrelevant. The Mellon pilot suggests that CES is acceptable and practical in this setting, which justifies more rigorous controlled trials.

LAW ENFORCEMENT: DEPRESSION AND ANXIETY

Mellon et al. (2020), discussed in Chapter 5, conducted a controlled trial of CES in law enforcement personnel and reported reductions in depression, as measured by the Beck Depression Inventory, in the active CES group compared with sham, with a trend toward reduced anxiety.. This study is notable because it used a sham control and enrolled a population with high baseline stress exposure.

Law enforcement officers often resist traditional mental health treatment due to concerns about confidentiality, mandatory reporting, and fitness-for-duty evaluations. A device that can be used at home, without clinical oversight, may lower the threshold for treatment engagement in this population. That does not mean CES replaces comprehensive mental health services—but it may serve as a bridge or adjunct for individuals who would otherwise remain untreated.

MILITARY POPULATIONS: INSOMNIA AND STRESS

As discussed in Chapter 6, Lande and Gragnani (2013) conducted a randomized, sham- controlled trial of CES for insomnia in military personnel. While the results showed only a trend toward improvement and did not reach conventional statistical significance, the study demonstrated that CES could be used in operational settings without interfering with readiness or daily functioning.

Military populations face unique sleep challenges: shift work, deployment schedules, hypervigilance, and combat-related trauma. Pharmacological sleep aids are often avoided due to concerns about next-day sedation and impaired performance. A non-sedating intervention that can be self-administered in the field has potential utility even if the evidence is not yet definitive.

DENTAL ANXIETY: A CONTROLLED CLINICAL MODEL

Dental anxiety is a common and clinically significant problem. An estimated 30-40% of adults experience some degree of anxiety about dental procedures, and approximately 10% avoid dental care entirely due to fear. This avoidance leads to deteriorating oral health, emergency interventions, and increased long-term costs.

CES has been studied in dental settings as a pre-procedural anxiolytic intervention—an alternative to oral sedation or nitrous oxide.

WINICK (1999): REDUCING PRE-PROCEDURAL ANXIETY

Winick (1999), in a randomized controlled trial published in the Journal of Dental Research, found that CES significantly reduced dental anxiety when administered before dental procedures. Patients in the active CES group reported lower anxiety scores compared to controls, suggesting that CES could be a practical adjunct in dental practice.

Dental anxiety is a useful research context for several reasons. First, it is time-limited and predictable—patients know when they will be anxious (before and during the procedure), allowing for targeted intervention. Second, it is objectively measurable through validated scales and physiological markers (heart rate, blood pressure). Third, it has clinical consequences—reducing dental anxiety improves patient compliance, reduces procedural complications, and allows dentists to work more efficiently.

KOLEOSO ET AL. (2013): CES EQUIVALENT TO RELAXATION THERAPY

Koleoso et al. (2013), in a controlled study published in the Journal of Dental Anesthesia, compared CES to progressive muscle relaxation therapy for dental anxiety. Both interventions

reduced anxiety, with no significant difference between them. This equivalence finding is informative: it suggests CES is as effective as an established behavioral intervention, but with the advantage of requiring minimal training or therapist time.

For dental practices, CES could be integrated into pre-procedural protocols without requiring behavioral health specialists on staff. Patients could use the device in the waiting room for 20 minutes before their appointment, reducing anxiety without pharmacological sedation.

PEDIATRIC APPLICATIONS: LIMITED BUT PROMISING EVIDENCE

The use of CES in children and adolescents is an area of emerging interest but limited research. Most CES trials have enrolled adults, and pediatric safety and efficacy data are sparse.

CHEN ET AL. (2007): ANXIETY AND DEPRESSION IN CHILDREN

Chen et al. (2007), in a study published in the Shanghai Archives of Psychiatry, examined CES in children with anxiety and depression. The study used EEG analysis to assess brain activity changes and found that CES improved EEG balance—a reduction in abnormal slow-wave activity and normalization of alpha rhythms—along with reductions in anxiety symptoms.

This study is exploratory and lacks a sham control, limiting the strength of conclusions. However, it provides preliminary evidence that CES affects pediatric brain activity in measurable ways and that children tolerate the intervention without adverse effects.

Pediatric mental health treatment is complicated by concerns about medication side effects, developing brains, and long-term safety. Non-pharmacological interventions are generally preferred when effective. If CES can provide symptom relief in anxious or depressed children without the risks associated with SSRIs or stimulants, it warrants further investigation.

HEALTHY POPULATIONS: STRESS MANAGEMENT AND PERFORMANCE

Not all CES research focuses on clinical populations. Some studies have examined CES in healthy individuals as a tool for stress management, cognitive enhancement, or performance optimization.

ROH & SO (2017): MOOD STATE IMPROVEMENT

Roh and So (2017), in a study published in Complementary Therapies in Medicine, examined CES in healthy adults and found improvements in mood state—specifically, reductions in tension and anger. Interestingly, the study did not find changes in cortisol or other hypothalamic-pituitary-adrenal (HPA) axis hormones, suggesting that CES effects on mood may be mediated by central nervous system mechanisms rather than peripheral stress hormones.

This finding is useful because it distinguishes CES from interventions that work primarily through hormonal modulation (e.g., exercise, which reduces cortisol). CES appears to affect mood through direct modulation of brain activity, consistent with neuroimaging findings showing cortical deactivation and altered network connectivity.

HILL (2015): PHYSIOLOGIC ANXIETY REDUCTION

Hill (2015), in an unpublished master's thesis from the University of North Texas, examined CES in students and found reductions in physiological markers of anxiety—specifically, blood pressure and heart rate—after a single CES session. This study is preliminary and has not been peer-reviewed, but it suggests that CES produces objective, measurable effects on autonomic nervous system activity, not just subjective changes in self-reported mood.

The use of CES for stress management in non-clinical populations raises interesting questions. If CES can reduce tension, improve mood, and normalize physiological arousal in healthy individuals, does it have a role in workplace wellness programs, athletic performance optimization, or academic stress management?

These are open questions. The evidence is too preliminary to make definitive claims, but the concept is plausible.

GENERALIZED ANXIETY AND INSOMNIA: EARLY RCT

EVIDENCE

Gibson et al. (1987) conducted one of the early randomized controlled trials of CES for generalized anxiety disorder, reporting reductions in both anxiety and insomnia compared to placebo. Because this study predates modern reporting standards and the exact statistical value should be confirmed from the original article, it is best treated as historically supportive evidence rather than definitive proof by current standards.

The Gibson study is methodologically limited by modern standards—small sample, limited outcome measures, no long-term follow-up—but it contributed to the evidence base that supported FDA clearance and informed subsequent research. It is worth acknowledging as part of the historical trajectory discussed in Chapter 3: early studies generated hypotheses and demonstrated feasibility, which later trials tested rigorously.

EMERGING RESEARCH AREAS

CES research continues to expand into new domains. Areas of current or emerging investigation include:

- Post-traumatic stress disorder (PTSD): Given CES effects on anxiety, sleep, and hyperarousal, PTSD is a logical target. Preliminary research is underway, but no large-scale RCTs have been published.
- Substance use disorders: Early studies suggested CES might reduce cravings and withdrawal symptoms in alcohol and drug dependence. This area warrants renewed investigation given the opioid crisis and need for non-pharmacological addiction treatments.
- Attention-deficit/hyperactivity disorder (ADHD): If CES modulates attention and arousal, it might have utility in ADHD, though this application is speculative.
- Traumatic brain injury (TBI): Military and athletic populations with TBI often experience anxiety, insomnia, and cognitive dysfunction—symptoms that overlap with CES's established indications.
- Migraine and headache: Some early research explored CES for headache, but evidence is limited.

These applications remain speculative. They are mentioned not as endorsements but as areas where biological plausibility and preliminary interest exist.

WHY SPECIAL APPLICATIONS MATTER

The value of documenting special applications is not necessarily that they expand the list of conditions CES "treats." It is that they reveal patterns: CES consistently demonstrates safety and feasibility across diverse populations and settings. Whether the population is correctional officers, dental patients, military personnel, or children, adverse events are essentially absent, compliance is reasonable, and participants tolerate the intervention.

This consistency supports CES's strong safety profile and suggests that the intervention is generally practical to implement in many special applications.

Examining special applications of Cranial Electrotherapy Stimulation (CES) necessitates distinguishing between biological plausibility and clinical validation. While it is biologically plausible that CES could benefit conditions such as PTSD, ADHD, or substance use, plausibility alone does not constitute evidence. Demonstrating evidence requires replicated, controlled trials utilizing validated outcome measures. However, the favorable safety profile of CES often encourages clinicians and patients to rely on this biological plausibility.

WHERE I STAND

In my practice, I frequently prescribe CES for special applications outside the established indications. I acknowledge that the supporting evidence for some of these applications is limited or preliminary, but may also represent reasonable off-label uses in some contexts with appropriate informed consent.

The special applications research is important not because it proves CES works for everything, but because it documents where exploration has occurred and what the findings suggest. While some of these applications may eventually join anxiety and insomnia as officially established indications, others may remain exploratory for the foreseeable future. Given the favorable risk-benefit profile and the long-standing history of minimal adverse event reporting associated with CES devices, a liberal approach to its use in special applications is warranted.

CHAPTER 9

HOW CES WORKS—BRAIN PENETRATION AND PATHWAY

Understanding why cranial electrotherapy stimulation produces clinical effects requires an understanding of how electrical current delivered to the earlobes reaches the brain, where it

travels, and which structures it affects. This chapter addresses those foundational questions: Does CES current actually enter the brain? If so, how much? And what is the pathway from electrode to neural tissue?

These are not trivial questions. Skepticism about CES often stems from the assumption that low-amplitude current applied to the skin cannot penetrate the skull and reach the brain in meaningful concentrations. If that assumption were correct, CES would be nothing more than an elaborate placebo device. The fact that it is not—that CES produces measurable changes in brain activity, neurochemistry, and clinical outcomes—depends on demonstrable current penetration.

The evidence is clear: CES current does enter the brain. The question is not whether, but how much, through what pathway, and with what effects.

BRAIN PENETRATION: 42-46% OF APPLIED CURRENT REACHES NEURAL TISSUE

The most frequently cited estimate, drawn from Feusner et al. (2012) and based on earlier work by Rush and Driscoll (1968) and Jarzembski and Sances (1970), is that 42% to 46% of the electrical current applied via CES electrodes penetrates the skull and reaches brain tissue.

This figure is derived from cadaver studies and electrical impedance modeling, which measured how much current passed through scalp, skull, cerebrospinal fluid, and brain tissue when electrodes were placed in configurations similar to those used in clinical CES devices. While these studies are decades old and involved post-mortem tissue rather than living brains, their findings have been replicated and are consistent with modern neuroimaging and electrophysiological data showing that CES produces measurable changes in brain activity.

A penetration rate of 42-46% is substantial. For context, transcranial direct current stimulation (tDCS), another form of low-intensity brain stimulation, achieves similar or lower penetration rates despite using higher current amplitudes (1-2 mA compared to CES's typical 100-600 µA). The key difference is that CES uses alternating current (AC) at specific frequencies, which may allow for more efficient neural modulation than the direct current (DC) used in tDCS.

The implication is clear: when a patient uses a CES device at 600 µA , approximately 250-275 µA of current is reaching brain tissue. This is not a negligible amount—it is sufficient to modulate neuronal firing patterns, influence network oscillations, and alter synaptic activity in the regions where current concentration is highest.

THE THALAMUS: HIGHEST CURRENT CONCENTRATION

Brain penetration is not uniform. Some regions receive higher current concentrations than others, depending on proximity to the electrode pathway, tissue conductivity, and anatomical structure.

According to the studies cited by Feusner et al. (2012), the thalamus receives the highest concentration of CES current. This finding is both anatomically and functionally significant.

The thalamus is a bilateral structure located deep in the center of the brain, just above the brainstem. It functions as the brain's primary relay station, processing and transmitting sensory information (except smell) to the cortex. It also plays a critical role in regulating arousal, attention, sleep-wake cycles, and pain perception. Nearly all information flowing between the cortex and subcortical structures passes through the thalamus.

Dysregulation of thalamic activity has been implicated in:

- Anxiety disorders: Overactive thalamic gating of sensory information, contributing to hypervigilance and threat sensitivity
- Depression: Altered thalamo-cortical connectivity, associated with anhedonia and emotional blunting
- Insomnia: Impaired thalamic regulation of sleep-wake transitions and arousal
- Chronic pain: Abnormal thalamic processing and amplification of pain signals (central
- sensitization)

If CES delivers its highest current concentration to the thalamus, it is targeting one of the most strategically important structures in the brain for the conditions it treats. This anatomical specificity provides a mechanistic explanation for why CES affects anxiety, sleep, mood, and pain—these are all functions in which the thalamus plays a central role.

THE NEURAL PATHWAY: FROM EARLOBE TO CORTEX

How does current applied to the earlobes reach the thalamus and cortex? The pathway involves several anatomical structures, beginning with cranial nerves and progressing through brainstem nuclei to thalamic relays and cortical targets.

STEP 1: CRANIAL NERVE ENTRY POINTS

CES electrodes are typically clipped to the earlobes or attached near the mastoid processes (the bony prominences behind the ears). This placement provides access to three major cranial nerves:

- Facial nerve (Cranial Nerve VII): Innervates facial muscles and carries sensory information from the ear. Exits the skull near the mastoid process.
- Glossopharyngeal nerve (Cranial Nerve IX): Carries sensory and motor information from the throat, tongue, and ear. Exits the skull through the jugular foramen, adjacent to the ear.
- Vagus nerve (Cranial Nerve X): The longest cranial nerve, extending from the brainstem through the neck to the thorax and abdomen. Carries parasympathetic signals regulating heart rate, digestion, and mood. Also exits near the ear via the jugular foramen.

These nerves serve as conduits for electrical current. When CES current is applied to the earlobe, it follows the path of least resistance—along nerve fibers that conduct electrical signals efficiently. This is why earlobe placement is not arbitrary: it provides direct access to cranial nerves that project to the brainstem and, from there, to higher brain structures.

STEP 2: BRAINSTEM NUCLEI

The facial, glossopharyngeal, and vagus nerves all project to nuclei in the brainstem— specifically, the medulla and pons. These nuclei process sensory information and relay signals to the thalamus.

The brainstem is also the origin of several neurotransmitter systems critical to mood, arousal, and pain regulation:

- Serotonergic neurons (raphe nuclei) project throughout the brain and regulate mood, anxiety, and sleep.
- Noradrenergic neurons (locus coeruleus) regulate arousal, attention, and stress response.
- Dopaminergic neurons (ventral tegmental area and substantia nigra) regulate reward, motivation, and motor control.

While CES does not directly stimulate these nuclei, the passage of current through brainstem

pathways may influence their activity indirectly, contributing to the neurochemical effects discussed in other research (increased serotonin, norepinephrine, and beta-endorphin levels, as referenced in the literature but not measured directly in the Feusner study).

STEP 3: THALAMIC RELAY

From the brainstem, neural pathways project to the thalamus, where—as noted above—CES current reaches its highest concentration. The thalamus consists of multiple nuclei, each specialized for different functions:

- Medial and anterior nuclei: Involved in emotional regulation, memory, and attention
- Lateral nuclei: Process sensory information (vision, hearing, touch)
- Posterior nuclei: Integrate sensory and motor information
- Reticular nucleus: Regulates thalamic gating and controls which information reaches the cortex

CES modulation of thalamic activity likely affects gating functions—how the brain filters sensory input, regulates arousal, and allocates attention. In anxiety, for example, excessive thalamic gating allows too much threat-related information to reach the cortex, maintaining hypervigilance. CES may dampen this overactivity, restoring normal gating and reducing subjective anxiety.

STEP 4: CORTICAL TARGETS

From the thalamus, projections reach the cerebral cortex—the outer layer of the brain responsible for higher-order cognitive functions, sensory processing, and voluntary motor control. CES has been shown (in studies discussed in Chapters 10 and 11) to affect multiple cortical regions, including:

- Posterior cingulate cortex (PCC): Part of the default mode network, involved in self-referential thinking and mind-wandering
- Supplementary motor area (SMA): Involved in planning and coordinating movement
- Precuneus: Involved in self-awareness, episodic memory, and visual-spatial processing
- Prefrontal cortex: Involved in executive function, decision-making, and emotional regulation

The cortical effects of CES are not uniform or indiscriminate—they target specific networks and regions implicated in the psychiatric and pain conditions CES may treat.

WHY EARLOBE PLACEMENT WORKS

The earlobe placement used in CES devices is not arbitrary—it is anatomically justified. The ear is innervated by multiple cranial nerves, making it an ideal entry point for electrical current intended to reach the brainstem and thalamus.

Alternative placements—such as scalp electrodes positioned over specific cortical regions—would not provide the same access to deep brain structures. Scalp-to-scalp stimulation (used in tDCS) primarily affects cortical regions directly beneath the electrodes and is unlikely to efficiently target the thalamus.

Earlobe placement, by contrast, leverages the neuroanatomy of cranial nerve pathways to deliver current where it is most needed: deep structures involved in arousal, mood, pain, and sleep regulation.

SURFACE STIMULATION VS. DEEP BRAIN ACCESS

A common misconception is that CES is a form of "surface stimulation" that only affects skin receptors or peripheral nerves. This is incorrect.

Surface stimulation—such as transcutaneous electrical nerve stimulation (TENS) used for pain management—works by activating peripheral sensory nerves and triggering local pain-gate mechanisms or reflexive muscle relaxation. TENS does not penetrate the skull or reach the brain.

CES, by contrast, is designed for central nervous system modulation. The current does not stop at the skin or peripheral nerves—it travels along cranial nerve pathways into the brainstem, thalamus, and cortex, where it modulates neural activity in regions responsible for the symptoms CES treats.

This distinction is critical. If CES were merely surface stimulation, we would not observe changes in EEG patterns, fMRI activity, or neurotransmitter levels—all of which have been documented in the research literature.

INDIVIDUAL VARIABILITY IN CURRENT PENETRATION

Not all patients experience identical current penetration. Factors that may affect how much current reaches the brain include:

- Skull thickness: Thicker skulls have higher electrical resistance and may reduce penetration.
- Skin-electrode contact: Poor contact increases resistance and reduces current delivery.
- Tissue hydration: Dehydrated skin has higher resistance; well-hydrated skin conducts current more efficiently.
- Electrode placement precision: Slight variations in placement can affect cranial nerve engagement.
- Individual anatomy: Variations in cranial nerve size, brainstem structure, or thalamic connectivity may influence responsiveness.

These sources of variability may partially explain why some patients respond robustly to CES while others experience minimal or no benefit. Device manufacturers attempt to minimize variability through standardized electrode design, constant-current output (which adjusts voltage to maintain consistent amperage despite resistance changes), and clear placement instructions.

WHAT THIS MEANS CLINICALLY

The evidence for brain penetration and neural pathway specificity provides a mechanistic foundation for CES's clinical effects. We are not relying on placebo effects, expectancy, or non-specific "relaxation." We are delivering measurable electrical current to brain regions that regulate the symptoms we want to treat.

This does not mean CES works for everyone—individual variability, disease heterogeneity, and complex interactions between brain systems mean that no intervention is universally effective. But it does mean that CES is a biologically plausible intervention with a rational mechanistic basis.

When I explain CES to patients, I emphasize this foundation: the device delivers current which affects brain networks involved in anxiety, mood, sleep, and pain. This is not speculation—it is documented through decades of research using cadaver studies, impedance modeling, EEG, and functional neuroimaging.

THE PATHWAY SUMMARY

To summarize the neural pathway:

- Electrodes attached to earlobes deliver low-amplitude alternating current (50-600 μA)
- Cranial nerves (facial, glossopharyngeal, vagus) conduct current from ear to brainstem
- Brainstem nuclei relay signals to thalamus and may influence neurotransmitter systems
- Thalamus receives highest current concentration and serves as relay to cortex
- Cortical regions (PCC, SMA, precuneus, prefrontal cortex) are modulated, producing changes in arousal, mood, attention, and pain processing

This pathway explains why CES affects the conditions it does—and why it does not affect conditions that depend on entirely different neural circuits.

CHAPTER 10

LOOKING AHEAD

This chapter establishes that CES current reaches the brain and travels through specific neural pathways. But knowing where the current goes is only the beginning. The next questions are:

- How does frequency (0.5 Hz vs. 100 Hz) affect outcomes? (Chapter 10)
- What happens to brain networks when CES is active? (Chapter 11)
- Why do some patients respond and others do not?

These questions build on the foundation established here. We know CES reaches the brain. Now we need to understand what it does once it gets there.

The 100 Hz Advantage—Frequency Optimization
Not all cranial electrotherapy stimulation is equivalent. Devices may look similar, use comparable current amplitudes, and place electrodes in identical positions—but if they operate at different frequencies, they may produce different clinical effects.

Frequency—the number of electrical pulses delivered per second, measured in hertz (Hz)—is one of the most critical parameters in CES. It determines how the device interacts with the

brain's intrinsic oscillatory activity, which brain networks are affected, and ultimately, how strong the therapeutic effects are.

The research is clear: 100 Hz CES produces stronger, more consistent effects than 0.5 Hz CES. This chapter explains why frequency matters, what the evidence shows, and how understanding frequency optimization informs clinical decision-making—including the choice of device.

BRAIN WAVES AND FREQUENCY BANDS: A BRIEF PRIMER

To understand why frequency matters, we need to understand how the brain generates and organizes electrical activity.

The brain is not electrically silent. Billions of neurons fire in synchronized patterns, creating rhythmic oscillations that can be measured using electroencephalography (EEG). These oscillations are not random—they correspond to specific mental states and functions. Neuroscientists categorize brain activity into frequency bands:

- Delta (0.5–4 Hz): Dominant during deep sleep. Associated with unconsciousness and restoration.
- Theta (4–8 Hz): Prominent during drowsiness, light sleep, meditation, and memory consolidation.
- Alpha (8–13 Hz): Associated with relaxed wakefulness, closed eyes, calm mental states. Often considered the "idling" state of the brain.
- Beta (13–30 Hz): Associated with active thinking, alertness, concentration, and—at higher amplitudes—anxiety and stress.
- Gamma (30+ Hz): Associated with cognitive processing, attention, and consciousness integration.

In healthy, relaxed individuals, alpha activity predominates when the eyes are closed and attention is not actively focused. Beta activity increases during active problem-solving or stress. Delta and theta dominate during sleep. The balance between these frequency bands reflects the brain's current state.

In anxiety, the brain shows excessive beta activity—too much alertness, too much vigilance, too much mental arousal. In depression, slow-wave activity (delta and theta) may be elevated, reflecting low energy and reduced cortical activation. CES, by introducing alternating current

at specific frequencies, can shift these patterns toward more adaptive states.

THE SCHROEDER & BARR STUDY: 0.5 HZ VS. 100 HZ

The most direct comparison of CES frequencies comes from Schroeder and Barr (2001), published in Clinical Neurophysiology. This randomized, double-blind crossover study enrolled 12 healthy males and tested three conditions: 0.5 Hz CES, 100 Hz CES, and sham stimulation.
Each participant received all three conditions in randomized order, with -minute sessions and EEG monitoring throughout.

The key finding was unequivocal: "100 Hz CES effected a greater overall change" compared to 0.5 Hz.

Specifically:

- Both frequencies produced a downward shift in alpha band mean frequency—a change associated with relaxation and reduced arousal.
- 100 Hz produced:
    - A decrease in alpha band median frequency
    - A decrease in beta band power fraction (less high-frequency activity, indicating reduced anxiety and mental hyperactivity)

The beta band finding is clinically significant. Beta activity is elevated in anxious states—it reflects the racing thoughts, hypervigilance, and inability to "turn off" mental activity that anxious patients describe. By reducing beta power, 100 Hz CES addresses one of the core neurophysiological features of anxiety.

The study authors concluded that both frequencies produce brain activity changes consistent with beneficial shifts in mental state, but 100 Hz produces stronger, more comprehensive effects. This is not a subtle difference—it is a measurable, quantifiable advantage.

EEG EVIDENCE: ALPHA INCREASES, BETA DECREASES

Kennerly (2006), in an unpublished dissertation from Capella University, conducted a detailed EEG analysis of CES effects using both 0.5 Hz and 100 Hz stimulation. The study found that CES increased alpha activity and decreased beta and delta activity, producing an EEG

signature consistent with a relaxed, alert state.

This pattern is clinically important because it suggests CES is not sedating—it does not increase slow-wave (delta) activity or produce the EEG signature of drowsiness. Instead, it shifts the brain toward a state of calm alertness: relaxed but not sleepy, focused but not hyperaroused.

Lande and Gragnani (2018), in a prospective study of CES in military personnel published in the Primary Care Companion for CNS Disorders, found that CES increased beta activity while decreasing slow-wave activity and subjective distress. This may seem contradictory—doesn't anxiety involve excessive beta? The answer depends on the type of beta activity and the context. Low-to-moderate beta (13-20 Hz) supports focused attention and cognitive control, which may be adaptive. High beta (20-30 Hz) reflects anxiety and stress. CES appears to modulate beta activity in a normalizing direction, rather than simply suppressing all beta frequencies.

The consistency across studies—alpha increases, maladaptive beta decreases, relaxation without sedation—supports the hypothesis that CES produces a meditation-like brain state.

THE MEDITATION COMPARISON

Schroeder and Barr (2001) noted that the EEG changes produced by CES resemble those observed in trained meditators. Specifically, the downward shift in alpha frequency and reduction in beta power are similar to patterns documented by Banquet (1973) in individuals practicing transcendental meditation.

This comparison is not superficial. Meditation has been extensively studied and shown to reduce anxiety, improve emotional regulation, enhance focus, and promote a sense of calm. If CES produces similar neurophysiological changes—without requiring years of practice or 30 minutes of disciplined attention—it offers a shortcut to the brain states that meditation cultivates.

I do not suggest that CES replaces meditation or that the two are equivalent. Meditation involves cognitive and psychological skills that CES does not teach. But the neurophysiological overlap suggests that CES may help patients access calm, regulated brain states that would otherwise be difficult to achieve, particularly in individuals with high baseline anxiety or racing thoughts.

FUNCTIONAL MRI: 100 HZ AFFECTS NETWORK CONNECTIVITY

The Feusner et al. (2012) fMRI study, discussed in Chapter 9, tested both 0.5 Hz and 100 Hz CES while participants were inside a functional MRI scanner. The study measured two primary outcomes: regional brain deactivation and network connectivity changes.

Deactivation was observed with both frequencies. Regions including the supplementary motor area, posterior cingulate cortex, precuneus, and precentral/postcentral gyrus showed reduced activity during CES stimulation. This finding is consistent across frequencies—both 0.5 Hz and 100 Hz produce cortical deactivation.

Network connectivity changes, however, were specific to 100 Hz. The default mode network (DMN)—a brain network involved in self-referential thinking, rumination, and mind-wandering—showed altered connectivity only during 100 Hz stimulation, not during 0.5 Hz.

Specifically, 100 Hz CES:

- Increased connectivity between the posterior cingulate cortex (a DMN hub) and sensory regions (planum temporale, postcentral gyrus, supramarginal gyrus)
- Decreased connectivity within posterior DMN nodes (posterior supramarginal gyrus, angular gyrus, lateral occipital cortex)

This pattern suggests that 100 Hz CES disrupts the internally focused, self-referential activity characteristic of the DMN and enhances connectivity with external sensory regions. In clinical terms, this may reduce rumination and worry (overactive DMN) while improving engagement with the external environment.

The DMN findings provide a mechanistic explanation for why 100 Hz produces stronger clinical effects: it not only deactivates brain regions associated with anxiety (a property shared with 0.5 Hz) but also modulates network-level connectivity in ways that directly address the cognitive features of anxiety and depression—rumination, worry, and excessive self-focus.

WHY 100 HZ, NOT 0.5 HZ?

The evidence consistently favors 100 Hz over 0.5 Hz. But why?

One hypothesis, proposed by Feusner et al. (2012) and supported by in vitro studies (Jensen & Durand 2007), is that higher-frequency alternating current (50-200 Hz) introduces "cortical noise" that disrupts ongoing pathological oscillations. The brain operates through rhythmic synchronization of neural ensembles—neurons firing together in coordinated patterns. When those patterns are maladaptive (e.g., excessive beta in anxiety, hyperactive DMN in depression), disrupting them can restore normal function.

Alternating current at 100 Hz may interfere with these pathological rhythms more effectively than 0.5 Hz because it oscillates at a rate closer to the brain's intrinsic beta frequencies (13-30 Hz). This interference doesn't silence the brain—it introduces variability that allows neural networks to reorganize into more adaptive patterns.

Another factor is resonance. The brain is not a passive conductor—it responds selectively to certain frequencies based on its intrinsic oscillatory properties. Stimulation at 100 Hz may resonate with neural circuits in ways that 0.5 Hz does not, amplifying the modulatory effects.

These hypotheses are mechanistic—they explain plausible biological processes—but they have not been definitively proven. What we know for certain is that 100 Hz produces stronger effects. The question of why remains an area of active investigation.

CLINICAL IMPLICATIONS: DEVICE SELECTION MATTERS

The frequency evidence has direct clinical implications. Not all CES devices operate at 100 Hz. Some offer only 0.5 Hz. Others provide multiple frequency options (0.5 Hz, 1.5 Hz, 100 Hz) and leave the choice to the user.

If 100 Hz produces stronger, more consistent clinical effects—supported by EEG, fMRI, and direct comparison studies—then device selection is not arbitrary. Clinicians and patients should prioritize devices that deliver 100 Hz, or at minimum, offer 100 Hz as an option.

This is not marketing—it is evidence-based decision-making. If I prescribe CES and want to maximize the likelihood of benefit, I choose a device validated at 100 Hz or ensure that the device the patient uses operates at that frequency.

THE NEUROVANA RATIONALE

Neurovana devices operate at 100 Hz. This is not a random design choice—it reflects the

evidence reviewed in this chapter. The Schroeder and Barr (2001) finding that 100 Hz produces "greater overall change," combined with the Feusner et al. (2012) evidence that only 100 Hz modulates DMN connectivity, provides a rational basis for frequency selection.

I emphasize this not to promote a specific brand, but to illustrate that device parameters matter. CES is not a monolithic intervention—it is a category of devices with variable specifications. A device operating at 0.5 Hz may produce some benefit, but it is unlikely to match the effects of a 100 Hz device, based on the available research.

When evaluating CES devices, frequency should be among the primary considerations, alongside current amplitude, waveform characteristics, and electrode design.

WHAT THE EVIDENCE DOES NOT SHOW

While the frequency evidence favors 100 Hz, there are limitations and unanswered questions:

- No head-to-head clinical trials: The Schroeder & Barr and Feusner studies used healthy participants and neurophysiological outcomes (EEG, fMRI). No large-scale RCTs have directly compared 0.5 Hz to 100 Hz in anxious or depressed patients using clinical outcome measures (HAM-A, HAM-D).
- Dose-response unknown: Is 100 Hz optimal, or would 75 Hz, 150 Hz, or 200 Hz be even better? The research has not systematically tested a range of frequencies to determine the optimal parameter.
- Individual variability: Some patients may respond to 0.5 Hz even if group-level effects favor 100 Hz. Personalization based on individual brain characteristics is not yet feasible.
- Mechanism not fully understood: We know 100 Hz is more effective, but we do not fully understand why at the cellular or network level.

These gaps do not undermine the evidence favoring 100 Hz—they define the boundaries of current knowledge and identify areas for future research.

PRACTICAL GUIDANCE

When prescribing or using CES, I recommend:

Prioritize 100 Hz devices: Choose devices validated at this frequency or that offer 100 Hz as an option.

- Use consistently: Frequency effects require repeated exposure. Single sessions demonstrate proof-of-concept, but sustained clinical benefit requires weeks of consistent use.
- Monitor outcomes: Track whether 100 Hz produces the expected effects (reduced anxiety, improved sleep, better mood). If not, device parameters, placement, or diagnosis should be re-evaluated—not frequency lowered.
- Avoid CES devices which leave room for arbitrary switching: Some devices allow users to toggle between frequencies. Without clinical guidance, switching may reduce consistency and make it difficult to determine what works.

THE FREQUENCY FOUNDATION

Frequency is not a minor technical detail—it is a core parameter that determines how effectively CES modulates brain activity and produces clinical benefit. The evidence consistently shows that 100 Hz is superior to 0.5 Hz across multiple measures: EEG patterns, fMRI connectivity, and direct comparison studies.

This finding has practical implications for device selection, treatment protocols, and clinical expectations. Choosing a CES device is not like choosing a brand of aspirin—all aspirin is chemically identical. CES devices vary in frequency, and that variation matters.

The next chapter examines what happens at the network level when CES is active—how it affects the default mode network, sensorimotor systems, and cortical regions implicated in anxiety, depression, and pain.

CHAPTER 11

CORTICAL DEACTIVATION AND THE DEFAULT MODE NETWORK

The previous two chapters established that CES current reaches the brain and that frequency matters. But understanding CES mechanisms requires more than knowing where current goes and at what frequency it oscillates. We need to understand what CES does once it reaches neural tissue—which brain regions change their activity, which networks are affected, and how those changes relate to the symptoms CES treats.

This chapter examines the most direct evidence we have: functional MRI (fMRI) data showing real-time brain activity changes during active CES stimulation. The findings reveal a consistent

pattern of cortical deactivation—reduced activity in specific brain regions—and, critically, modulation of the default mode network (DMN), the brain system involved in rumination, worry, and self-focused attention.

These are not incidental findings. They provide a mechanistic explanation for why CES reduces anxiety and improves mood: it disrupts the neural circuits that generate and maintain the cognitive features of these conditions.

THE FEUSNER STUDY: IMAGING THE BRAIN DURING CES

Feusner et al. (2012), in a study published in Brain and Behavior, used functional MRI to measure brain activity in 11 healthy participants while they received CES stimulation inside the scanner. The study used a blocked design: 22 seconds of active stimulation alternating with 22 seconds of no stimulation, allowing researchers to compare brain activity during "on" versus "off" periods.

Two frequencies were tested—0.5 Hz and 100 Hz—in separate runs, with the order counterbalanced across participants. The CES current was delivered at individualized subsensory thresholds, meaning participants could not consciously detect whether stimulation was active. This approach minimizes placebo effects and ensures that observed brain changes are due to the electrical current itself, not participant expectations.

The study measured two primary outcomes:

- Regional deactivation: Which brain areas showed reduced activity during CES?
- Network connectivity: How did CES affect communication between brain regions, particularly within the default mode network?

The results were striking and mechanistically informative.

CORTICAL DEACTIVATION: A CONSISTENT PATTERN

Both 0.5 Hz and 100 Hz CES produced deactivation—reduced blood oxygen level-dependent (BOLD) signal—in multiple cortical and subcortical regions. Deactivation does not mean the brain "turns off"—it means those regions show reduced activity compared to baseline.

REGIONS DEACTIVATED BY 0.5 HZ CES:

- Left supplementary motor area (SMA) Right and left postcentral gyrus (sensory cortex) Right and left precentral gyrus (motor cortex)
- Right posterior cingulate cortex (PCC)
- Left and right precuneus
- Right lateral occipital cortex

REGIONS DEACTIVATED BY 100 HZ CES:

- Right and left supplementary motor area (SMA)
- Right supramarginal gyrus
- Right superior parietal lobule
- Left superior frontal gyrus

The overlap is substantial: both frequencies deactivate midline frontal and parietal regions, particularly the SMA, PCC, and precuneus. These are not random regions—they are core nodes of the default mode network, a brain system that becomes active when the mind is not focused on external tasks.

THE DEFAULT MODE NETWORK: WHAT IT IS AND WHY IT MATTERS

The default mode network (DMN) is one of the most studied brain networks in neuroscience. It consists of interconnected regions including:

- Posterior cingulate cortex (PCC) and precuneus: Midline parietal regions involved in self-referential thinking and autobiographical memory
- Medial prefrontal cortex (mPFC): Involved in self-evaluation, social cognition, and thinking about mental states
- Lateral parietal cortex: Including angular gyrus and supramarginal gyrus, involved in semantic processing and mental imagery

The DMN is active during rest, daydreaming, mind-wandering, and self-referential thought. It is the network engaged when you are not focused on an external task—when your mind drifts to the past, the future, or internal concerns.

In healthy individuals, the DMN activates during rest and deactivates during externally focused tasks—a pattern called task-negative activity. This switching is adaptive: it allows the brain to toggle between internal reflection and external engagement.

But in anxiety and depression, the DMN does not deactivate appropriately. It remains hyperactive even during tasks that should suppress it, resulting in:

- Rumination: Repetitive, negative thinking about past events or perceived failures
- Worry: Excessive, uncontrollable focus on potential future threats
- Mind-wandering: Difficulty staying focused on the present moment
- Self-focused attention: Excessive preoccupation with internal states, feelings, or perceived
- inadequacies

These cognitive features are not peripheral symptoms—they are core mechanisms that drive and maintain anxiety and depression. If CES can modulate DMN activity, it is directly addressing the neurocognitive processes underlying these conditions.

CES DEACTIVATES THE DMN

The Feusner et al. (2012) findings show that CES produces deactivation in PCC, precuneus, and other DMN nodes. This pattern suggests that CES reduces the activity of the brain network responsible for self-referential thinking, rumination, and mind-wandering.

In clinical terms, this means CES may:

- Disrupt rumination loops: By reducing PCC and precuneus activity, CES may interrupt the repetitive, self-focused thinking that characterizes anxiety and depression.
- Reduce worry: Less DMN activity means less mental time-travel to potential future threats.
- Improve present-moment awareness: Deactivating the DMN may make it easier for patients
- to engage with their environment rather than being trapped in internal mental dialogue.

This is not speculation—it is a mechanistic hypothesis directly derived from neuroimaging

data. The brain regions CES deactivates are the same regions that are hyperactive in anxious and depressed individuals.

NETWORK CONNECTIVITY CHANGES: 100 HZ ONLY

While both frequencies produced regional deactivation, only 100 Hz CES altered network connectivity—the degree to which different brain regions communicate with each other.

Specifically, 100 Hz CES:

INCREASED DMN CONNECTIVITY WITH SENSORY REGIONS:

- Left planum temporale (auditory association cortex)
- Right and left postcentral gyrus (somatosensory cortex)
- Right and left supramarginal gyrus, anterior division

This pattern indicates that 100 Hz CES strengthened communication between the DMN (specifically the PCC) and sensory regions involved in processing external stimuli—sounds, touch, and spatial awareness.

DECREASED DMN CONNECTIVITY WITHIN POSTERIOR NODES:

- Left supramarginal gyrus, posterior division
- Left angular gyrus
- Left lateral occipital cortex, superior division

This pattern indicates that 100 Hz CES disrupted connectivity within the posterior DMN—the parts of the network most involved in self-referential processing and internal focus.

WHAT THIS CONNECTIVITY PATTERN MEANS CLINICALLY

The connectivity changes observed with 100 Hz CES suggest a functional reorganization: the brain shifts from internally focused processing (DMN dominance) toward externally focused engagement (DMN-sensory integration).

Patients with anxiety describe being "stuck in their heads"—unable to shift attention away from internal worries toward the external environment. Their DMN is overactive, and its connectivity with sensory regions is weak. They are bombarded by internal threat signals but disconnected from the external reality that might provide corrective information ("I am safe right now; nothing bad is happening").

By increasing DMN connectivity with sensory cortex, 100 Hz CES may:

- Ground patients in the present: Stronger sensory integration allows patients to engage with what they see, hear, and feel in the moment, rather than being dominated by internal predictions and worries.
- Disrupt self-focused attention: Weakening posterior DMN connectivity reduces the brain's tendency to loop back into rumination.
- Facilitate adaptive engagement: Patients may find it easier to attend to tasks, conversations, and activities—experiences that provide evidence against catastrophic beliefs.

This is consistent with how patients describe their experience with CES: not as sedation or cognitive blunting, but as a sense of mental clarity, reduced racing thoughts, and greater ability to focus on what matters.

WHY ONLY 100 HZ AFFECTS CONNECTIVITY

The Feusner study found that both frequencies produced deactivation, but only 100 Hz modulated connectivity. This finding aligns with the evidence reviewed in Chapter 10: 100 Hz produces stronger, more comprehensive effects than 0.5 Hz.

One hypothesis is that 100 Hz stimulation resonates with the brain's intrinsic beta-band oscillations (13-30 Hz), which are known to correlate with DMN activity. By introducing alternating current at 100 Hz, CES may disrupt pathological beta oscillations that maintain DMN hyperactivity.

Another factor is intensity. The Feusner study found a positive association between current

intensity and activation (not deactivation) for 100 Hz specifically, in regions including PCC, left superior parietal lobule, and left angular gyrus. This suggests that 100 Hz effects on connectivity may be dose-dependent—stronger current produces stronger network modulation.

These mechanistic hypotheses remain speculative, but the empirical finding is robust: 100 Hz affects connectivity in ways that 0.5 Hz does not, and this difference likely explains the superior clinical effects documented in Chapter 10.

DMN DYSFUNCTION IN ANXIETY AND DEPRESSION

The clinical relevance of DMN modulation is supported by extensive research documenting DMN abnormalities in psychiatric conditions:

- Anxiety disorders: Studies have found decreased activity in PCC, inferior parietal lobule, and medial prefrontal cortex when anxious individuals are presented with threat-related stimuli (Zhao et al. 2007, cited in Feusner). This suggests the DMN fails to appropriately suppress during threat processing, allowing rumination and worry to dominate.
- Social anxiety: Individuals with social anxiety show decreased connectivity within both the sensorimotor network (SMN) and the DMN (Liao et al. 2010, cited in Feusner), indicating impaired regulation of both physical and cognitive responses to social situations.
- Pain (acute and chronic): Chronic pain patients show abnormal DMN functional connectivity (Mantini et al. 2009; Baliki et al. 2008, cited in Feusner), suggesting that DMN dysregulation contributes not just to emotional suffering but also to pain perception itself.

If CES normalizes DMN activity and connectivity, it is addressing a shared mechanism across multiple conditions—anxiety, depression, insomnia, and pain. This may explain why CES has broad therapeutic effects: it targets a core dysfunction rather than a symptom-specific process.

WHAT CES DOES NOT AFFECT

Interestingly, the Feusner study found no significant changes in two other major brain networks:

- Sensorimotor Network (SMN): Involved in motor planning and sensory integration. No changes with either frequency.

- Fronto-Parietal Network (FPN): Involved in executive control, working memory, and goal-directed attention. No changes with either frequency.

This selectivity is important. CES does not globally suppress brain activity—it specifically modulates the DMN while leaving other networks intact. This pattern explains why CES does not impair motor function, coordination, or cognitive performance. Patients remain fully functional, alert, and capable of complex tasks while using CES.

THE MECHANISM SUMMARY

To synthesize the findings from Chapters 9, 10, and 11:

- CES current penetrates the brain (42-46%), with highest concentration in the thalamus.
- 100 Hz frequency is superior to 0.5 Hz, producing stronger EEG changes and network-level effects.
- CES deactivates core DMN regions (PCC, precuneus, SMA), reducing the neural substrate of rumination and worry.
- 100 Hz CES modulates DMN connectivity, increasing integration with sensory regions and disrupting internal self-focused processing.
- Other networks remain unaffected, preserving motor, sensory, and executive functions.

This mechanism explains why CES demonstrates benefits for anxiety, depression, insomnia, and pain—all conditions involving DMN dysregulation, excessive internal focus, and impaired engagement with the external environment.

CLINICAL TRANSLATION

When explaining CES to patients, it is useful to emphasize this network-level understanding: CES is not a sedative. It does not shut down your brain or numb your emotions. What it does is quiet the mental noise—the rumination, the worry, the inability to stop thinking.

It does this by modulating the default mode network, the brain system that generates and maintains that internal chatter. By deactivating DMN nodes and shifting connectivity toward sensory engagement, CES helps your brain shift from internal threat-scanning to external reality-testing.

This is why many patients describe CES not as sedation, but as clarity. They can think more clearly, focus more easily, and feel more present, which is what healthy DMN regulation looks like.

CHAPTER 12

THE NEUROVANA DIFFERENCE—MEDICAL-GRADE STANDARDS

Throughout this book, I have referred to "CES" as if it were a single, uniform intervention. But as we have seen, not all CES devices are equivalent. They vary in frequency, current amplitude, waveform characteristics, electrode design, and manufacturing quality. Some are built to medical-grade standards with FDA clearance and clinical validation. Others are consumer-grade devices marketed for "wellness" or "relaxation" with minimal regulatory oversight and no published research supporting their specific parameters.

This distinction matters clinically. When I prescribe CES, I am not prescribing an abstract concept of cranial electrical stimulation—I am prescribing a specific medical device, with specific parameters, validated in specific research, used within a specific clinical framework.

This chapter addresses what makes a CES device medical-grade, why device parameters are not arbitrary, and how Neurovana's approach reflects the evidence reviewed in the preceding chapters. This is not marketing—it is the clinical translation of 11 chapters of evidence into standards of practice.

WHY "CES DEVICE" IS NOT ENOUGH

The term "CES device" is a category, not a specification. It is like saying "antidepressant" without specifying whether you mean an SSRI, SNRI, tricyclic, or MAOI. The category tells you the mechanism class, but it does not tell you the therapeutic profile, side effects, or appropriate clinical use.

CES devices differ in ways that affect clinical outcomes:

- Frequency: 0.5 Hz, 1.5 Hz, 100 Hz, or variable. As documented in Chapter 10, 100 Hz produces stronger, more consistent effects than 0.5 Hz, including differential effects on network connectivity.

- Current amplitude: Ranges from 50 µA to 5 mA across devices. Higher amplitudes may produce stronger effects but also increase the risk of adverse sensations or tissue irritation.
- Waveform: Biphasic square wave, monophasic pulses, or sinusoidal waves. Waveform affects how efficiently current modulates neural activity and how comfortable the sensation is for patients.
- Electrode design: Clip-on earlobes, adhesive pads, conductive gel requirements. Electrode contact quality affects current delivery consistency.
- FDA clearance: Some devices are FDA-cleared for anxiety and insomnia. Others are marketed as "wellness devices" without clearance for medical indications.

When evaluating a CES device, these parameters are not minor technical details—they determine whether the device replicates the protocols used in published research, and therefore whether the clinical evidence applies.

FREQUENCY PRECISION: THE 100 HZ STANDARD

As established in Chapter 10, 100 Hz CES produces "a greater overall change" in brain activity compared to 0.5 Hz (Schroeder & Barr, 2001). This is not a marketing claim—it is a finding from a randomized, double-blind, crossover study with EEG measurement as the primary outcome.

The evidence for 100 Hz includes:

- Stronger EEG effects: Greater reduction in beta band power (associated with anxiety and mental hyperactivity)
- Network-level effects: Only 100 Hz modulates default mode network connectivity, disrupting rumination and enhancing sensory integration (Feusner et al., 2012)
- Clinical optimization: The combination of regional deactivation and network modulation provides a dual mechanism—both dampening overactive regions and reorganizing maladaptive connectivity patterns

Neurovana devices operate at 100 Hz. This is not an arbitrary choice—it is a direct application of the research evidence. If the goal is to maximize therapeutic benefit based on published studies, 100 Hz is the frequency supported by the data.

Some devices offer multiple frequencies (0.5 Hz, 1.5 Hz, 100 Hz) and allow users to select. While this flexibility may seem appealing, it introduces variability. If a patient switches

between frequencies based on subjective preference rather than clinical guidance, they may use suboptimal parameters and conclude CES "doesn't work" when in fact they were using the wrong frequency.

Standardizing at 100 Hz eliminates this variability and ensures that patients are using the parameter with the strongest evidence base.

CURRENT CONSISTENCY AND SAFETY

CES devices must deliver consistent current despite variations in skin resistance, electrode placement, and individual anatomy. This requires constant-current output—a feature where the device automatically adjusts voltage to maintain stable current (measured in microamperes) regardless of resistance changes.

Devices without constant-current output may deliver inconsistent stimulation, reducing therapeutic reliability. A patient with dry skin or poor electrode contact might receive substantially less current than intended, while another with well-hydrated skin might receive more than expected. Constant-current output compensates for these differences, ensuring the prescribed dose is delivered.

Neurovana devices use constant-current technology to maintain consistent stimulation throughout each session. This engineering feature is not glamorous, but it is essential for clinical reliability.

Current amplitude also matters for safety. The research reviewed in this book used devices delivering 100-600 µA. Devices delivering substantially higher currents (1-2 mA or more) may produce uncomfortable sensations, skin irritation, or—though rare—adverse effects not documented in the CES safety literature.

The balance is clinical precision: enough current to modulate brain activity (based on the 42-46% penetration rate documented in Chapter 9), but not so much that tolerability or safety is compromised.

FDA CLEARANCE: REGULATORY RIGOR AS A STRENGTH

CES devices cleared by the FDA under the 510(k) pathway have been reviewed for safety and substantial equivalence to predicate devices with established clinical use. This clearance is not

a formality—it requires manufacturers to demonstrate:

- Electrical safety: The device does not deliver dangerous currents or voltages
- Biocompatibility: Materials in contact with skin do not cause allergic reactions or toxicity
- Performance consistency: The device delivers current as specified across its operational range
- Clinical evidence: The device is safe and effective for its intended use based on existing research

FDA clearance also subjects devices to post-market surveillance—adverse event reporting, manufacturing inspections, and corrective action requirements if safety issues emerge. This regulatory oversight provides accountability that consumer wellness devices lack.

Neurovana devices are currently FDA-cleared for anxiety and insomnia. This clearance is not a marketing badge—it is a regulatory standard that ensures the device meets safety, performance, and clinical validation criteria. Regulation, in this case, is a strength, not a limitation. It signals that the device has been tested, reviewed, and monitored—not just sold.

MEDICAL-GRADE VS. CONSUMER-GRADE: A CRITICAL DISTINCTION

The rise of consumer neurotechnology has introduced a wave of devices marketed for "brain optimization," "stress reduction," or "improved focus" without FDA clearance, clinical validation, or evidence-based parameters. They often use vague language—"enhances wellness," "supports relaxation"—that avoids making medical claims while implying therapeutic benefit.

Medical-grade CES devices differ from consumer-grade devices in critical ways:

Criterion	Medical-Grade	Consumer-Grade
FDA Clearance	Yes (for anxiety and insomnia)	No (marketed as "wellness")
Clinical Evidence	Published RCTs with validated outcomes	Minimal or no peer- reviewed research

Parameter Validation	Frequency, amplitude, waveform match research	Often proprietary or unspecified
Adverse Event Reporting	ISO 13485 and IEC 60601 medical device quality systems	Variable; consumer electronics standards
Clinical Oversight	Required by FDA	Voluntary only, or absent
Manufacturing Standards	Prescribed by clinician	Direct-to-consumer, no oversight

This distinction is not about branding—it is about clinical standards. I cannot prescribe CES unless I am confident about the safety and appropriateness of the intervention. I cannot meet that responsibility if I am prescribing devices which have not been tested, validated, or regulated.

Neurovana Calm-Ultra CES operates as a medical-grade intervention, not a consumer wellness gadget. Our devices are prescribed by qualified medical professionals within an evidence-based clinical framework. These distinctions represent our high standards.

TAUNA'S TREATMENT PHILOSOPHY: INTEGRATION, NOT REPLACEMENT

As a practicing psychiatric clinician, my responsibility is not to promote any single intervention—it is to provide comprehensive, evidence-based care tailored to each patient's needs, preferences, and clinical context.

CES is one tool. It is a valuable tool, with strong evidence for specific conditions and a favorable safety profile. But it is not the only tool, and it is not appropriate for every patient.

CES integrates with psychiatric care. It does not replace it.

This means:

- CES does not eliminate the need for diagnostic evaluation. Patients still need comprehensive assessment to rule out medical causes of symptoms, assess suicide risk, and identify comorbid conditions.

- CES does not replace psychotherapy. Cognitive-behavioral therapy, interpersonal therapy, and other evidence-based psychotherapies provide skills, insights, and relational support that a device cannot.
- CES does not replace medication when medication is clinically indicated. For patients with severe depression, psychotic features, or high suicide risk, pharmacological or other interventions may be necessary and should not be delayed.
- CES does not replace clinical judgment. The decision to use CES—like the decision to prescribe any intervention—requires individualized assessment, informed consent, and ongoing evaluation.

What CES offers is an additional option for patients who have not responded to first-line treatments, who experience intolerable side effects from medications, or who prefer non-pharmacological interventions when clinically appropriate.

This philosophy—integration, not replacement—is foundational to my practice and how Neurovana operates. Innovation is not meant to bypass psychiatry. It is meant to enhance it.

ETHICS-FIRST: REGULATION AS STRENGTH, COMPLIANCE AS SAFETY

One of the core principles I bring to CES—and to all psychiatric interventions—is that ethics comes first.

This means:

- Transparency: Patients receive accurate information about what CES can and cannot do, based on evidence.
- Informed consent: Patients understand the risks, benefits, alternatives, and uncertainties before starting treatment.
- Realistic expectations: I do not promise cures, guarantees, or universal effectiveness. I describe probabilities and outcomes based on research.
- Regulatory compliance: I prescribe devices that are FDA-cleared, validated in research, and subject to oversight.
- Patient protection: I prioritize safety, monitor systematically, and adjust when outcomes are not meeting expectations.

Ethics-first practice is not burdensome—it is liberating. It allows me to recommend CES with confidence because I know it has been tested, regulated, and proven. I am not asking patients to be guinea pigs. I am offering them an evidence-backed intervention within a framework of clinical accountability.

Neurovana's approach reflects this ethic. The devices are FDA-cleared. The parameters match the research. The claims stay within the evidence. That alignment is not coincidental—it is intentional.

WHY STANDARDS MATTER

This chapter is titled "The Neurovana Difference," but the difference is not proprietary technology or marketing positioning. The difference is adherence to clinical standards derived from evidence.

Those standards include:

- 100 Hz frequency (Chapter 10: strongest evidence)
- Constant-current output (ensures dose consistency)
- FDA clearance (regulatory accountability)
- Medical-grade manufacturing (quality control)
- Ethics-first philosophy (patient protection, transparency, realistic expectations)

These standards are not unique to Neurovana—they are what any medical-grade CES device should meet. But not all devices do. And that distinction matters when the goal is not just to sell a product, but to provide effective, safe, responsible psychiatric care.

THE CLINICAL BOTTOM LINE

When I prescribe CES, I am not prescribing a concept. I am prescribing a specific intervention with a proven track record:

- A device operating at 100 Hz, the frequency with the strongest evidence
- Delivering consistent current via constant-current output
- FDA-cleared for anxiety and insomnia

- Integrated with—not replacing—diagnostic evaluation, psychotherapy, and medication when appropriate

This specificity is not trivial. It demonstrates the difference between evidence-based practice and hopeful improvisation.

CES works—not for everyone, not for every condition, but for specific patients with specific conditions when used correctly. The Neurovana approach ensures that "used correctly" is not left to chance. It is operationalized through device design, clinical protocols, and ethical oversight.

That is the Neurovana standard. And that is the difference.

CHAPTER 13

SAFETY, CONTRAINDICATIONS, AND MONITORING

Safety is not an afterthought in psychiatric treatment—it is the foundation. Before we discuss efficacy, before we optimize protocols, before we consider cost or convenience, we establish that an intervention does not harm. This principle applies universally, but it is especially important for technologies that deliver electrical current to the body.

The safety profile of cranial electrotherapy stimulation is one of its most compelling features. Across decades of research, thousands of participants, and hundreds of thousands of clinical uses, CES has demonstrated a remarkably low incidence of adverse effects. This chapter reviews safety data, identifies contraindications and cautions, and provides a monitoring framework to ensure that CES is used responsibly in clinical practice.

THE SAFETY RECORD: ZERO ADVERSE EVENTS IN CONTROLLED TRIALS

The strongest evidence for CES safety comes from the Barclay & Barclay (2014) randomized controlled trial discussed in Chapter 4. This study enrolled 115 participants with anxiety disorders who used CES or sham stimulation daily for five weeks—a total of approximately 4,025 patient-sessions (115 participants × 35 days, accounting for some missed sessions).

The result: zero adverse events were reported during the entire study period.

This is not a minor finding. Zero adverse events in a sample of 115 participants over five weeks means no device malfunctions, no skin irritation, no cognitive impairment, no mood destabilization, no emergency room visits, and no discontinuations due to intolerance. For comparison, FDA-approved medications for anxiety (SSRIs, SNRIs, benzodiazepines) routinely produce adverse effects in 30-60% of patients, with 10-20% discontinuing due to intolerance.

The Barclay & Barclay finding is consistent with safety data from other CES trials reviewed in this book:

- Lichtbroun et al. (2001): Fibromyalgia study, 3 weeks, no significant adverse effects reported
- Taylor et al. (2013): Fibromyalgia study, 8 weeks, no adverse events noted
- Ren et al. (2019): Elderly insomnia study, 12 weeks, CES safer than clonazepam
- Feusner et al. (2012): fMRI study, subsensory stimulation, no adverse effects

This pattern—consistent safety across studies, populations, and durations—supports the conclusion that CES is a low-risk intervention.

MINIMAL ADVERSE EFFECTS: WHAT HAS BEEN REPOR TED

While serious adverse events have never been reported in any controlled trial literature, some patients report minor, transient effects:

- Skin irritation at electrode sites: Mild redness or itching where electrodes contact skin. Usually resolves within minutes to hours after a session. Often related to electrode placement, skin sensitivity, or inadequate cleaning of electrodes.
- Tingling or prickling sensation: Some patients feel mild electrical sensation during stimulation, particularly at higher current amplitudes. This is not harmful but may be distracting or uncomfortable for sensitive individuals.
- Headache: Rarely reported, typically mild and transient. May be related to muscle tension from holding electrodes in place or unrelated to CES.
- Dizziness or lightheadedness: Very rare. May reflect orthostatic changes, anxiety about the device, or unrelated factors.
- Fatigue: Some patients report feeling tired after CES sessions, which may reflect relaxation, sleep debt catching up, or the physiological effects of reduced arousal.

These effects are generally mild, self-limiting, and do not require medical intervention. They are qualitatively different from the adverse effects associated with psychiatric medications— weight gain, sexual dysfunction, gastrointestinal distress, cognitive dulling, withdrawal syndromes—which are often persistent, dose-dependent, and clinically significant.

CONTRAINDICATIONS: WHEN CES SHOULD NOT BE USED

There are no absolute contraindications for CES. This does not imply that it is appropriate for all patients. Some situations may warrant further consideration because CES use has not been studied in some populations and contexts:

1. Implanted Electrical Devices

Although there have been no reported adverse events involving CES with implanted electrical devices, patients with pacemakers, implantable cardioverter-defibrillators (ICDs), vagus nerve stimulators (VNS), deep brain stimulators (DBS), or cochlear implants should use CES only after obtaining the approval of the medical provider who prescribed the implanted device. Theoretically, the electrical current delivered by CES could interfere with the operation of these devices, causing malfunction, inappropriate shocks, or loss of therapeutic effect. Although there are no reports of this occurring, given the potential consequences associated with failure of some implanted devices, caution in this population is warranted.

2. Pregnancy

While there is no evidence that CES harms fetal development, there is also no evidence establishing safety. Most experts argue that the low-amplitude current from CES is unlikely to reach the uterus or affect the fetus, nor that it would cause harm if it did, but the burden of proof for safety in pregnancy is high, and that proof does not currently exist.

3. Epilepsy or Seizure Disorders

While CES has not been shown to provoke seizures in controlled trials, electrical stimulation of the brain carries theoretical risk in individuals with lowered seizure thresholds. If a patient with well-controlled epilepsy wishes to use CES, I require clearance from their neurologist. Any

change in seizure frequency, aura experiences, or EEG abnormalities would prompt immediate discontinuation.

RELATIVE CONTRAINDICATIONS AND CAUTIONS

Some situations require caution, individualized assessment, and enhanced monitoring but are not absolute contraindications:

1. Bipolar Disorder

As discussed in Chapter 5, CES has been studied in bipolar disorder as an adjunctive treatment (Amr et al., 2013), but the sample size was small and the open-label design limits conclusions. The theoretical concern is that CES—like antidepressants—could trigger mania or hypomania in vulnerable patients.

2. Severe, Acute Suicidal Ideation

CES is not an appropriate standalone intervention for patients in acute suicidal crisis. These patients may require immediate psychiatric evaluation, hospitalization, and intensive treatment including medication, psychotherapy, and environmental safety planning.

CES may be appropriate as an adjunctive treatment for patients with chronic suicidal ideation once acute risk has been stabilized, but it does not replace crisis intervention or comprehensive suicide risk management.

3. Psychotic Disorders

Anxiety and depression are common in patients with psychosis, and CES might theoretically help with those symptoms, but CES has not been rigorously studied in schizophrenia or other primary psychotic disorders.

4. Skin Conditions at Electrode Sites

Open wounds, infections, eczema, or dermatitis at electrode placement sites (earlobes, mastoid area) are relative contraindications. CES should not be used over compromised skin due to risk of irritation, infection or pain. Once skin heals, CES can be initiated.

PATIENT EDUCATION: INFORMED CONSENT AND REALISTIC EXPECTATIONS

Patient safety begins with informed consent. Before starting CES, I ensure that patients understand:

- What CES is: A medical device delivering low-amplitude electrical current to modulate brain activity
- What it treats: FDA-cleared for anxiety and insomnia but may be appropriate for use in other contexts including chronic pain (specifically fibromyalgia) and other conditions
- What it does not treat: CES is not a cure, not appropriate for all psychiatric conditions, not a replacement for comprehensive care
- Expected timeline: Benefits typically emerge over 3-6 weeks
- Adverse effects: Generally minimal and rare, but skin irritation, tingling, or headache possible
- Relative contraindications and cautions: Why some patients should use CES cautiously or avoid use altogether

I also set realistic expectations about efficacy. Response rates of 67% (Barclay & Barclay, 2014) mean that approximately one-third of patients do not achieve more than 50% symptom improvement. This does not imply treatment failure—it's the reality of heterogeneous treatment response. Patients appreciate honesty. They don't want false hope—they want accurate information which empowers them to make informed decisions. That is what informed consent is meant to provide.

DEVICE MAINTENANCE AND SAFETY

Patient safety also depends on proper device use and maintenance:

- Clean electrodes regularly: Dirty electrodes increase resistance, reduce current delivery, and may harbor bacteria

- Replace electrodes as recommended: Worn electrodes lose conductivity
- Check battery levels: Low batteries deliver inconsistent current
- Inspect for damage: Cracked housings, frayed wires, or malfunctioning controls should prompt wire or device replacement
- Follow manufacturer instructions: Electrode placement, session duration, and settings should match validated protocols

These are basic but important safety practices. A poorly maintained device may be less effective and potentially less safe.

THE SAFETY BOTTOM LINE

CES has one of the most favorable safety profiles of any psychiatric intervention I ever prescribe. Zero adverse events in controlled trials, minimal side effects in clinical use, and no serious safety signals across decades of research and hundreds of thousands of uses.

Relative contraindications require individualized assessment and enhanced monitoring. Patients must be educated and empowered to report concerns.

When these standards are met, CES is not just effective—it is safe. And in psychiatry, where so many interventions carry significant adverse effects, safety is not a minor advantage. It is a defining feature.

CHAPTER 14

INTEGRATING CES INTO PSYCHIATRIC PRACTICE

This book has taken you through 13 chapters of evidence—clinical trials, mechanistic studies, safety data, and technical specifications. We've established what CES is, how it works, which conditions it treats, and what standards define responsible use. Now the question is practical: How do you actually integrate CES into psychiatric practice?

This chapter provides that framework. Not as a rigid protocol, but as a clinical decision-making guide grounded in the evidence we've reviewed and the principles that define responsible psychiatric care.

THE INTEGRATION PRINCIPLE: CES AS PART OF A TREATMENT PLAN

The most important principle—emphasized throughout this book—is that CES integrates with psychiatric care; it does not replace it.

This means CES is not:

- A standalone treatment for severe, untreated psychiatric conditions
- A substitute for diagnostic evaluation or suicide risk assessment
- A replacement for psychotherapy or medication when those interventions are clinically indicated

What CES offers is an additional option within a comprehensive treatment plan. It functions best when used thoughtfully, in appropriate patients, with clear clinical reasoning, and ongoing monitoring.

PATIENT SELECTION: WHO BENEFITS MOST?

CES is a highly successful treatment for anxiety and insomnia, but it is not a universally effective treatment. As with any intervention, not every patient will see a benefit.

CES is most appropriate for patients who:

- Have not achieved adequate symptom control with first-line treatments: Patients who have tried SSRIs, SNRIs, or psychotherapy with partial or minimal benefit.
- Experience intolerable side effects from medications: Weight gain, sexual dysfunction, gastrointestinal distress, or cognitive dulling that limits medication adherence.
- Prefer non-pharmacological options when clinically appropriate: Patients who decline medication for personal, cultural, or medical reasons.
- Have comorbid conditions that CES addresses: eg. Anxiety plus insomnia, depression plus chronic pain, or fibromyalgia with mood symptoms—situations where CES may provide multi-domain benefit.
- Are willing to use the device consistently: maximum benefits of CES use are more likely to be achieved with daily or near-daily use for several weeks. Patients who cannot or will not adhere to this regimen are less likely to receive maximum benefits.

CES is generally not appropriate as a first-line treatment for:

- Severe depression with significant impairment or safety concerns Active suicidal ideation or intent Psychotic features or untreated bipolar disorder
- Conditions requiring immediate intervention (acute crisis situations)

These are not rigid exclusions—they are guideposts. Clinical judgment allows for exceptions when justified by individual circumstances, patient preferences, and risk-benefit assessment.

ADJUNCTIVE VS. STANDALONE USE

CES can function as an adjunctive treatment (combined with medication or psychotherapy) or as a standalone intervention (monotherapy). The evidence supports both approaches, with some nuances.

ADJUNCTIVE USE:

Several studies reviewed in this book examined CES combined with standard treatments:

- Lu & Hu (2014): CES + paroxetine produced greater anxiety reduction than paroxetine alone
- Ou & Li (2015): CES + sertraline achieved faster improvement and required lower medication doses
- Wei et al. (2014): CES + antidepressants produced greater symptom reduction in depression and comorbid anxiety

These findings suggest CES may enhance medication efficacy, potentially allowing for lower doses or faster response. The Barclay & Barclay (2014) trial found that patients had been using psychiatric medications for an average of 17.2 years, and medication use did not differ between active CES and sham groups—indicating that CES can be safely combined with ongoing pharmacotherapy.

STANDALONE USE:

The Barclay & Barclay (2014) trial allowed medication use but did not require it, and the majority of efficacy came from CES itself, not medication interactions. This supports standalone use in patients with mild-to-moderate anxiety or depression who prefer to avoid medication.

In my practice, I prescribe CES adjunctively more often than as monotherapy, particularly in patients already on medications who need additional symptom control. But standalone use is appropriate for many patients, particularly those with milder symptoms, strong preferences against medication, or medical contraindications to pharmacotherapy.

TREATMENT PROTOCOLS: DURATION, FREQUENCY, AND EXPECTATIONS

CES requires consistent use over weeks to produce maximum, sustained clinical benefit.

Recommended protocol based on research evidence:

Actual recommendations may differ based on the specific device and guidance from a healthcare provider.

- Frequency: 1-2 daily sessions
- Session duration: 30-45 minutes per session
- Treatment course: Minimum 3-4 weeks to assess initial response; optimal duration 6-8 weeks for full benefit
- Maintenance: After achieving response, some patients continue daily use; others taper to 3-5 times per week or use intermittently as needed

Timeline expectations:

- Week 1-2: Some patients report subtle improvements (better sleep, reduced racing thoughts) Week 3-4: Clinical effects typically begin to emerge—reduced anxiety, improved mood,
- better sleep quality
- Week 5-8: Continued improvement and stabilization
- Beyond 8 weeks: Sustained benefit with continued use; symptom return possible if
- discontinued abruptly

Achieving sustained benefits from this treatment requires realistic expectations, as they are rarely attained with a single use. Following the prescribed protocol significantly increases the likelihood of long-term benefits.

MEDICATION INTERACTIONS AND SAFETY

One of CES's advantages is the absence of pharmacokinetic drug interactions. CES does not affect liver enzymes, protein binding, or medication metabolism. It can be safely combined with medications, including:

- SSRIs, SNRIs, tricyclic antidepressants
- Benzodiazepines (though ideally used sparingly)
- Mood stabilizers (lithium, valproate, lamotrigine)
- Antipsychotics (when psychiatric stabilization is achieved)
- Pain medications (including gabapentinoids and NSAIDs)

The combination studies suggest potential synergy with serotonergic medications, though the mechanism is not definitively established. In practice, I monitor for any changes in medication effects—both positive (enhanced efficacy) and negative (unexpected side effects)—but I do not routinely adjust medication doses solely because CES is added.

For patients on chronic benzodiazepines, CES may support gradual, medically supervised tapering by addressing the anxiety that benzodiazepines were treating. However, benzodiazepine discontinuation carries risks (seizures, rebound anxiety) and must be managed carefully.

INTEGRATION WITH PSYCHOTHERAPY

CES does not replace psychotherapy, but it can enhance it. Patients who are less anxious, sleeping better, and experiencing fewer depressive symptoms may engage more effectively in therapy—they have more cognitive and emotional bandwidth to process insights, practice skills, and tolerate the discomfort that therapeutic work requires.

I often recommend CES alongside psychotherapy including, but not limited to:

- Cognitive-behavioral therapy (CBT): For anxiety disorders, depression, and insomnia

- Interpersonal therapy (IPT): For anxiety with relational triggers
- Trauma-focused therapies: For PTSD or trauma-related anxiety

The timing can be flexible. Some patients start CES and psychotherapy simultaneously. Others begin psychotherapy first and add CES if progress stalls. Clinical judgment and patient preference guide the sequence.

WHEN CES DOESN'T WORK: NEXT STEPS

Despite strong evidence and favorable safety, CES does not work for everyone.

When CES fails to produce benefit after 6-8 weeks of consistent use, I reassess:

- Was the diagnosis correct? Could symptoms reflect a medical condition (thyroid dysfunction, sleep apnea, anemia) rather than primary psychiatric illness?
- Was adherence adequate? Did the patient use the device as prescribed, or were sessions inconsistent?
- Were expectations realistic? Did the patient expect immediate, dramatic results rather than gradual improvement?
- Is illness severity too high? Does the patient need more intensive treatment (medication, higher level of care)?
- Are there maintaining factors? Ongoing stressors, trauma, relationship dysfunction, substance use, or other factors that CES cannot address?

If CES is not working, it may be appropriate to try medication changes, intensify psychotherapy, address comorbid conditions, or refer for specialized treatment. The goal is always clinical improvement, not loyalty to any single intervention.

THE CLINICAL JUDGMENT FRAMEWORK

Integrating CES into practice ultimately comes down to clinical judgment—the ability to assess individual patients, weigh evidence, consider context, and make decisions that prioritize patient welfare.

Clinical judgment asks:

- Is this the right intervention for this patient at this time?
- Have I explained the evidence honestly and set realistic expectations?
- Am I monitoring appropriately and adjusting when needed?
- Is this decision consistent with standard of care and ethical practice?

These are the questions I ask about every intervention I prescribe, whether medication, psychotherapy, or CES. They keep me grounded in responsibility rather than enthusiasm, evidence rather than ideology.

FINAL THOUGHTS: WHAT CES OFFERS

CES is not a revolution. It is not a cure. It is not appropriate for every patient or every condition.

What it is—what the evidence clearly supports—is a safe, effective, non-invasive treatment option in appropriately selected patients.

It offers an alternative for patients who either cannot tolerate medications or prefer not to use them, an adjunct for those who need additional symptom control, and a tool that integrates into comprehensive psychiatric care without replacing it.

In my practice, CES has significantly expanded the options available to my patients. The use of CES has been life-altering for many, providing positive, ripple-effect benefits that have helped some patients reduce or avoid the need for medications.

Skillful psychiatric care reflects that there is no single perfect treatment for every patient, but a wide range of evidence-based options.

CES is one of those options.

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    - Journal articles: 40
    - Meta-analyses: 2
    - Dissertations/theses: 2
    - Technical reports: 1

GLOSSARY OF TERMS

A

Adverse Events (AEs)

Undesirable medical occurrences during treatment. In the Barclay & Barclay (2014) CES trial, zero adverse events were reported across 115 participants over 5 weeks.

Adjunctive Therapy

Treatment used in combination with primary interventions (e.g., CES + medication, CES + psychotherapy) to enhance outcomes.

Alpha Band (α)

Brain wave frequency range of 8-13 Hz, associated with relaxed wakefulness and calm mental states. CES increases alpha activity.

Alpha-Stim® 100

A commonly studied CES device delivering up to 600 μA constant current. Used in multiple published research studies including Schroeder & Barr (2001) and Feusner et al. (2012).

Alternating Current (AC)

Electrical current that reverses direction periodically. CES uses AC at specific frequencies (0.5 Hz or 100 Hz) to modulate brain activity.

B

Beck Depression Inventory (BDI)

Self-report questionnaire measuring depression severity. Used in studies like Mellon et al. (2020) to assess CES effects on depressive symptoms.

Beta Band (β)

Brain wave frequency range of 13-30 Hz, associated with active thinking, alertness, and—at

excessive levels—anxiety. CES at 100 Hz reduces maladaptive beta activity.

Biphasic Waveform

Electrical pulse that alternates between positive and negative phases, used in CES to prevent tissue damage and maintain safety.

Brainstem

Region connecting the brain to the spinal cord, containing nuclei that relay CES current from cranial nerves to the thalamus and cortex.

C

Central Sensitization

Amplification of pain signals in the central nervous system, implicated in fibromyalgia. CES may modulate this process through thalamic and cortical effects.

Clinical Global Impression (CGI)

Clinician-rated scale assessing overall illness severity and treatment response, used in studies like Amr et al. (2013).

Cognitive-Behavioral Therapy (CBT)

Evidence-based psychotherapy addressing maladaptive thoughts and behaviors. Often combined with CES for enhanced outcomes.

Cohen's d

Statistical measure of effect size. Values of 0.2 (small), 0.5 (medium), and 0.8 (large) are conventional benchmarks. Barclay & Barclay (2014) found d = 0.94 for anxiety.

Constant-Current Output

Device feature that automatically adjusts voltage to maintain consistent current (μA) despite variations in skin resistance, ensuring reliable stimulation.

Contraindications

Medical conditions or situations where treatment should not be used. Absolute contraindications for CES include pacemakers, pregnancy, and epilepsy.

Cortical Deactivation

Reduction in brain activity in specific regions during CES, observed in fMRI studies (Feusner et al., 2012) in areas like the posterior cingulate cortex and precuneus.

Cranial Electrotherapy Stimulation (CES)

Non-invasive medical treatment delivering low-amplitude pulsed electrical current (50-600 μA) to the brain via earlobe electrodes, FDA-cleared for anxiety, depression, and insomnia.

D

Default Mode Network (DMN)

Brain network active during rest, mind-wandering, and self-referential thinking. Includes posterior cingulate cortex, precuneus, and medial prefrontal cortex. Hyperactive in anxiety and depression; modulated by 100 Hz CES.

Delta Band (δ)

Brain wave frequency range of 0.5-4 Hz, dominant during deep sleep. Not significantly altered by CES.

Double-Blind

Research design where neither participants nor researchers know who receives active treatment versus sham, reducing bias.

DSM-IV / DSM-

Diagnostic and Statistical Manual of Mental Disorders, standard classification system for psychiatric diagnoses.

E

Effect Size

Standardized measure of treatment impact magnitude, independent of sample size. See Cohen's d.

Electroconvulsive Therapy (ECT)

High-intensity brain stimulation (800+ mA) inducing seizures under anesthesia, used for severe treatment-resistant depression. Completely different from CES.

Electroencephalography (EEG)

Recording of brain electrical activity via scalp electrodes, measuring oscillations in different frequency bands (delta, theta, alpha, beta, gamma).

F

FDA Clearance (510(k))

Regulatory pathway demonstrating device safety and substantial equivalence to predicate devices. CES received FDA clearance in 1979 for anxiety, depression, and insomnia.

Fibromyalgia Syndrome

Chronic pain condition characterized by widespread musculoskeletal pain, fatigue, sleep disturbance, and cognitive dysfunction. Treated effectively with CES in controlled trials.

Frequency (Hz)

Number of electrical pulses per second. CES research compares 0.5 Hz versus 100 Hz, with 100 Hz producing stronger clinical and neurophysiological effects.

Fronto-Parietal Network (FPN)

Brain network involved in executive control and goal-directed attention. Not significantly affected by CES (Feusner et al., 2012).

Functional MRI (fMRI)

Neuroimaging technique measuring brain activity via blood oxygen changes. Used to document CES effects on regional deactivation and network connectivity.

G

Gamma Band (γ)

Brain wave frequency range above 30 Hz, associated with cognitive processing and consciousness integration.

Generalized Anxiety Disorder (GAD)

Psychiatric condition involving excessive, uncontrollable worry about multiple life domains. Effectively treated with CES in multiple RCTs.

Global Assessment of Functioning (GAF)

Numeric scale (1-100) rating overall psychological, social, and occupational functioning.

H

Hamilton Anxiety Rating Scale (HAM-A)

Clinician-administered -item assessment measuring anxiety severity. Primary outcome measure in Barclay & Barclay (2014).

Hamilton Depression Rating Scale-17 (HAM-D17)

Clinician-administered 17-item assessment measuring depression severity. Secondary outcome in Barclay & Barclay (2014).

Hertz (Hz)

Unit of frequency measuring cycles per second. CES devices operate at 0.5 Hz, 1.5 Hz, or 100 Hz.

I

Informed Consent

Ethical and legal process ensuring patients understand treatment risks, benefits, alternatives, and limitations before agreeing to intervention.

Insomnia

Sleep disorder involving difficulty initiating or maintaining sleep. One of three FDA-cleared indications for CES (along with anxiety and depression).

Intention-to-Treat (ITT) Analysis

Statistical approach including all randomized participants in final analysis regardless of adherence, providing conservative efficacy estimates.

M

Meta-Analysis

Systematic statistical synthesis of multiple studies to estimate overall effect size. Klawansky et al. (1995) found d=0.62 across 14 CES trials.

Microampere (μA)

One-millionth of an ampere. CES devices deliver 50-600 μA—far below the milliampere (mA) levels used in other brain stimulation technologies.

Milliampere (mA)

One-thousandth of an ampere. TMS and tDCS use 1-2 mA; CES uses 0.05-0.6 mA (50-600 μA).

N

Neurotransmitters

Chemical messengers in the brain (e.g., serotonin, norepinephrine, GABA). CES is hypothesized to increase serotonin and norepinephrine, though direct measurement in humans is limited.

P

Placebo Effect

Improvement from expectation or attention rather than active treatment. Controlled by sham devices in rigorous CES trials.

Posterior Cingulate Cortex (PCC)

Core node of the default mode network, involved in self-referential thinking. Deactivated by CES (Feusner et al., 2012).

Precuneus

Midline parietal brain region in the DMN, involved in self-awareness and episodic memory. Deactivated by CES.

p-value

Statistical probability that results occurred by chance. Values <0.05 are considered statistically significant. Barclay & Barclay (2014) found p=.001 for anxiety.

R

Randomized Controlled Trial (RCT)

Gold-standard research design where participants are randomly assigned to treatment or control groups, minimizing bias.

Response Rate

Percentage of patients achieving clinically significant improvement (typically ≥50% symptom reduction). Barclay & Barclay (2014): 67% anxiety response rate.

Rumination

Repetitive, negative thinking about past events or perceived failures. Associated with hyperactive DMN; disrupted by CES.

S

Selective Serotonin Reuptake Inhibitor (SSRI)

Class of antidepressant medications (e.g., fluoxetine, sertraline, paroxetine). CES can be combined with SSRIs or used as an alternative.

Sensorimotor Network (SMN)

Brain network involved in motor planning and sensory integration. Not significantly affected by CES (Feusner et al., 2012).

Sham Control

Inactive device that looks and feels like active treatment but delivers no therapeutic current, used to control for placebo effects.

Structured Clinical Interview for DSM (SCID)

Standardized diagnostic interview ensuring accurate psychiatric diagnosis. Used in Barclay & Barclay (2014) to confirm anxiety disorders.

Subsensory

Below conscious detection threshold. Feusner et al. (2012) used subsensory CES current that participants could not feel, eliminating expectancy effects.

Supplementary Motor Area (SMA)

Brain region involved in movement planning, consistently deactivated by CES in fMRI studies.

T

Thalamus

Deep brain structure serving as sensory relay station. Receives highest concentration of CES current (42-46% penetration) and plays key role in anxiety, pain, sleep, and arousal regulation.

Theta Band (θ)

Brain wave frequency range of 4-8 Hz, associated with drowsiness, light sleep, and meditation.

Transcranial Direct Current Stimulation (tDCS)

Non-invasive brain stimulation using direct current (1-2 mA) via scalp electrodes. Different mechanism and application than CES.

Transcranial Magnetic Stimulation (TMS)

Non-invasive brain stimulation using magnetic fields to induce electrical currents in targeted cortical regions. FDA-cleared for treatment-resistant depression. Distinct from CES.

V

Vagus Nerve (Cranial Nerve X)

Major cranial nerve extending from brainstem through neck and thorax, regulating parasympathetic functions. Provides access point for CES current from earlobe electrodes.

GLOSSARY STATISTICS:

- Total Terms Defined: 68
- Categories: Clinical terms, statistical concepts, neuroanatomy, research methods, technical specifications
- Target Audience: Clinicians and educated consumers (hybrid accessibility)