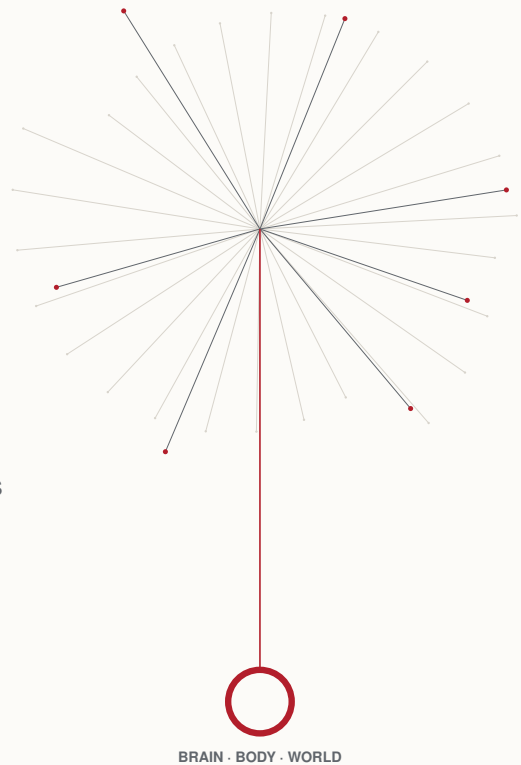


BELIEF, BRAIN CHEMISTRY & THE CONSTRUCTION OF PERCEIVED REALITY

Emotion, nonconscious behavior, trauma, plasticity,
placebo biology, deliberate change, and scientific limits



CENTRAL CONCLUSION

Belief can become a biological cause through prediction, attention, bodily regulation, learning, and action. It can alter experienced reality and behavior-mediated outcomes. Conviction alone cannot select neurotransmitters, erase trauma, or command external events.

Contents

This report separates mechanism, evidence, interpretation, and practice. Bracketed numbers refer to the numbered bibliography. Evidence grades apply to individual claims, not to whole traditions or disciplines.

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Abstract

Can a person deliberately believe an idea so intensely that the brain changes its chemistry, reorganizes its processing, and ultimately changes reality? Modern neuroscience supports a qualified version of this proposal and rejects its strongest version. Beliefs and expectations are not immaterial spectators: they are physically implemented states of a living brain-body system. Through attention, appraisal, prediction, learning, autonomic regulation, endocrine and immune signaling, and behavior, they can alter perception, pain, emotion, symptoms, choices, relationships, and exposure to opportunities. Repeated experience can modify synaptic efficacy, network recruitment, habits, and even measurable brain structure. Placebo and nocebo experiments provide unusually direct evidence that meaning and expectation can recruit endogenous opioids, dopamine, autonomic responses, and conditioned immune effects [27–35]. Trauma provides a different demonstration of experience-dependent biology: severe threat can recalibrate learning, memory, arousal, interoception, stress physiology, and avoidance, although post-traumatic stress disorder is neither inevitable nor adequately described as permanent “brain damage” [45,46,56–60].

The popular causal story remains misleading. There is no single reservoir called “brain chemistry” that the will can dial up or down, no neurotransmitter that maps one-to-one onto happiness or fear, and no scientifically privileged fixed “natural state” from which belief simply pushes the brain. Neural function is electrochemical, networked, embodied, developmental, and continuously regulated. Dopamine, serotonin, norepinephrine, cortisol, oxytocin, and endogenous opioids have multiple receptor-, circuit-, timescale-, and context-dependent effects [1–9]. Psychiatric illness is not generally explained by a simple chemical imbalance; rejecting that slogan does not imply that medication is ineffective [42–44].

Conscious practice can change processing, but mainly indirectly and probabilistically. Attention training, cognitive reappraisal, exposure-based psychotherapy, implementation intentions, mental contrasting, exercise, sleep protection, slow breathing, social learning, medication, and clinically delivered neuromodulation can influence different levels of the system with different effect sizes and risks [61–80]. Their effects depend on credible prediction, repeated experience, feedback, context, and biological constraints. Forcing oneself to endorse an implausible statement is not a reliable route to truth or transformation. Repetition can make a statement feel more true, while motivated evidence selection can protect prior beliefs; both processes can also produce error [22–26]. In extreme conditions, excessively strong priors may contribute to hallucination or delusion rather than reveal a hidden external reality [20,21].

The report therefore distinguishes four targets often collapsed into “reality”: sensory experience, symptom experience, the behavior-shaped social environment, and external physical events independent of the person’s behavior. Science supports substantial influence on the first three under specified conditions. It does not support the proposition that belief alone, without a mediating causal pathway, selects distant events or rewrites physical reality. A twelve-week protocol is proposed for ethically testing an evidence-aligned version: choose a behaviorally mediated goal, formulate a credible working belief, rehearse process rather than fantasy, use if-then plans, act, measure, update, and preserve falsifiability. This is deliberate neurobehavioral learning, not omnipotence.

Keywords: belief; predictive processing; neuromodulation; placebo and nocebo; interoception; trauma; neuroplasticity; expectancy; psychoneuroimmunology; evidence synthesis

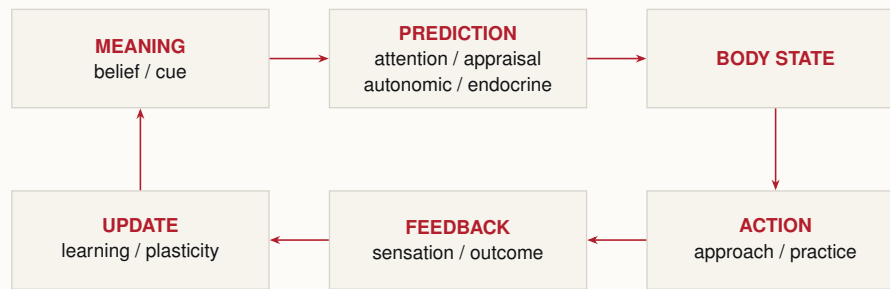
Executive answer

The defensible conclusion: a consciously adopted belief can become a biological cause when it changes prediction, attention, appraisal, bodily regulation, learning, or action. It can thereby change experienced reality and, through behavior, some external outcomes. Intensity of conviction alone is neither necessary nor sufficient, and there is no credible evidence that belief directly commands external physical events without a causal bridge.

Direct answers to the central questions

Table 1. Executive answer in brief

Question	Best current answer
Do chemical re- actions influence emotion and be- havior?	Yes, but “chemical reactions” are only one level of an electrochemical, networked, embodied system. Causation runs both ways: neural activity and experience also change chemical signaling.
Are unconscious behaviors biolog- ical?	They are biologically implemented, but not merely hardwired. Habits, conditioned responses, predictions, autonomic regulation, and learned policies reflect biology interacting with development and context.
Can forceful repetition make the brain accept an idea?	Repetition can increase familiarity and subjective truth, and behavior consistent with an idea can train new predictions. It cannot reliably make any proposition true or permanently override sensory evidence. Implausible self-statements can be rejected or create conflict.
Can belief alter brain chemistry?	Yes, in domain-specific ways. Expectancy can recruit endogenous opioids and dopamine, and learned cues can alter autonomic or immune responses. These effects are constrained, variable, and often strongest for symptoms rather than disease mechanisms.
Is trauma proof that thought can reprogram the brain?	Trauma proves that salient experience can alter learning and regulation. It is not equivalent to voluntary affirmation: trauma combines threat, surprise, uncontrollability, arousal, hormones, memory consolidation, and repeated avoidance. PTSD is heterogeneous and not inevitable.
Is there a fixed natural process- ing state?	No single fixed state. Healthy brains regulate changing internal needs through homeostasis and allostasis. Useful baselines are individualized ranges and flexible recovery, not one universal chemical set point.
Can people con- sciously change neural process- ing?	Yes, mostly through repeated practice, experience, behavior, environment, and evidence-based treatment. One cannot precisely choose a neurotransmitter concentration by will alone.
Can this alter reality?	It can alter perception, symptoms, decisions, relationships, and behavior-mediated external outcomes. No reliable evidence shows that belief alone changes external events independent of action or another physical pathway.



Genes, development, sleep, health, relationships, institutions, and chance constrain the loop.

Figure 1. A recursive biological model. Belief is one state within the loop, not an external force acting on a passive brain.

The causal model

The strongest model is neither “mind over matter” nor “chemicals control the person.” It is a recursive system:

Meaning and belief influence predictions, attention, appraisal, physiology, and action; resulting sensations and outcomes generate prediction errors; learning then updates belief and future action. Genes, development, sleep, health, drugs, relationships, institutions, and chance constrain every stage.

A necessary correction to the word belief

In neuroscience, a belief need not be a sentence consciously repeated. It is better treated as a probability-bearing model or expectation that guides interpretation and action. Some beliefs are explicit (“this treatment will help”), others are implicit (a dark hallway predicts danger), and still others are enacted as habits without verbal endorsement. A stated belief, a felt expectation, and an automatized policy can diverge. This is why saying an affirmation is biologically different from learning through repeated, credible evidence.

1. Scope, method, and standards of inference

1.1 What this report investigates

This is a deep targeted synthesis across systems neuroscience, psychopharmacology, affective science, learning and memory, placebo research, trauma science, clinical psychology, psychiatry, psychoneuroimmunology, contemplative research, and behavior change. It asks three nested questions:

- 1 Implementation: how are emotion, belief, and nonconscious behavior physically realized in brain and body?
- 2 Plasticity: when and how do experience, expectation, and deliberate practice alter those processes?
- 3 Reach: which forms of “reality” can change, by what causal route, and where does the evidence stop?

The report is not a registered systematic review and does not claim exhaustive coverage. Searches and source verification were conducted through 5 September 2026, prioritizing primary experiments, major reviews, meta-analyses, consensus guidelines, regulatory documents, and large multisite studies. Search families covered neuromodulation, predictive processing, interoception, emotion networks, habit and reinforcement learning, placebo/nocebo, illusory truth, stress and allostasis, trauma and PTSD, reconsolidation, psychotherapy, reappraisal, meditation, exercise, breathing and heart-rate-variability biofeedback, neurofeedback, noninvasive stimulation, antidepressants, psychedelic trials, expectancy bias, and research-method limitations.

1.2 Evidence grades

Table 2. Evidence grades used in this report

Grade	Meaning in this report
A — established	Convergent causal evidence, robust physiological principle, or consistent high-quality synthesis.
B — supported with limits	Replicated or meta-analytic support with modest effects, heterogeneity, domain restrictions, or methodological caveats.
C — suggestive	Mechanistically plausible or supported by preliminary, correlational, small, or context-sensitive evidence.
D — unsupported or contradicted	Missing causal bridge, failed direct tests, or interpretation exceeds the data.

Evidence grades belong to specific claims. A treatment can have Grade A support for one disorder, Grade C evidence for a biomarker mechanism, and no evidence for altering unrelated external events.

1.3 The causal ladder

Academic caution is essential because biological language can make a weak claim sound stronger than it is.

Table 3. The causal ladder: what each class of observation supports

Observation	What it supports	What it does not establish
A neurotransmitter changes during a task	Association with that task under those conditions	That the chemical is the emotion, is sufficient for it, or explains the person
A brain area activates	Recruitment of a region within a network	A unique mental process inferred backward from the image [81]
Observation	What it supports	What it does not establish
A biomarker differs between groups	Average statistical association	Diagnosis of an individual, causation, permanence, or inevitability
A treatment changes symptoms	Clinical efficacy under studied conditions	That the favored molecular explanation is correct
Expectation changes a symptom	Meaning has a causal effect on experience	Cure of underlying pathology or mind-over-matter without physiology
Brain structure changes after practice	Experience-dependent plasticity	Global improvement, moral progress, or unlimited rewiring

Small samples, analytic flexibility, selective publication, imperfect blinding, and low statistical power have inflated claims across neuroscience [82–84]. Brain-wide association studies often require samples in the thousands for reproducible estimates [83]. Neuroimaging is valuable, but a colored activation map is not a photograph of a belief or proof of a mechanism.

1.4 Four meanings of reality

The phrase “alter reality” becomes scientifically tractable only when divided into targets:

- 1 Perceptual reality: what is consciously seen, heard, felt, remembered, or inferred.
- 2 Symptom reality: pain, nausea, fatigue, anxiety, breathlessness, effort, and other lived bodily states.
- 3 Behavior-shaped reality: habits, conversations, relationships, performance, opportunities sampled, and environments selected or built.
- 4 Observer-independent external events: events not caused through the person’s body, communication, tools, institutions, or any identified physical interaction.

Belief has strong or moderate evidence for influencing layers 1–3 in particular settings. Layer 4 is where manifestation-like claims become extraordinary; no accepted biological mechanism or reliable evidence establishes direct influence.

2. What “brain chemistry” actually means

2.1 The brain is electrochemical, not a chemical soup

Neurons maintain ion gradients across membranes. Voltage-gated channels generate action potentials; synapses convert electrical activity into transmitter release; receptors and intracellular cascades alter membrane excitability, gene transcription, protein synthesis, and synaptic strength. Neuromodulators adjust the gain, timing, plasticity, and state of circuits rather than carrying a single emotional message [1]. Astrocytes regulate transmitter clearance, metabolism, blood flow, and synaptic environments; microglia participate in immune surveillance and plasticity; oligodendrocytes and myelin affect transmission. Cerebral blood flow and energy supply constrain what networks can do [95,96].

The relevant unit is therefore not “a chemical” but a multiscale state:

- molecular concentrations and receptor occupancy;
- ion-channel and synaptic dynamics;
- local microcircuits and long-range networks;
- glial, vascular, metabolic, and immune support;
- autonomic and endocrine signals from the body;
- developmental history and current environment;
- ongoing perception, action, and social interaction.

A neurotransmitter can inhibit one cell and excite or modulate another depending on receptor subtype and circuit. The same molecule can have different effects at different doses and timescales. Measurements in blood, saliva, cerebrospinal fluid, and a specific synapse are not interchangeable.

2.2 Neuromodulators are control signals, not emotions in bottles

These corrections matter for practice. A person cannot responsibly infer, “I feel unmotivated, therefore my dopamine is low,” then choose a supplement or extreme behavior. Subjective states are multiply determined; similar symptoms can arise from sleep loss, illness, medication, grief, environment, learning, endocrine disorders, or psychiatric conditions.

2.3 Causation is circular

Chemistry affects neural firing and behavior, but behavior also affects chemistry. Exercise changes metabolic and neurotrophic signaling; a threat appraisal recruits autonomic and endocrine responses; social safety alters arousal; learning changes synaptic weights; sleep modifies neuromodulatory state and memory processing [10,45,46,65,72,73]. This circularity dissolves a false choice between “biological” and “psychological.” A conversation and a drug are both physical interventions, but they enter the system at different points

Table 4. Popular slogans about neuromodulators and more accurate accounts

Popular slogan	More accurate account
Dopamine is pleasure	Dopamine contributes to reward prediction error, incentive salience, vigor, learning, and action selection. Its role differs across pathways and timescales [6,7].
Serotonin is happiness	Serotonin participates in diverse forms of behavioral regulation, patience, aversive processing, flexibility, mood, sleep, appetite, and more; receptor families have different actions [8].
Norepinephrine is stress	Locus-coeruleus norepinephrine helps regulate arousal, uncertainty, attention, exploration, and network gain. Too little and too much can both impair performance [9].
Oxytocin is love	Oxytocin can influence social salience, affiliation, threat, memory, and in-group behavior in context-dependent ways; it is not a universal prosocial molecule [97].
Cortisol is bad	Cortisol mobilizes energy and helps coordinate adaptation. Timing, magnitude, duration, controllability, and recovery determine whether a response is useful or costly [10,45,46].
Endorphins make positivity work	Endogenous opioids can mediate some placebo analgesia, but not all placebo effects, and they do not convert every expectation into an outcome [27–31].

and with different specificity.

2.4 Why the chemical-imbalance story fails

The public slogan that depression is simply caused by low serotonin is not supported as a general causal account. An umbrella review found no consistent evidence that depression is caused by reduced serotonin activity or concentration [42]. Important critiques note that the review does not settle every serotonergic mechanism and should not be used to conclude that antidepressants never work. A large network meta-analysis of 522 randomized trials involving 116,477 adults found all 21 studied antidepressants more efficacious than placebo for short-term acute depression, with differing acceptability profiles [43].

Both statements can be true:

- a simple deficiency narrative is inadequate;
- drugs affecting monoamine systems can still produce clinical benefit through downstream adaptation, plasticity, expectancy, side effects, and heterogeneous individual mechanisms.

Modern accounts of psychiatric disorders are multilevel. For schizophrenia, for example, dopamine remains important but interacts with glutamatergic, circuit, developmental, cognitive, and environmental processes [44]. For any disorder, a biomarker that differs on average is not equivalent to a laboratory test that explains one person's condition.

Chemical imbalance is best treated as a historical communication metaphor, not a complete diagnosis, measurement, or causal theory.

3. Emotion as distributed brain-body regulation

3.1 No single emotion center

Emotions recruit distributed networks involved in salience, valuation, memory, interoception, action preparation, executive control, and social inference [2,3]. The amygdala is important for detecting and learning biologically relevant uncertainty and threat, but it is not a simple “fear center.” Fear, anxiety, anger, grief, and joy cannot be localized to one chemical or region. Similar network elements participate in multiple mental states; the configuration, timing, body state, and context matter.

3.2 The body is part of the computation

Interoception is the sensing and interpretation of internal bodily signals: heartbeat, breathing, gut state, temperature, pain, hunger, and visceral arousal. The brain predicts causes of these signals and regulates the body while receiving new evidence [4,5]. This creates a bidirectional loop:

- 1 a situation is perceived or imagined;
- 2 prior learning generates predictions about relevance and danger;
- 3 autonomic, endocrine, and motor preparation change the body;
- 4 bodily signals are sensed and interpreted;
- 5 the resulting feeling updates appraisal and action.

This explains why an idea can feel physically true. Imagining social rejection can accelerate the heart; a benign palpitation interpreted as danger can amplify panic; slow exhalation can change cardiorespiratory input and reduce arousal for some people. The body is not merely obeying a detached mind. Appraisal, prediction, sensation, and regulation form one loop.

3.3 Stress physiology and allostasis

Homeostasis is often pictured as a thermostat returning one variable to one point. Living systems more often regulate prospectively. Allostasis describes stability through change: the brain predicts needs and coordinates autonomic, endocrine, immune, metabolic, and behavioral resources [10–12,45,46]. Cortisol and sympathetic activation are not pathology by definition. Acute mobilization can be adaptive. Cost accumulates when activation is excessive, chronic, poorly timed, uncontrollable, or followed by inadequate recovery.

There is therefore no universal “natural processing state” of the brain. Wakefulness, deep sleep, focused work, play, illness, fasting, safety, and threat require different states. A scientifically useful baseline is an individual’s distribution across time: sleep-wake regularity, affective variability, recovery after challenge, performance, and function. Health is flexible

regulation, not chemical stillness.

4. Where nonconscious behavior comes from

4.1 Nonconscious does not mean irrational or immutable

Much perception, motor control, valuation, and action preparation occurs before or without reportable awareness. This is necessary: conscious deliberation cannot compute every muscle correction, sensory feature, or familiar routine. “Unconscious behavior” is an umbrella term, not one brain system. It includes:

- conditioned responses to cues;
- habits triggered by stable contexts;
- model-free reinforcement learning;
- automatized motor and cognitive skills;
- attentional capture and perceptual prediction;
- implicit social learning;
- autonomic and endocrine regulation;
- defensive reactions and avoidance;
- memory effects that influence choice without explicit recollection.

These processes are biological, but biology includes learning. A habit is not simply innate chemistry. Repetition in a stable context can transfer control from deliberative evaluation toward efficient cue-response policies involving corticostriatal circuitry [13–16]. Goals may still influence whether the routine begins, and habits remain sensitive to context, reward, stress, and competing actions. Laboratory habit tasks themselves show poor convergence, warning against treating any one paradigm as the essence of automatic behavior [102].

4.2 Two interacting control modes

Reinforcement-learning models distinguish, imperfectly, between model-based control that evaluates an internal model of consequences and model-free control that caches action values from past reinforcement [14,15]. Human behavior mixes both. Fatigue, time pressure, stress, and extensive training can change their balance.

This helps explain why conscious belief and automatic behavior conflict. A person may sincerely believe exercise matters while an evening cue triggers scrolling. The explicit proposition lives at one level; learned action selection lives at another. Repetition of the proposition does not automatically retrain the cue-response policy. Changing the environment, making the first action easy, rehearsing an if-then response, and delivering timely reward directly target the behavioral system.

4.3 Unconscious prediction and action

Predictive-processing theories describe the nervous system as using learned generative models to anticipate sensory causes and bodily needs [17–19]. Prediction error — the mismatch between expected and observed input — can update the model, change attention, or provoke action that makes the prediction come true. This is not magic. If I expect a room to be cold, I may bring a coat; the expectation changes my action, not the room's temperature. If social rejection is expected, guarded behavior can elicit distance from others, creating a self-confirming interpersonal loop.

Biological implementation does not make such loops inevitable. When prediction error is sufficiently precise, safe, repeated, and attended, learning can occur. When evidence is ambiguous, threatening, or selectively sampled, prior beliefs may persist.

5. Belief as a biological state

5.1 Belief does not act on the brain from outside

The question “can belief force the brain to change its chemistry?” contains a hidden dualism. A belief is already a pattern realized by the brain-body system: distributed neural activity, memory, linguistic and sensory representations, confidence, bodily feeling, and dispositions to act. Its biological consequences are not the action of a nonphysical commander on passive tissue. They are the propagation of activity through a coupled system.

This distinction does not make belief powerless. A software instruction is physically realized yet can change a computer’s subsequent state. Similarly, an interpreted instruction, remembered promise, diagnosis, threat, or goal can change neural processing because it changes the model by which incoming evidence is evaluated. The scientific questions are then specific: which representation changed, how credible was it, what predictions followed, what pathways were recruited, and what outcome moved?

5.2 Priors, likelihoods, and precision

In a simplified Bayesian description, the nervous system estimates a hidden cause h from sensory data d :

$$P(h \mid d) \propto P(d \mid h) \times P(h)$$

The prior $P(h)$ reflects what was expected before the current evidence; the likelihood $P(d \mid h)$ reflects how compatible the data are with a hypothesis. Predictive-processing models add the crucial idea of precision: confidence assigned to prediction errors or priors [17–19].

This framework explains both the power and the limit of belief:

- when input is noisy or ambiguous, a strong prior can substantially shape perception;
- when sensory evidence is clear and reliable, it normally constrains or corrects the prior;
- attention can change which signals receive weight;
- action can sample confirming or disconfirming evidence;
- social testimony can function as evidence, especially when the source is trusted;
- chronic threat can assign excessive precision to danger cues;
- rigid confidence can suppress updating;
- an implausible statement can create large prediction error rather than effortless acceptance.

The equations are models, not literal proof that every brain implements one algorithm. Predictive processing remains a broad and debated research program. It is nevertheless

more precise than saying “thoughts create reality.”

5.3 Expectations alter perception under constraint

Expectations can speed recognition, bias ambiguous interpretations, and change sensory-cortical responses [17]. In one influential visual study, expected orientations produced reduced average V1 activity but more informative stimulus representations, consistent with efficient prediction rather than merely stronger activation. The important word is ambiguous: expectation exerts its greatest leverage when incoming evidence permits multiple interpretations.

Conditioning can also produce false perceptions. Powers and colleagues paired a visual cue with a tone; participants later reported tones on some no-tone trials, and stronger learned perceptual priors were associated with hallucination propensity [20]. This does not mean that people with hallucinations simply “believe too much” or are responsible for their symptoms. Psychosis research implicates interacting levels of prior belief, prediction error, salience, dopamine, sensory reliability, trauma, sleep, and social context [21,44]. Depending on task and hierarchy, studies find both stronger and weaker use of priors.

A prior can construct a perceptual interpretation. It does not manufacture the external stimulus that the interpretation is about.

5.4 Enactive loops and self-fulfilling prophecies

Beliefs often change the world through action. Consider the working belief “I can improve at public speaking.” It may increase practice, reduce avoidance, change posture and voice, solicit feedback, and increase exposure to speaking opportunities. Those actions create new evidence and skill. The outcome is not purely internal; the person’s behavior has changed a social situation.

The same loop can be harmful. A belief that others are hostile may increase vigilance, interpret ambiguity as insult, produce guarded behavior, and evoke reciprocal coldness. The later response appears to confirm the prior. Such self-fulfilling effects remain probabilistic and relational. Other people retain agency; institutions and material constraints matter; a person’s belief is not the sole cause.

6. What repetition and “forcing belief” can do

6.1 The illusory-truth effect

Repeated statements are often judged more true than novel statements, even when the repetition adds no evidence. Familiarity and processing fluency can be misattributed to accuracy [22–24]. A 2026 systematic review and meta-analysis covering 182 studies, 366 effects, and 31,184 participants estimated a bias-adjusted effect of $g = 0.37$ (95% CI 0.30–0.44), with substantial heterogeneity [23]. When participants initially evaluated truth, the effect was much smaller ($g = 0.10$) than after passive exposure or an irrelevant task.

This is important but easily exaggerated:

- most outcomes were immediate laboratory truth ratings, not durable identity change;
- familiarity is not factual accuracy;
- prior knowledge can reduce but does not always eliminate the effect;
- frequency, spacing, source credibility, plausibility, and warning conditions matter;
- repetition can propagate misinformation as easily as a helpful belief.

The finding therefore supports “repetition can bias subjective acceptance,” not “the brain must eventually believe anything” and certainly not “repetition makes an external claim true.”

6.2 Confidence and selective evidence sampling

Confidence can become self-protective. Experimentally increased confidence reduced subsequent change of mind and weakened neural incorporation of inconsistent evidence in perceptual decisions [25]. People may also choose information sources and tests likely to support their current view [26]. These processes form a loop:

- 1 repeated claim becomes familiar;
- 2 familiarity is felt as plausibility;
- 3 confidence increases;
- 4 confirming evidence is preferentially noticed or sampled;
- 5 disconfirmation is discounted;
- 6 confidence appears justified.

This is neurocognitive adaptation, but it is not necessarily improvement. A system can become efficiently wrong. Scientific practice therefore adds calibration: predictions must be specific, alternative explanations must be considered, and failed forecasts must count.

6.3 Why affirmations sometimes backfire

An affirmation is most likely to help when it is credible, behaviorally relevant, and coupled to action. “I am learning to speak with greater steadiness” permits evidence and practice. “I am the most confident person in every room” may clash with lived evidence and heighten self-discrepancy. For some people, suppressing doubt creates monitoring for the unwanted thought, shame about normal emotion, or avoidance of needed help.

A safer formulation is a working belief:

- provisional rather than absolute;
- within plausible personal influence;
- linked to observable behavior;
- open to revision;
- compatible with uncertainty and emotional complexity.

Example: “If I practice two ten-minute retrieval sessions on four days each week, my recall is likely to improve.” This belief can recruit action, produces measurable predictions, and can be updated. It does not require pretending that success is certain.

6.4 Trauma is not an affirmation with more intensity

The analogy between traumatic learning and forced positive belief is biologically incomplete. Catastrophic events may combine actual danger, pain, helplessness, surprise, intense sympathetic and noradrenergic activation, cortisol changes, perceptual narrowing, sleep disruption, rapid associative learning, social rupture, and repeated avoidance. These signals mark an event as consequential and may consolidate threat predictions [45,46,56–58]. Ordinary verbal repetition generally lacks this conjunction.

There is no ethical experiment randomly assigning catastrophic trauma to compare with affirmation. The non-equivalence is therefore inferred from converging mechanism research, not a direct head-to-head trial. The lesson is not to recreate trauma-like intensity. Extreme arousal, sleep deprivation, coercion, pain, hyperventilation, or drug use can impair judgment and harm health. Effective learning usually requires tolerable challenge, credible feedback, repetition, and recovery.

7. Placebo and nocebo: the strongest causal bridge from meaning to physiology

7.1 What placebo effects are

A placebo response is change observed after treatment, including natural history, regression to the mean, reporting, co-intervention, and context. A placebo effect is the part causally attributable to treatment context, expectation, conditioning, or meaning, ideally estimated against a no-treatment or otherwise appropriate control. This distinction prevents every improvement after a ritual from being attributed to belief.

Placebo and nocebo research demonstrates that information and learned context can influence symptoms and some physiological systems. It does not show that imagination cures every disease. Effects vary by outcome, mechanism, learning history, and measurement method [31–34].

7.2 Endogenous opioid evidence

In a foundational double-blind experiment, naloxone reduced postoperative placebo analgesia, implicating endogenous opioid mechanisms [27]. Later meta-analysis supported an opioid contribution while also showing heterogeneity [28]. PET work found placebo analgesia associated with endogenous mu-opioid activity in pain- and affect-related regions [29]. These studies supply a genuine causal chain:

**treatment context and expectancy → brain appraisal → endogenous opioid signaling
→ altered pain experience**

The chain is important precisely because it is specific. Naloxone does not block every placebo effect. Pain experience includes nociceptive input, attention, threat, meaning, affect, and report; changing it is clinically real without necessarily removing tissue damage.

7.3 Dopamine and treatment expectation

In six people with Parkinson disease, placebo administration was associated with reduced raclopride binding consistent with endogenous dopamine release, averaging approximately 17% in caudate and 19% in putamen [30]. The sample was extremely small, but it is a striking proof of principle that expectation can recruit a disease-relevant neurotransmitter system.

Expectation can also modulate an active drug. In a within-person experiment with 22 participants receiving the same remifentanyl concentration and heat stimulation, positive expectation approximately

doubled reported analgesic benefit, whereas negative expectation abolished it, with corresponding brain-imaging differences [99]. This does not mean expectation replaces pharmacology. It means the total treatment effect can include molecular action, context, prior learning, and prediction.

7.4 Conditioned immune effects

Goebel and colleagues paired a flavored drink with cyclosporine in a double-blind placebo-controlled study of 34 men. Later presentation of the drink with placebo suppressed interleukin-2 and interferon-gamma expression and lymphocyte proliferation [35]. The result is not an example of verbal belief alone. The immune response was conditioned using an active immunosuppressive drug. Reviews find the most reproducible human psychoneuroendocrine conditioning evidence for immunosuppression and allergic responses, with many other endocrine findings preliminary [101].

This establishes a bounded possibility: learned cues can retrieve physiological responses previously paired with pharmacology. Translation to care requires careful dosing, replication, and medical supervision; it is not a license to discontinue medication.

7.5 How large and general are placebo effects?

A Cochrane review comparing placebo with no treatment across 234 trials found no important general clinical effect. For continuous outcomes, 158 trials with 10,525 participants yielded an overall standardized mean difference around -0.23; effects were larger for patient-reported than observer-reported outcomes, and pain results ranged from negligible to clinically important [33]. An open-label-placebo meta-analysis found a small-to-moderate self-reported effect (SMD = 0.43) but essentially no objective effect (SMD = -0.02), with low or very-low certainty [34].

A participant-level fMRI meta-analysis of placebo analgesia across 20 studies and 603 participants found distributed pain-related changes, but voxel-level effects were generally smaller than $g = 0.20$ and increases were heterogeneous [100]. These findings resist both dismissal and hype. Placebo mechanisms are real; their average effects are not universal, unlimited, or proof of a hidden power.

7.6 Nocebo and ethical communication

Negative expectation can amplify pain, nausea, dizziness, and perceived adverse effects. In 12 COVID-19 vaccine trials including 45,380 participants, systemic symptoms were reported by 35.2% of placebo recipients after dose one and 31.8% after dose two [103]. These rates combine background symptoms, attention, anxiety, solicitation, and attribution; they do not isolate expectation alone. Still, they illustrate how ordinary sensations can be interpreted within a treatment narrative.

Ethical care should neither hide material risks nor catastrophize them. Framing can preserve truth while emphasizing frequency, reversibility, coping, and the benefits of adherence. Nocebo research is not a reason to blame patients for symptoms.

7.7 Mindset studies: provocative, not universal

Several experiments report that labels or beliefs about activity, food, stress, or genetic risk changed behavior, symptoms, or selected physiology [36–39]. Hotel workers told that their work satisfied exercise recommendations later showed changes in weight, blood pressure, and body fat [36]. A “sensible” versus “indulgent” milkshake label altered reported satiety and ghrelin despite identical drinks [37]. Information about genetic risk changed exercise capacity or satiety-related outcomes in two experiments [38].

These studies are valuable demonstrations of meaning effects, but they often have modest samples, multiple outcomes, short follow-up, and difficult blinding. Independent replication and precise mechanisms matter. A 2024 meta-analysis of stress-arousal reappraisal and stress mindset interventions found a small performance effect ($d = 0.23$, bias-adjusted about 0.14); mindset-only effects were not significant, and physiological effects were not clearly established [40]. The correct inference is selective influence, not a general law that belief controls physiology.

7.8 A 2026 frontier result: reward neurofeedback and immunity

A randomized study of 85 participants tested real-time fMRI neurofeedback targeting reward-related activity around vaccination. Both neurofeedback groups increased target activation; within participants, ventral tegmental-area regulation correlated with antibody change ($r = 0.31$, $p = .018$), but there was no significant between-group difference in antibody levels [41]. No adverse events were reported. The study was innovative but included investigator intellectual-property interests.

This is exactly how frontier evidence should be read. It suggests that trained brain states may covary with immune response and warrants larger confirmatory trials. Because the randomized groups did not differ on the antibody outcome, it is not proof that conscious control boosted immunity, and it says nothing about arbitrary external events.

8. Trauma, stress, and biological adaptation

8.1 PTSD is not a single malfunction

Post-traumatic stress disorder is a clinically defined pattern that can include intrusion, avoidance, negative changes in cognition and mood, and hyperarousal after trauma. Its biology spans threat learning, contextual memory, interoception, autonomic regulation, sleep, endocrine and immune signaling, and distributed neural networks [56,57]. It is heterogeneous: two people can meet diagnostic criteria with substantially different symptoms and mechanisms.

Calling PTSD a “brain malfunction” captures suffering but obscures adaptation. Hypervigilance and rapid threat detection may be understandable predictions in a dangerous environment; they become costly when generalized to safe contexts and resistant to updating. This framing neither romanticizes the disorder nor denies pathology. It locates symptoms in a once-protective system that is now miscalibrated for current conditions.

8.2 Circuits, not a fear center

Threat expression and regulation involve interactions among amygdala, hippocampus, insula, cingulate cortex, prefrontal regions, brainstem, striatum, and sensory systems [56,57]. A common shorthand — overactive amygdala and underactive prefrontal cortex — is incomplete. Circuit engagement differs across acquisition, extinction, recall, context, dissociation, and symptom subtype. Animal models allow causal manipulation but cannot reproduce human autobiographical meaning, moral injury, social context, or language.

A preregistered meta-analysis of 92 human studies and 6,732 participants found general learning and memory impairment and impaired fear extinction in PTSD; a simple claim of universally enhanced traumatic memory was better supported in animals than in humans [58]. Laboratory conditioning captures only fragments of lived trauma.

8.3 Structural and physiological findings are group averages

The ENIGMA-PGC consortium found smaller hippocampal volume in PTSD than in trauma-exposed controls with a small effect ($d = -0.17$, $p = .00054$); the amygdala difference ($d = -0.11$) did not survive corrected significance [59]. Such overlap is far too large for an individual scan to diagnose PTSD. Smaller hippocampal volume may be cause, consequence, correlate, or mixture. A monozygotic-twin study found smaller hippocampi in unexposed co-twins of veterans with PTSD, supporting pre-existing familial vulnerability in at least some cases [108]. Prospective work also suggests acquired changes and region-specific relationships [109].

Stress-hormone findings likewise resist slogans. Cortisol can causally influence cognition: four days of high-dose hydrocortisone reversibly impaired verbal recall in a 51-person randomized double-blind experiment, but this short manipulation is not a model of all

stress [98]. A meta-analysis of 47 studies, 123 effects, and 6,008 participants found lower daily cortisol output in PTSD than non-trauma controls ($d = -0.36$), with a larger difference when depression was comorbid [104]. A later 108-study synthesis found

small reductions in morning and 24-hour cortisol [105]. Timing, sex, trauma type, depression, medication, sleep, and assay method materially change estimates. PTSD is not simply “too much cortisol.”

Inflammatory markers are elevated on average in some PTSD samples. Across 54 studies and 8,394 participants, reported standardized differences included 0.64 for C-reactive protein, 0.94 for interleukin-6, and 0.89 for tumor-necrosis factor alpha [106]. Body mass, smoking, sleep, physical illness, socioeconomic adversity, and depression can confound or mediate these associations. No inflammatory value is currently a stand-alone explanation or diagnostic test.

8.4 Trauma is not destiny

In 26 World Mental Health surveys totaling 71,083 respondents, estimated lifetime PTSD prevalence was 3.9% overall and 5.6% among trauma-exposed people; approximately half of cases were persistent [107]. Rates depend on trauma type and measurement, but the central point is robust: exposure does not deterministically produce PTSD.

A synthesis of 54 longitudinal studies found a minimal-stable symptom trajectory to be the modal pattern, with recovery, chronic, and delayed trajectories also present [60]. “Resilience” does not mean absence of distress, stoicism, superior character, or immunity to later difficulty. It means relatively stable functioning across the measurement window. Social support, ongoing adversity, prior health, resources, biology, meaning, and chance all contribute.

Trauma changes probability, not destiny. A biomarker difference is not a sentence, and a person’s symptoms are not proof of irreversible damage.

8.5 Epigenetics and intergenerational claims

Trauma can be associated with epigenetic marks that regulate gene expression, but epigenetics is not genetic rewriting and does not imply a mystical memory stored in DNA. Human intergenerational research is difficult because offspring share family environments, culture, nutrition, stress exposure, and sometimes germline factors. Reviews conclude that evidence for trauma-related biological transmission is intriguing but does not yet establish stable transgenerational inheritance in humans [91–93].

Small studies reporting methylation change after psychotherapy are hypothesis-generating, not proof that a specific belief rewrote the genome. Claims should distinguish within-person gene-expression regulation, intergenerational effects involving directly exposed pregnancies, and true transgenerational germline inheritance.

9. Plasticity, memory updating, and the limits of rewiring

9.1 Plasticity is normal, constrained, and value-neutral

Neural plasticity includes changes in synaptic efficacy, dendritic structure, myelination, receptor expression, network recruitment, and strategy. Skill learning has been associated with measurable structural changes in adults [47,48]. These findings refute a static adult brain, but “neuroplasticity” is not a promise of unlimited self-design.

Constraints include age, genetics, injury, health, sleep, stress, medication, task dose, prior learning, available feedback, and the requirement that competing skills share time and metabolic resources. Plasticity can support language learning, recovery, chronic pain, addiction, prejudice, rumination, or avoidance. A changed scan is not automatically a better brain.

9.2 Memory is reconstructed, not freely editable

Remembering reactivates a distributed representation in a new context. In rodents, retrieved fear memories can become transiently dependent on protein synthesis, a process called reconsolidation [49]. A landmark human conditioning study reported reduced return of fear when extinction occurred inside a proposed reconsolidation window [50]. Later replication and meta-analytic work found variable effects dependent on timing, memory strength, outcome measure, and paradigm [51,52].

Complex autobiographical memories differ from conditioned tones and shocks. They have semantic, episodic, bodily, moral, and social components strengthened across repeated retrievals. Clinical claims of reliably “erasing” trauma through one reconsolidation protocol exceed current evidence.

9.3 Extinction is new learning, not deletion

Exposure-based treatment repeatedly encounters feared cues without the expected catastrophe, ideally in conditions that permit new safety or tolerance learning. Extinction usually inhibits expression of the older association rather than deleting it [53,54]. Fear may return with time, stress, or a new context — spontaneous recovery, reinstatement, and renewal [55].

This is not treatment failure. It explains why varied contexts, retrieval practice, sleep, booster sessions, and willingness to experience some fear can matter. The realistic objective is greater discrimination and choice: “this cue can be safe now” alongside the historical memory, not “the event never happened.”

9.4 Mental rehearsal versus real practice

Imagery can activate some task-relevant representations and improve performance relative to no practice, but physical practice usually produces larger effects [94]. Process imagery — rehearsing specific actions, obstacles, and responses — is generally more actionable than fantasizing only about an end state. Vividness is not equivalent to motor load, sensory feedback, social negotiation, or consequence.

The practical rule is to use imagery as a primer for behavior. Rehearse the first observable action and the response to a likely obstacle, then enter the real feedback loop.

10. Can consciousness deliberately change biology?

10.1 Yes, through layered control

Conscious control is real but indirect. A person can select a task, redirect attention, reinterpret meaning, slow breathing, inhibit a response, alter the environment, ask for support, take prescribed treatment, and repeat a skill. Each choice changes inputs to systems that then operate partly outside awareness. One cannot normally specify “increase prefrontal serotonin by 12%” or “erase this synapse.” The accessible control variables are actions, attention, interpretation, and context.

The range is best represented as layers:

Table 5. Deliberate influence on biology: examples, routes, and limits

	Example	Biological route	Typical limit
Attention and appraisal	Reappraisal, attentional redirection	Network recruitment, autonomic appraisal, memory encoding	Effortful; state- and context-dependent
Learning and behavior	Exposure, skills, implementation intentions	Prediction error, reinforcement, habit, social feedback	Requires repetition and tolerable challenge
Body regulation	Slow breathing, exercise, sleep regularity	Cardiorespiratory, metabolic, endocrine, immune, plasticity pathways	Effects are broad, not transmitter-specific
Social and environmental design	Support, cue removal, friction, opportunity	Changes stressors, affordances, evidence sampled, reinforcement	Other agents and institutions constrain results
Medication	Antidepressant, analgesic, antiadrenergic treatment	Receptor/transporter and downstream network effects	Average effects, side effects, heterogeneity; clinician oversight
Device-based treatment	rTMS, ECT, device-specific neurofeedback	Electrical/magnetic modulation plus learning/context	Indication- and protocol-specific; access and risk

10.2 Reappraisal and psychotherapy

Cognitive reappraisal changes the interpretation of an emotional stimulus. Meta-analytic neuroimaging links reappraisal to distributed control, semantic, and affective systems rather than one top-down switch [61]. The ability to reinterpret does not mean every emotion should be suppressed. Accurate grief, anger at injustice, or fear in danger can be informative.

Psychotherapies are structured learning environments. A large network meta-analysis supports several psychotherapies for adult depression, while effect estimates vary with comparator, bias, and follow-up [62]. For PTSD, guideline-recommended trauma-focused therapies have stronger disorder-specific evidence than generic positive thinking [74,75,124]. Their mechanisms may include exposure, cognitive change, memory contextualization, emotion regulation, therapeutic relationship, expectancy, and corrective experience. Demonstrated efficacy does not require one exclusive molecular story.

10.3 Exercise, sleep, and autonomic training

Exercise has evidence for reducing depressive symptoms across multiple modalities, with effects shaped by intensity, adherence, baseline severity, and study quality [65]. For PTSD, a 2026 meta-analysis of 14 randomized trials estimated a modest pooled effect ($SMD = -0.35$), supporting exercise as an adjunct rather than a replacement for first-line treatment [111].

Sleep loss increases emotional reactivity and weakens coordinated prefrontal-amygdala function in laboratory paradigms [72,73]. Treating chronic insomnia with cognitive behavioral therapy can improve sleep; in a small PTSD trial, full insomnia remission occurred in 41% versus 0% on a waitlist, while PTSD symptoms changed in both groups [112]. Sleep is not a passive gap in manifestation practice. It affects learning, emotional calibration, reward valuation, and the capacity to update beliefs.

Slow breathing provides a direct, accessible example of conscious influence on physiology. Across 223 studies, slow breathing increased vagally mediated heart-rate-variability measures during practice, immediately after, and after repeated training [67]. A 2024 meta-analysis of 31 studies and 1,133 participants estimated immediate changes in RMSSD ($SMD = 0.37$), SDNN (0.77), and systolic blood pressure (-0.45), while perceived-stress reduction narrowly missed conventional significance [113]. HRV is affected by respiration, posture, fitness, drugs, and measurement choices; it is not a meter of spiritual alignment.

10.4 Meditation: modest benefits and real adverse events

A review of 47 trials with 3,515 participants found small-to-moderate improvements in anxiety, depression, and pain from mindfulness programs, without evidence of superiority to established active treatments [63]. PTSD-specific reviews suggest small-to-medium benefits, but guidelines place trauma-focused psychotherapy above generic meditation [75,114].

Meditation is not risk-free. A systematic review of 83 studies and 6,703 participants estimated adverse-event prevalence at 8.3%, with wide variation due to definitions and ascertainment; reported events included anxiety, depression, and cognitive anomalies [64]. This is not an individual probability estimate, but it justifies screening, gradual dose, qualified support, and particular caution with trauma, dissociation, mania, psychosis, sleep deprivation, and intensive retreats.

10.5 Biofeedback and neurofeedback

Biofeedback makes a physiological signal visible so that the person can learn a strategy correlated with change. A meta-analysis of heart-rate-variability biofeedback reported substantial effects on self-reported stress and anxiety, but included small heterogeneous studies and varied controls [66]. The method may help regulation without proving conscious access to a unique neurotransmitter.

Neurofeedback evidence depends on condition, signal, feedback quality, control group, and blinding. Apparent training effects can include expectation, coaching, task practice,

artifacts, and nonspecific reward [68]. A 2025 PTSD review found moderate-to-large effects against passive controls but no symptom advantage in two sham-controlled fMRI trials; certainty was very low to low [115]. The FDA-cleared Prism EEG device is an adjunctive, device-specific intervention, not validation of all neurofeedback or self-administered brain training [116].

10.6 Brain stimulation and medication

Transcranial magnetic stimulation changes cortical excitability through time-varying magnetic fields. ECT induces a controlled seizure under anesthesia and is among the most effective acute treatments for severe depression; it also carries anesthesia, confusion, and memory risks. These are medical interventions, not demonstrations that conscious intention controls electricity [70,71].

For PTSD, evidence must be kept current and device-specific. A 2024 Cochrane review concluded that generic rTMS probably produced little or no immediate difference from sham across heterogeneous small trials [117]. In June 2026, the FDA cleared a personalized MeRT system as an adjunct for PTSD on the 510(k) pathway. Its trial included 158 participants and reported approximate between-group effects of -0.32 on PCL-5 and -0.51 on CAPS-5; whether EEG-based personalization added benefit over fixed-frequency TMS was not isolated [118]. Clearance of one protocol does not establish a class effect or long-term durability.

In May 2026 the FDA granted De Novo authorization to Modius Spero, a prescription home-use vestibular stimulation device used alongside a comprehensive treatment plan for adults with PTSD [119,120]. A 383-person double-blind sham-controlled trial reported greater symptom reduction with active treatment; effectiveness beyond 12 weeks and rare or long-term risks remain uncertain. Dizziness, imbalance, visual effects, headache, nausea, skin irritation, and tinnitus are relevant.

ECT is not a standard primary PTSD treatment: a 2024 review found only 18 reports, including two randomized trials, and apparent benefit often involved comorbid depression [121]. Deep-brain stimulation evidence for refractory PTSD remains invasive, very small, and experimental [122]. These technologies demonstrate that neural circuits are physically modifiable, not that a person can safely reproduce their effects by conviction.

Medication and stimulation show an important boundary: humans can alter brain chemistry and processing directly, but precision requires pharmacology or devices, clinical indications, dosing, monitoring, and acceptance of tradeoffs. This is different from voluntary belief.

10.7 Psychedelic research and expectancy

MDMA-assisted therapy produced large symptom differences in phase 3 PTSD trials, including a 2023 study in which 71.2% of participants in the MDMA group no longer met diagnostic criteria at endpoint [87,123]. Yet the FDA issued a Complete Response Letter in 2024 requiring another well-controlled study, citing evidence and safety concerns including functional unblinding, study conduct, abuse-related events, cardiac and liver characterization, psychotherapy contribution, and durability [86]. As of 5 September 2026,

MDMA-assisted therapy is not FDA-approved.

Psychedelic trials present unusually strong expectancy and blinding problems because participants and therapists often infer assignment from obvious psychoactive effects [88,89]. A 2026 randomized psilocybin trial for treatment-resistant depression did not find a statistically significant primary response advantage and reported important adverse events, reminding the field that compelling experience is not synonymous with clinical efficacy [90]. The FDA's July 2026 final guidance treats psychedelic products as investigational and specifies trial-design and safety considerations [85].

Do-it-yourself psychedelic, stimulant, sedative, hormone, or supplement use is not a scientific manifestation practice. Product identity, dose, interactions, bipolar or psychosis vulnerability, cardiovascular risk, dependence, and delayed adverse effects require professional evaluation.

11. Comparative evidence map

11.1 What has actually succeeded?

Table 6. What has actually succeeded: outcomes with the best current support

	Outcome with best support	Evidence	Mechanism status	What it does not show
Expectancy/ placebo analgesia	Pain experience; modulation of active analgesia	A/B: pharmacologic blockade, PET, fMRI, controlled trials [27–31,99,100]	Endogenous opioid and appraisal mechanisms partly established	Cure of tissue pathology or universal healing
Conditioned immunosuppression	Retrieval of selected immune suppression after drug pairing	B: small human controlled studies [35,101]	Associative conditioning plausible; durability/clinical utility uncertain	Belief alone commanding immunity
Reappraisal	Short-term emotional response and regulation	B [61]	Distributed control/semantic/affective networks	Elimination of valid emotion or guaranteed life outcomes
Trauma-focused psychotherapy	PTSD symptom reduction	A for CPT, EMDR, PE as treatment packages [74,75,124–126]	Multiple overlapping learning and relational mechanisms	Literal erasure of memory or identical benefit for everyone
Depression psychotherapy	Depressive symptom reduction	A/B [62]	Multiple common and specific processes	A unique chemical correction
Exercise	Depressive symptoms; general health; adjunctive PTSD benefit	A/B [65,111]	Multisystem, behavioral, social, metabolic	Replacement for urgent or indicated care
CBT for insomnia	Chronic insomnia; some downstream function	A for insomnia guidelines; smaller PTSD-specific evidence [112]	Sleep learning, timing, arousal, behavior	Direct cure of every comorbid disorder
Slow breathing/ HRV biofeedback	Acute HRV and blood-pressure modulation; stress/anxiety symptoms	B [66,67,113]	Cardiorespiratory/autonomic coupling	Exact control of vagal tone, neurotransmitters, or external events
Mindfulness programs	Small-to-moderate anxiety, depression, pain benefits	B [63,64]	Attention, appraisal, exposure, behavior; no single settled pathway	Universal benefit, no risk, or superiority to first-line therapy
Antidepressants	Average short-term acute-depression response	A [43]	Drug- and person-dependent downstream mechanisms	Proof of a pre-existing serotonin deficiency

	Outcome with best support	Evidence	Mechanism status	What it does not show
PTSD medication	Modest average symptom benefit for selected drugs	A/B under guideline use [75,110,127]	Multiple; no single biomarker explains response	Self-prescribing or guaranteed response
Neurofeedback	Signal-learning in some protocols; uncertain clinical superiority	C/B, highly protocol-dependent [41,68,115,116]	Specific plus expectancy/task effects difficult to separate	General mental access to brain chemistry
TMS/vestibular stimulation	Device- and indication-specific adjunctive effects	B/C; current authorizations [117–120]	Physical stimulation; personalization questions remain	Validation of all stimulation protocols or thought-based control
Mental imagery	Small performance benefit versus no practice	B [94]	Rehearsal of task representations	Equivalence to physical practice or result-only fantasy
Implementation intentions	Goal attainment across many domains	B; context and bias matter [78]	Cue-response preparation	Outcome control when opportunity or resources are absent
Mental contrasting plus implementation intentions	Small average goal-attainment improvement	B; $g \approx 0.34$ [79]	Links desired future, obstacle, and response	Attraction of events without action

11.2 Why biological endpoints need disciplined interpretation

A change in cortisol, HRV, antibody titer, BOLD signal, or receptor binding can be meaningful, but none is a universal score of success. Biomarkers should be chosen in advance because they lie on a justified causal pathway. Multiple testing can almost guarantee an interesting result if enough molecules and regions are examined. A mechanistic claim is strongest when an intervention changes the proposed mediator, the mediator predicts outcome, blocking the mediator reduces the effect, and alternative pathways are controlled.

The cleanest examples in this report are naloxone blockade of some placebo analgesia and active-drug conditioning of immune responses. Even these do not generalize to all symptoms or goals.

12. Perceived reality versus external reality

12.1 Layer 1: sensory and interpretive experience

Perception is generative in a technical sense: the nervous system infers likely causes of incomplete sensory signals using prior learning [17–21]. Color, depth, bodily ownership, and object identity are not delivered as finished labels by the environment. The brain constructs a best-supported percept constrained by input.

This permits illusions and expectancy effects. It does not imply that there is no external world or that every interpretation is equally valid. A generative model succeeds by being corrigible: predictions are tested against sensory evidence and action consequences.

12.2 Layer 2: symptom experience

Pain, nausea, breathlessness, fatigue, anxiety, and effort are real experiences produced by integrated sensory, predictive, affective, and regulatory systems. Meaning can modulate them. A lower pain rating is not “imaginary” simply because expectation contributed. Conversely, symptom relief does not always mean that infection, tumor, inflammation, fracture, or vascular risk has resolved. Objective and subjective outcomes answer different questions.

12.3 Layer 3: behavior-shaped environments

Belief can alter external life through causal participation:

- attention changes which opportunities are detected;
- expectations change approach or avoidance;
- practice changes skill and performance;
- communication changes other people’s responses;
- persistence increases the number of attempts;
- planning changes timing and resource allocation;
- identity changes which environments are entered;
- collective belief can build institutions, norms, markets, and technologies.

These are substantial alterations of reality. They also depend on other people, power, access, discrimination, health, luck, and material conditions. A scientific model avoids both helplessness and total personal responsibility.

12.4 Layer 4: events without a causal bridge

The proposition that belief alone changes a distant event — a lottery draw, another person's private decision, a disease mechanism, or a physical process — requires a detectable channel. Biology provides no mechanism by which semantic content exits the brain and selects such an outcome without behavior, communication, or another physical interaction. Coincidence, selective memory, base-rate neglect, multiple attempts, flexible prediction, and post hoc meaning can create compelling personal narratives.

Absence of evidence is not logical proof of impossibility. It is, however, sufficient reason not to represent the claim as science, not to sell it as treatment, and not to blame a person when an uncontrollable event occurs.

12.5 The boundary in one diagram

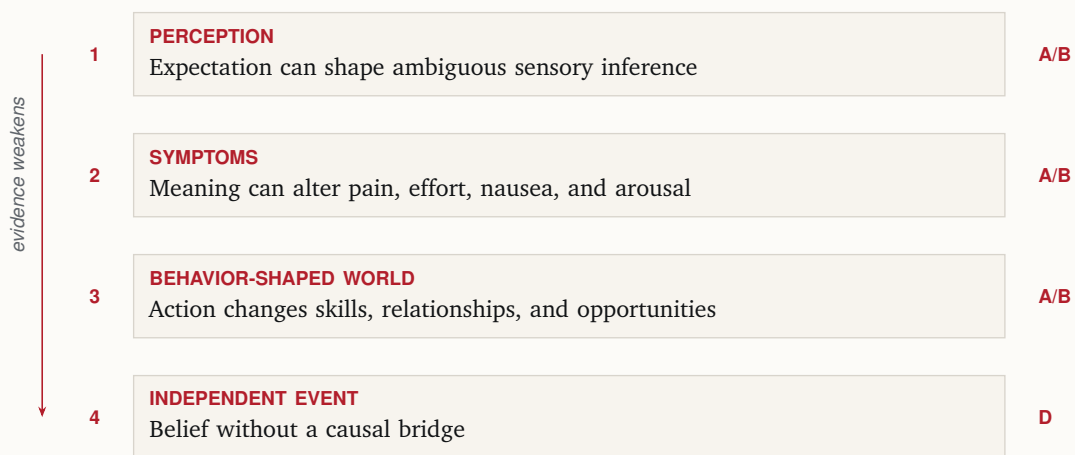


Figure 2. Four targets commonly collapsed into “reality.” Evidence weakens as the claim moves away from perception and behavior toward unmediated external events.

Table 7. Four targets of change: routes and scientific boundaries

	Can deliberate practice influence it?	Main route	Scientific boundary
Perception and appraisal	Often	Priors, attention, precision, interoception	Sensory evidence and pathology constrain effects
Symptoms and regulation	Sometimes substantially	Expectancy, learning, opioids, autonomic/endocrine pathways	Effects vary; subjective change may not alter disease
Behavior and social outcomes	Yes, probabilistically	Planning, habit, skill, communication, exposure	Resources, chance, institutions, and others' agency remain
Independent external event	No reliable evidence without a bridge	None established	Strong manifestation claim remains unsupported

13. Translation to manifestation and yogic practice

13.1 What biology adds to the earlier quantum analysis

Quantum physics did not establish that desire selects physical outcomes. Biology explains why manifestation can nevertheless feel effective. A ritual may narrow attention, calm arousal, increase expectancy, organize identity, trigger planned action, shape memory, and change interpersonal behavior. These mechanisms can produce genuine results without a quantum channel.

The biological account is therefore richer than “positive thinking”:

**intention → credible prediction → attentional and bodily state → chosen action →
environmental feedback → learning and plasticity → updated model**

Every arrow is conditional. If the action is absent, the environment blocks it, or feedback contradicts the prediction, belief should update.

13.2 Yogic practices as training, not biochemical command

Breath regulation, concentration, meditation, ethical restraint, and nonattachment can be interpreted as methods for shaping attention, arousal, response inhibition, self-observation, and values-consistent action. That interpretation is a bridge, not a claim that ancient texts predicted neurotransmitters. A yogic practice also has philosophical and spiritual meanings that exceed clinical outcome measures.

The safest scientific translation preserves three distinctions:

- sankalpa or intention organizes a chosen direction; it does not guarantee an event;
- practice repeatedly trains attention and behavior; it does not make every thought true;
- nonattachment reduces entitlement to a specific outcome and supports updating; it does not mean passivity.

Slow, comfortable breathing may modulate cardiorespiratory and autonomic state [67,113]. Forceful hyperventilation, long breath holds, extreme cold exposure, fasting, or sleep deprivation are not required and can be dangerous. A small experimental program combining breathing, meditation, and cold exposure showed voluntary sympathetic activation and altered inflammatory responses during experimental endotoxemia in healthy men [76,77]. It is a narrow proof of principle, not a general wellness prescription and not evidence of immune mastery.

13.3 The ethical correction

Manifestation rhetoric can become harmful when illness, trauma, poverty, abuse, or discrimination is attributed to insufficient belief. Biology shows that agency is real but distributed. Outcomes emerge from person, body, history, relationships, resources, institutions, and chance. A responsible practice increases controllable action while explicitly refusing victim-blame.

14. A scientific twelve-week practice

14.1 Purpose and exclusions

This protocol is a low-risk behavioral experiment for a nonurgent, behaviorally mediated goal: study consistency, creative output, job applications, rehabilitation adherence, a sleep routine, or a communication skill. It is not treatment for psychosis, mania, severe depression, suicidality, eating disorders, substance dependence, neurological disease, or post-traumatic stress disorder. Those conditions warrant licensed assessment and appropriate care.

Do not use the protocol to stop medication, provoke extreme arousal, revisit trauma without support, manipulate another person, or test whether thought alone controls external randomness.

14.2 The pre-registration sheet

Before starting, write one page containing:

Table 8. The pre-registration sheet

Field	Required specification
Goal	One outcome substantially influenced by your behavior, bounded to twelve weeks
Primary measure	One observable weekly metric, selected before data collection
Process measure	A behavior under direct control: minutes practiced, applications sent, sessions completed
Baseline	Two weeks of ordinary measurement if safe and feasible
Working belief	Credible and provisional: “This process is likely to improve X”
Alternative explanation	At least one reason improvement could occur without the belief ritual
Failure condition	What result would count as no useful effect
Safety stop	Symptoms or circumstances that end self-experimentation and prompt help

Examples of valid primary measures are percentage correct on a fixed quiz, pages submitted, objectively logged bedtime regularity, or number of difficult conversations initiated. “My vibration increased” is not operational unless linked to a validated or observable measure.

14.3 Weeks 1–2: baseline and causal map

Measure the outcome without trying to transform it. Record sleep duration, major stressors, illness, and relevant medication changes because they can confound interpretation. Draw the shortest plausible causal chain from action to result.

For example:

Four retrieval-practice sessions → better access to studied material → improved score on a parallel test

If no behavioral or physical pathway can be named, choose a different goal. This is the protocol's strongest protection against metaphysical drift.

14.4 Weeks 3–4: credible intention and mental contrasting

Write a one-sentence working belief that you can sincerely treat as plausible. Avoid certainty language. Spend three minutes imagining the valued benefit, then identify the most likely internal obstacle. Mental contrasting is designed to connect a desired future with present reality. Meta-analysis of mental contrasting with implementation intentions across 21 studies and 15,907 participants estimated a small average improvement in goal attainment ($g = 0.336$), with possible publication bias [79].

Positive fantasy alone can reduce effort when the imagined reward produces premature emotional satisfaction [80]. End each imagery session with the first physical action, not an extended victory scene.

14.5 Weeks 5–6: if-then plans and environmental engineering

Form one specific implementation intention:

If situation X occurs, then I will perform response Y.

Example: “If I close lunch at 13:00, then I will open the study deck and answer ten questions before messaging.” Implementation intentions have shown moderate average goal-attainment effects across domains, with heterogeneity and publication concerns [78]. They work by pre-linking a cue with a response, not by attracting the result.

Alter friction:

- make the desired first action visible and easy;
- remove one competing cue;
- schedule a stable context;
- use a small immediate reward;
- add a supportive person or accountability check;
- prepare a recovery plan for missed days.

14.6 Weeks 7–8: process imagery and graded action

Rehearse the actual sequence for two to five minutes: starting, meeting a foreseeable obstacle, regulating arousal, and continuing. Then perform a graded real action. Increase difficulty only when the current step is repeatable. Mental practice can supplement but generally does not equal physical practice [94].

For anxiety-related goals, do not design unsupervised exposure to severe trauma cues. A clinician can calibrate exposure, dissociation risk, safety, and response prevention. Ordinary performance discomfort should remain tolerable enough for learning; panic is not proof of transformation.

14.7 Weeks 9–10: body-state support

Choose supports that improve the conditions for learning:

- regular sleep and wake windows;
- appropriately scaled exercise;
- meals and hydration consistent with medical needs;
- social contact and recovery time;
- five minutes of slow, comfortable breathing, preferably with a slightly longer exhale, stopping if dizzy or distressed;
- reduced intoxication and avoidance of unprescribed psychoactive manipulation.

These practices do not guarantee a result. They reduce noise, improve energy and attention, and create safer conditions for updating.

14.8 Weeks 11–12: blinded review and updating

Graph the primary and process measures before rereading daily reflections. Compare baseline and intervention periods. Ask:

- 1 Did the controlled behavior increase?
- 2 Did the outcome move beyond ordinary variability?
- 3 Did change begin before the intervention?
- 4 Were sleep, illness, deadlines, season, or social events alternative causes?
- 5 Did expectancy improve self-report but not objective performance?
- 6 What observation contradicts the favored story?
- 7 Is the practice worth its time, burden, and risk?

Conclude with one of four decisions: continue unchanged, modify one variable, discontinue as ineffective, or seek professional assessment. Do not reinterpret every null result as hidden progress.

14.9 Daily micro-practice: eight minutes plus action

- 1 Orient, one minute: name location, date, body state, and immediate context.
- 2 Regulate, two minutes: comfortable slow breathing; no breath holds or hyperventilation.
- 3 State the working belief, thirty seconds: credible, conditional, behavior-linked.
- 4 Contrast, ninety seconds: desired near-term result and most likely internal obstacle.
- 5 Rehearse, two minutes: see the first process steps and obstacle response.
- 6 Commit, one minute: say the if-then plan and begin the smallest action immediately.

The action is part of the practice, not evidence that the universe has agreed.

15. An N-of-1 scientific design

15.1 Basic interrupted time series

For a reversible, low-risk behavior, collect at least 10–14 baseline observations and 30 or more intervention observations. Plot every point. Use the same measurement time and instrument. Mark deviations such as illness or travel. Compare level, trend, variability, and adherence rather than relying on a single before-and-after impression.

15.2 Alternating components

If the goal permits, alternate two predeclared versions in random order:

- A: process plan plus immediate action;
- B: equal-duration relaxation or neutral reading plus immediate action.

This tests whether the belief/imagery component adds value beyond time, ritual, and action. Do not use withdrawal or alternation when it would interrupt clinical care.

15.3 Subjective and objective outcomes

Measure both when possible. For example, rate confidence before a presentation and obtain a blinded rubric score from an evaluator. If confidence improves while performance does not, that may still be useful, but it is a different result. Placebo research shows why separating reports from objective endpoints matters [33,34].

15.4 Bayesian updating in plain language

Begin with a moderate prior rather than certainty. A strong positive result replicated across weeks should increase confidence. A small, unstable result should move it slightly. A null or opposite result should reduce it. The goal is calibration, not winning an argument with reality.

16. Safety, clinical boundaries, and failure modes

16.1 Stop conditions

Stop self-experimentation and seek qualified help for suicidal thoughts, rapidly decreasing need for sleep, escalating grandiosity, hallucinations, severe paranoia, dangerous compulsions, inability to function, traumatic flooding, dissociation, substance withdrawal, or significant medication adverse effects. Emergency services or a local crisis service are appropriate when there is immediate risk.

Do not frame these experiences as proof that manifestation is “working,” energy is rising, or old beliefs are detoxifying. Such interpretations can delay care.

16.2 Trauma-specific care

The 2023 VA/DoD guideline strongly recommends individual Cognitive Processing Therapy, Eye Movement Desensitization and Reprocessing, or Prolonged Exposure over medication for PTSD, and strongly discourages benzodiazepines and cannabis as PTSD treatments [75,128]. NICE similarly prioritizes trauma-focused CBT and EMDR [124]. A network meta-analysis found large post-treatment differences from waitlist for EMDR and trauma-focused CBT, although comparative rankings and long-term estimates were less certain [74].

In a 916-person veteran trial, both Prolonged Exposure and Cognitive Processing Therapy improved symptoms; the between-treatment difference was small and below the prespecified clinical threshold, and dropout was substantial [125]. EMDR works as a treatment package, while the unique contribution of eye movements is smaller and more debated than some mechanistic claims suggest [126].

The ethical implication is choice among evidence-based options, collaborative pacing, and monitoring — not forced positive belief.

16.3 Common failure modes

17. Claim-by-claim verdict

Table 10. Claim-by-claim verdict

Major claim	Grade	Scientific verdict
Brain and body chemistry influence emotion and behavior	A	True but incomplete; effects are circuit-, receptor-, state-, and context-dependent.
Beliefs are biologically instantiated	A	True; belief and chemistry are interacting descriptions of one physical system.

Major claim	Grade	Scientific verdict
Nonconscious behavior is purely hardwired	D	False; innate constraints interact with learning, habits, context, and development.
Repetition can increase subjective truth	A/B	Supported with a modest heterogeneous effect; this is familiarity, not factuality.
Sufficient force makes the brain accept any idea	D	Unsupported; conflict, sensory evidence, identity, and prediction error constrain updating.
Expectation can alter neurotransmission	B	Supported in selected settings such as opioid analgesia and small Parkinson placebo studies.
Belief can condition immune responses	B/C	Learned cues can retrieve selected responses after pharmacologic pairing; belief alone is not established.
Positive mindset reliably changes objective physiology	C	Some provocative results, but effects are selective, often small, and replication-sensitive.
Mental disorders are simple chemical imbalances	D	Unsupported oversimplification. Disorders and treatment effects are multilevel and heterogeneous.
The brain has one fixed natural state	D	Inconsistent with dynamic homeostasis, allostasis, circadian state, and individual variation.
Trauma always damages the brain	D	False; outcomes are heterogeneous, resilience is common, and biomarkers are small group averages.
Trauma can recalibrate learning and stress systems	A/B	Strongly supported, with causal direction differing across findings.
Conscious practice can change neural processing	A/B	Yes through attention, learning, behavior, bodily regulation, and treatment; effects are constrained.
Memory can be simply erased through reconsolidation	C/D	Reconsolidation is real; reliable erasure of complex traumatic memory is not established.
Meditation is a risk-free biochemical tool	D	False; average benefits are modest and adverse events occur.
Neurofeedback provides precise voluntary chemistry control	D	Unsupported; some protocol-specific learning/effects exist, with major control and blinding issues.
Belief changes perceived reality	A/B	Yes, especially under ambiguity and for symptoms, within sensory and biological constraints.
Belief changes external outcomes through behavior	A/B	Yes probabilistically via action, communication, persistence, skill, and environmental selection.
Belief alone changes independent physical events	D	No identified biological mechanism or reliable evidence.

Table 9. Common failure modes and corrective principles

Failure mode	Biological/psychological problem	Corrective principle
Repeating an unbelievable absolute	Prediction conflict, self-discrepancy, shame	Use a credible conditional working belief
Imagining only the end state	Premature reward, no action specification	Rehearse process, obstacle, and first action
Treating arousal as proof	Salience mistaken for truth	Check external evidence and function
Escalating intensity after a null result	Sleep loss, panic, impulsivity, coercion	Reduce dose, measure, stop when unsafe
Explaining every event as confirmation	Confirmation bias and unfalsifiability	Predeclare outcomes and failure criteria
Substituting ritual for treatment	Delayed diagnosis and care	Use practices as adjuncts within evidence-based care
Blaming the person for adversity	Ignores trauma, systems, chance, and resources	Separate agency from total responsibility
DIY chemical manipulation	Dose, interaction, dependence, contamination risk	Use qualified medical supervision

18. Limits of the science and priorities for future research

18.1 Measurement gaps

Very few studies experimentally manipulate a discrete belief while directly measuring neurotransmission. fMRI blood-oxygen signals are often mislabeled “brain chemistry.” PET can estimate receptor binding but has limited temporal resolution and radiation burden; magnetic resonance spectroscopy measures broad metabolites, not moment-to-moment synaptic release. Peripheral blood does not directly report a cortical synapse.

Future belief studies should combine preregistration, active controls, manipulation checks, objective outcomes, adverse-event monitoring, and plausible mediators. When possible, they should test mediation and perturb the proposed pathway rather than merely correlate it.

18.2 Generalizability and heterogeneity

Average treatment effects conceal responders, nonresponders, and people harmed. Samples often underrepresent older adults, adolescents, low-income communities, non-Western populations, people with multimorbidity, and those taking multiple medications. Cultural meaning changes expectancy. A ritual credible in one community may be inert or aversive in another.

18.3 Blinding and expectancy

Psychotherapy, exercise, meditation, neurofeedback, stimulation, and psychedelic trials are difficult to blind. Participants may infer assignment from sensations or instructions; therapists may transmit enthusiasm; outcome raters can remain blinded even when participants cannot. Psychedelic trials make the issue especially visible [88,89]. Future work should measure treatment guesses, expectancy over time, therapist allegiance, and adverse events, and use active placebos where ethical.

18.4 Replication and causal specificity

Neuroscience has learned that small studies and flexible analyses yield unstable brain-behavior associations [82–84]. Multisite samples, registered reports, shared data, multi-verse analysis, and out-of-sample prediction are needed. Mechanisms should be compared, not merely named after positive results.

18.5 The decisive experiment for strong manifestation

A strong claim that belief changes external events without behavior requires preregistered, blinded, independently replicated trials with a well-defined physical target, fixed stopping

rule, adequate power, protection against optional analysis, and a specified effect that scales reliably. Biological changes in the believer would not by themselves prove the external effect. No current evidence program meets this burden.

19. Integrated conclusion

Human beings are neither disembodied minds commanding chemistry nor passive machines commanded by chemicals. Belief, emotion, physiology, action, and environment are coupled levels of one adaptive system. Meaning can become biology because words, expectations, memories, and relationships change predictions and regulation. Placebo analgesia, conditioned immune responses, reappraisal, psychotherapy, exercise, sleep treatment, breathing, medication, and physical neuromodulation demonstrate different points of access to that system.

The reach of this influence is large but bounded. Repetition can create familiarity; it can also create misinformation. Strong priors can stabilize perception; they can also create error. Trauma can alter learning and stress regulation; it does not doom every exposed person or prove permanent brain damage. Plasticity permits change; it does not make the brain infinitely programmable. Clinical technologies can modify neural activity; they do not give the will precise control of molecules.

The most scientifically grounded form of manifestation is therefore a disciplined feedback practice: choose a meaningful and behaviorally mediated aim, hold a credible working belief, regulate enough to act, rehearse the process, change the environment, obtain real evidence, and update. This can alter perception, symptoms, skill, relationships, and the probability of external outcomes through known causal pathways. It cannot guarantee another person's choice, erase structural inequality, cure disease by conviction, or select observer-independent events.

Reality as experienced is partly constructed; reality as encountered pushes back. Human agency lives in that feedback, not in omnipotence.

Research-use note This report synthesizes evidence for academic and educational purposes. It is not a diagnosis, treatment plan, or instruction to alter medication. Clinical decisions should be made with appropriately licensed professionals who can assess the individual, the evidence, contraindications, and local standards of care.

References

- 1 Marder E. Neuromodulation of neuronal circuits: back to the future. *Neuron*. 2012;76(1):1–11. <https://doi.org/10.1016/j.neuron.2012.09.010>
- 2 Pessoa L. A network model of the emotional brain. *Trends in Cognitive Sciences*. 2017;21(5):357–371. <https://doi.org/10.1016/j.tics.2017.03.002>
- 3 LeDoux JE. Rethinking the emotional brain. *Neuron*. 2012;73(4):653–676. <https://doi.org/10.1016/j.neuron.2012.02.004>
- 4 Barrett LF, Simmons WK. Interoceptive predictions in the brain. *Nature Reviews Neuroscience*. 2015;16:419–429. <https://doi.org/10.1038/nrn3950>
- 5 Khalsa SS, et al. Interoception and mental health: a roadmap. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*. 2018;3(6):501–513. <https://doi.org/10.1016/j.bpsc.2017.12.004>
- 6 Berke JD. What does dopamine mean? *Nature Neuroscience*. 2018;21:787–793. <https://doi.org/10.1038/s41593-018-0152-y>
- 7 Schultz W, Dayan P, Montague PR. A neural substrate of prediction and reward. *Science*. 1997;275(5306):1593–1599. <https://doi.org/10.1126/science.275.5306.1593>
- 8 Dayan P, Huys QJM. Serotonin in affective control. *Annual Review of Neuroscience*. 2009;32:95–126. <https://doi.org/10.1146/annurev.neuro.051508.135607>
- 9 Aston-Jones G, Cohen JD. An integrative theory of locus coeruleus-norepinephrine function: adaptive gain and optimal performance. *Annual Review of Neuroscience*. 2005;28:403–450. <https://doi.org/10.1146/annurev.neuro.28.061604.135709>
- 10 McEwen BS, Gianaros PJ. Stress- and allostasis-induced brain plasticity. *Annual Review of Medicine*. 2011;62:431–445. <https://doi.org/10.1146/annurev-med-052209-100430>
- 11 Ramsay DS, Woods SC. Clarifying the roles of homeostasis and allostasis in physiological regulation. *Psychological Review*. 2014;121(2):225–247. <https://doi.org/10.1037/a0035942>
- 12 Theriault JE, et al. Allostasis at the core of brain function. *Neuron*. 2025. [https://www.cell.com/neuron/fulltext/S0896-6273\(25\)00716-0](https://www.cell.com/neuron/fulltext/S0896-6273(25)00716-0)
- 13 Wood W, R nger D. Psychology of habit. *Annual Review of Psychology*. 2016;67:289–314. <https://doi.org/10.1146/annurev-psych-122414-033417>
- 14 Dolan RJ, Dayan P. Goals and habits in the brain. *Neuron*. 2013;80(2):312–325. <https://doi.org/10.1016/j.neuron.2013.09.007>
- 15 Daw ND, Niv Y, Dayan P. Uncertainty-based competition between prefrontal and dorsolateral striatal systems for behavioral control. *Nature Neuroscience*. 2005;8:1704–1711. <https://doi.org/10.1038/nn1560>
- 16 Graybiel AM. Habits, rituals, and the evaluative brain. *Annual Review of Neuroscience*. 2008;31:359–387. <https://doi.org/10.1146/annurev.neuro.29.051605.112851>
- 17 de Lange FP, Heilbron M, Kok P. How do expectations shape perception? *Trends in Cognitive Sciences*. 2018;22(9):764–779. <https://doi.org/10.1016/j.tics.2018.06.002>

- 18 Clark A. Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*. 2013;36(3):181–204. <https://doi.org/10.1017/S0140525X12000477>
- 19 Friston K. The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*. 2010;11:127–138. <https://doi.org/10.1038/nrn2787>
- 20 Powers AR III, Mathys C, Corlett PR. Pavlovian conditioning-induced hallucinations result from overweighting of perceptual priors. *Science*. 2017;357(6351):596–600. <https://doi.org/10.1126/science.aan3458>
- 21 Sterzer P, et al. The predictive coding account of psychosis. *Biological Psychiatry*. 2018;84(9):634–643. <https://doi.org/10.1016/j.biopsych.2018.05.015>
- 22 Udry J, Barber SJ. The illusory truth effect: a review of how repetition increases belief in misinformation. *Current Opinion in Psychology*. 2024;56:101736. <https://doi.org/10.1016/j.copsyc.2023.101736>
- 23 Ye S, Attali D, Ghazi M, et al. Systematic review and meta-analysis of the evidence for an illusory truth effect and its determinants. *Nature Communications*. 2026;17:3270. <https://doi.org/10.1038/s41467-026-70041-x>
- 24 Hassan A, Barber SJ. The effects of repetition frequency on the illusory truth effect. *Cognitive Research: Principles and Implications*. 2021. <https://pubmed.ncbi.nlm.nih.gov/33983553/>
- 25 Rollwage M, et al. Confidence drives a neural confirmation bias. *Nature Communications*. 2020;11:2634. <https://doi.org/10.1038/s41467-020-16278-6>
- 26 Kaanders P, et al. Active evidence sampling in a volatile environment supports decision-making under uncertainty. *eLife*. 2022. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9038198/>
- 27 Levine JD, Gordon NC, Fields HL. The mechanism of placebo analgesia. *Lancet*. 1978;2(8091):654–657. [https://doi.org/10.1016/S0140-6736\(78\)92762-9](https://doi.org/10.1016/S0140-6736(78)92762-9)
- 28 Sauro MD, Greenberg RP. Endogenous opiates and the placebo effect: a meta-analytic review. *Journal of Psychosomatic Research*. 2005;58(2):115–120. <https://pubmed.ncbi.nlm.nih.gov/15820838/>
- 29 Zubieta JK, et al. Placebo effects mediated by endogenous opioid activity on mu-opioid receptors. *Journal of Neuroscience*. 2005;25(34):7754–7762. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6725254/>
- 30 de la Fuente-Fernández R, et al. Expectation and dopamine release: mechanism of the placebo effect in Parkinson's disease. *Science*. 2001;293(5532):1164–1166. <https://doi.org/10.1126/science.1060937>
- 31 Wager TD, Atlas LY. The neuroscience of placebo effects: connecting context, learning and health. *Nature Reviews Neuroscience*. 2015;16:403–418. <https://doi.org/10.1038/nrn3976>
- 32 Colloca L, Barsky AJ. Placebo and nocebo effects. *New England Journal of Medicine*. 2020;382:554–561. <https://doi.org/10.1056/NEJMr1907805>
- 33 Hróbjartsson A, Gøtzsche PC. Placebo interventions for all clinical conditions. *Cochrane Database of Systematic Reviews*. 2022;Issue 1:CD003974. <https://doi.org/10.1002/14651858.CD003974.pub3>
- 34 Spille L, Fendel JC, Seuling PD, Göritz AS, Schmidt S. Open-label placebos: a systematic

- review and meta-analysis of experimental studies with non-clinical samples. *Scientific Reports*. 2023;13:3640. <https://doi.org/10.1038/s41598-023-30362-z>
- 35 Goebel MU, et al. Behavioral conditioning of immunosuppression is possible in humans. *FASEB Journal*. 2002;16(14):1869–1873. <https://doi.org/10.1096/fj.02-0389com>
 - 36 Crum AJ, Langer EJ. Mind-set matters: exercise and the placebo effect. *Psychological Science*. 2007;18(2):165–171. <https://pubmed.ncbi.nlm.nih.gov/17425538/>
 - 37 Crum AJ, Corbin WR, Brownell KD, Salovey P. Mind over milkshakes: mindsets, not just nutrients, determine ghrelin response. *Health Psychology*. 2011;30(4):424–429. <https://pubmed.ncbi.nlm.nih.gov/21574706/>
 - 38 Turnwald BP, et al. Learning one's genetic risk changes physiology independent of actual genetic risk. *Nature Human Behaviour*. 2019;3:48–56. <https://doi.org/10.1038/s41562-018-0483-4>
 - 39 Crum AJ, Salovey P, Achor S. Rethinking stress: the role of mindsets in determining the stress response. *Journal of Personality and Social Psychology*. 2013;104(4):716–733. <https://pubmed.ncbi.nlm.nih.gov/23437923/>
 - 40 Bosshard M, Gomez P. A meta-analysis of stress-arousal reappraisal and stress mindset interventions. *Scientific Reports*. 2024;14:6147. <https://doi.org/10.1038/s41598-024-58408-w>
 - 41 Lubianiker N, et al. Upregulation of reward mesolimbic activity and immune response to vaccination: a randomized controlled trial. *Nature Medicine*. 2026;32(2):572–581. <https://doi.org/10.1038/s41591-025-04140-5>
 - 42 Moncrieff J, et al. The serotonin theory of depression: a systematic umbrella review of the evidence. *Molecular Psychiatry*. 2023;28:3243–3256. <https://doi.org/10.1038/s41380-022-01661-0>
 - 43 Cipriani A, et al. Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder. *Lancet*. 2018;391:1357–1366. [https://doi.org/10.1016/S0140-6736\(17\)32802-7](https://doi.org/10.1016/S0140-6736(17)32802-7)
 - 44 Howes OD, Bukala BR, Beck K. Schizophrenia: from neurochemistry to circuits, symptoms and treatments. *Nature Reviews Neurology*. 2024;20:22–35. <https://doi.org/10.1038/s41582-023-00904-0>
 - 45 McEwen BS. Physiology and neurobiology of stress and adaptation: central role of the brain. *Physiological Reviews*. 2007;87(3):873–904. <https://doi.org/10.1152/physrev.00041.2006>
 - 46 McEwen BS, et al. Mechanisms of stress in the brain. *Nature Neuroscience*. 2015;18:1353–1363. <https://doi.org/10.1038/nn.4086>
 - 47 Draganski B, et al. Neuroplasticity: changes in grey matter induced by training. *Nature*. 2004;427:311–312. <https://doi.org/10.1038/427311a>
 - 48 Zatorre RJ, Fields RD, Johansen-Berg H. Plasticity in gray and white: neuroimaging changes in brain structure during learning. *Nature Neuroscience*. 2012;15:528–536. <https://doi.org/10.1038/nn.3045>
 - 49 Nader K, Schafe GE, LeDoux JE. Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. *Nature*. 2000;406:722–726. <https://doi.org/10.1038/35021052>
 - 50 Schiller D, et al. Preventing the return of fear in humans using reconsolidation update

- mechanisms. *Nature*. 2010;463:49–53. <https://doi.org/10.1038/nature08637>
- 51 Beckers T, Kindt M. Memory reconsolidation interference as an emerging treatment for emotional disorders: strengths, limitations, challenges, and opportunities. *Annual Review of Clinical Psychology*. 2017;13:99–121. <https://doi.org/10.1146/annurev-clinpsy-032816-045209>
 - 52 Chalkia A, et al. No persistent attenuation of fear memories in humans: a registered replication of the reactivation-extinction effect. *Cortex*. 2020. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7115860/>
 - 53 Quirk GJ, Mueller D. Neural mechanisms of extinction learning and retrieval. *Neuropsychopharmacology*. 2008;33:56–72. <https://doi.org/10.1038/sj.npp.1301555>
 - 54 Craske MG, et al. Maximizing exposure therapy: an inhibitory learning approach. *Behaviour Research and Therapy*. 2014;58:10–23. <https://pubmed.ncbi.nlm.nih.gov/24864005/>
 - 55 Wang X, et al. Renewal of conditioned fear in humans: a systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews*. 2024. <https://pubmed.ncbi.nlm.nih.gov/38431150/>
 - 56 Pitman RK, et al. Biological studies of post-traumatic stress disorder. *Nature Reviews Neuroscience*. 2012;13:769–787. <https://doi.org/10.1038/nrn3339>
 - 57 Fenster RJ, Lebois LAM, Ressler KJ, Suh J. Brain circuit dysfunction in post-traumatic stress disorder: from mouse to man. *Nature Reviews Neuroscience*. 2018;19:535–551. <https://doi.org/10.1038/s41583-018-0039-7>
 - 58 Sep MSC, et al. Impaired learning, memory, and extinction in post-traumatic stress disorder: a preregistered meta-analysis. *Translational Psychiatry*. 2023. <https://doi.org/10.1038/s41398-023-02660-7>
 - 59 Logue MW, et al. Smaller hippocampal volume in posttraumatic stress disorder: a multisite ENIGMA-PGC study. *Biological Psychiatry*. 2018;83(3):244–253. <https://pubmed.ncbi.nlm.nih.gov/29217296/>
 - 60 Galatzer-Levy IR, Huang SH, Bonanno GA. Trajectories of resilience and dysfunction following potential trauma: a review and statistical evaluation. *Clinical Psychology Review*. 2018;63:41–55. <https://pubmed.ncbi.nlm.nih.gov/29902711/>
 - 61 Buhle JT, et al. Cognitive reappraisal of emotion: a meta-analysis of human neuroimaging studies. *Cerebral Cortex*. 2014;24(11):2981–2990. <https://doi.org/10.1093/cercor/bht154>
 - 62 Cuijpers P, et al. Psychotherapies for depression: a network meta-analysis covering efficacy, acceptability and long-term outcomes. *World Psychiatry*. 2021;20(2):283–293. <https://doi.org/10.1002/wps.20860>
 - 63 Goyal M, et al. Meditation programs for psychological stress and well-being: a systematic review and meta-analysis. *JAMA Internal Medicine*. 2014;174(3):357–368. <https://doi.org/10.1001/jamainternmed.2013.13018>
 - 64 Farias M, Maraldi E, Wallenkampf KC, Lucchetti G. Adverse events in meditation practices and meditation-based therapies: a systematic review. *Acta Psychiatrica Scandinavica*. 2020;142(5):374–393. <https://doi.org/10.1111/acps.13225>
 - 65 Noetel M, et al. Effect of exercise for depression: systematic review and network meta-analysis of randomised controlled trials. *BMJ*. 2024;384:e075847. <https://doi.org/10.1136/bmj-2023-075847>

- g/10.1136/bmj-2023-075847
- 66 Goessl VC, Curtiss JE, Hofmann SG. The effect of heart rate variability biofeedback training on stress and anxiety: a meta-analysis. *Psychological Medicine*. 2017;47(15):2578–2586. <https://pubmed.ncbi.nlm.nih.gov/28478782/>
 - 67 Laborde S, et al. Effects of voluntary slow breathing on heart rate and heart rate variability: a systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews*. 2022;138:104711. <https://doi.org/10.1016/j.neubiorev.2022.104711>
 - 68 Thibault RT, Lifshitz M, Raz A. Neurofeedback or neuroplacebo? *Brain*. 2017;140(4):862–864. <https://doi.org/10.1093/brain/awx033>
 - 69 Westwood SJ, et al.; European ADHD Guidelines Group. Neurofeedback for attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. *JAMA Psychiatry*. 2025;82(2):118–129. <https://doi.org/10.1001/jamapsychiatry.2024.3702>
 - 70 Vida RG, et al. Efficacy of repetitive transcranial magnetic stimulation for treatment-resistant depression: a systematic review and meta-analysis of sham-controlled randomized trials. *BMC Psychiatry*. 2023. <https://pubmed.ncbi.nlm.nih.gov/37501135/>
 - 71 National Institute of Mental Health. Depression: brain stimulation therapies and treatment overview. Updated resource. <https://www.nimh.nih.gov/health/publications/depression>
 - 72 Yoo SS, Gujar N, Hu P, Jolesz FA, Walker MP. The human emotional brain without sleep: a prefrontal amygdala disconnect. *Current Biology*. 2007;17(20):R877–R878. <https://pubmed.ncbi.nlm.nih.gov/17956744/>
 - 73 Goldstein AN, Walker MP. The role of sleep in emotional brain function. *Annual Review of Clinical Psychology*. 2014;10:679–708. <https://pubmed.ncbi.nlm.nih.gov/24499013/>
 - 74 Mavranouzouli I, et al. Psychological treatments for post-traumatic stress disorder in adults: a network meta-analysis. *Psychological Medicine*. 2020;50(4):542–555. <https://doi.org/10.1017/S0033291720000070>
 - 75 Department of Veterans Affairs and Department of Defense. VA/DoD Clinical Practice Guideline for Management of Posttraumatic Stress Disorder and Acute Stress Disorder. 2023; page updated 2025. <https://www.healthquality.va.gov/guidelines/MH/ptsd/>
 - 76 Kox M, et al. Voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans. *Proceedings of the National Academy of Sciences*. 2014;111(20):7379–7384. <https://doi.org/10.1073/pnas.1322174111>
 - 77 Zwaag J, et al. Involvement of lactate and pyruvate in the anti-inflammatory effect of voluntary activation of the sympathetic nervous system. *Scientific Reports*. 2022. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9071023/>
 - 78 Gollwitzer PM, Sheeran P. Implementation intentions and goal achievement: a meta-analysis of effects and processes. *Advances in Experimental Social Psychology*. 2006;38:69–119. [https://doi.org/10.1016/S0065-2601\(06\)38002-1](https://doi.org/10.1016/S0065-2601(06)38002-1)
 - 79 Wang G, Wang Y, Gai X. A meta-analysis of the effects of mental contrasting with implementation intentions on goal attainment. *Frontiers in Psychology*. 2021;12:565202. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8149892/>
 - 80 Oettingen G, Mayer D. The motivating function of thinking about the future: expectations versus fantasies. *Journal of Personality and Social Psychology*. 2002;83(5):1198–

1212. <https://pubmed.ncbi.nlm.nih.gov/12416922/>
- 81 Poldrack RA. Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Sciences*. 2006;10(2):59–63. <https://doi.org/10.1016/j.tics.2005.12.004>
 - 82 Button KS, et al. Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*. 2013;14:365–376. <https://doi.org/10.1038/nrn3475>
 - 83 Marek S, et al. Reproducible brain-wide association studies require thousands of individuals. *Nature*. 2022;603:654–660. <https://doi.org/10.1038/s41586-022-04492-9>
 - 84 Eklund A, Nichols TE, Knutsson H. Cluster failure: why fMRI inferences for spatial extent have inflated false-positive rates. *Proceedings of the National Academy of Sciences*. 2016;113(28):7900–7905. <https://doi.org/10.1073/pnas.1602413113>
 - 85 US Food and Drug Administration. Psychedelic Drugs: Considerations for Clinical Investigations — Guidance for Industry. Final guidance, July 2026. <https://www.fda.gov/regulatory-information/search-fda-guidance-documents/psychedelic-drugs-consideration-s-clinical-investigations>
 - 86 US Food and Drug Administration. Complete Response Letter, NDA 215455 (midomafetamine/MDMA). 8 August 2024. https://download.open.fda.gov/crl/CRL_NDA215455_20240808.pdf
 - 87 Mitchell JM, et al. MDMA-assisted therapy for moderate to severe PTSD: a randomized, placebo-controlled phase 3 trial. *Nature Medicine*. 2023;29:2473–2480. <https://doi.org/10.1038/s41591-023-02565-4>
 - 88 Muthukumaraswamy SD, Forsyth A, Lumley T. Blinding and expectancy confounds in psychedelic randomized controlled trials. *Expert Review of Clinical Pharmacology*. 2021;14(9):1133–1152. <https://pubmed.ncbi.nlm.nih.gov/34038314/>
 - 89 Orsini DK, et al. Blinding integrity in psychedelic randomized clinical trials: a systematic review. *JAMA Psychiatry*. 2026;83(7):755–769. <https://doi.org/10.1001/jamapsychiatry.2026.0255>
 - 90 Mertens LJ, et al. Efficacy and safety of psilocybin in treatment-resistant major depression: the EPISODE randomized clinical trial. *JAMA Psychiatry*. 2026;83(5):448–460. <https://doi.org/10.1001/jamapsychiatry.2026.0132>
 - 91 Yehuda R, Lehrner A. Intergenerational transmission of trauma effects: putative role of epigenetic mechanisms. *World Psychiatry*. 2018;17(3):243–257. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6127768/>
 - 92 Youssef NA, et al. Potential transgenerational epigenetic effects of trauma and PTSD in humans: advanced concepts and methods. *American Journal of Medical Genetics Part B*. 2018. <https://pubmed.ncbi.nlm.nih.gov/29738444/>
 - 93 Banushi B, et al. The epigenetic legacy of trauma: understanding intergenerational mechanisms and clinical limits. *Epigenomics*. 2025. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11989090/>
 - 94 Schuster C, et al. Best practice for motor imagery: a systematic literature review on motor imagery training elements in five different disciplines. *BMC Medicine*. 2011;9:75. <https://pmc.ncbi.nlm.nih.gov/articles/PMC3141540/>
 - 95 Magistretti PJ, Allaman I. A cellular perspective on brain energy metabolism and

- functional imaging. *Neuron*. 2015;86(4):883–901. <https://doi.org/10.1016/j.neuron.2015.03.035>
- 96 Dantzer R, O'Connor JC, Freund GG, Johnson RW, Kelley KW. From inflammation to sickness and depression: when the immune system subjugates the brain. *Nature Reviews Neuroscience*. 2008;9:46–56. <https://doi.org/10.1038/nrn2297>
 - 97 Bartz JA, Zaki J, Bolger N, Ochsner KN. Social effects of oxytocin in humans: context and person matter. *Trends in Cognitive Sciences*. 2011;15(7):301–309. <https://doi.org/10.1016/j.tics.2011.05.002>
 - 98 Newcomer JW, et al. Decreased memory performance in healthy humans induced by stress-level cortisol treatment. *Archives of General Psychiatry*. 1999;56(6):527–533. <https://doi.org/10.1001/archpsyc.56.6.527>
 - 99 Bingel U, et al. The effect of treatment expectation on drug efficacy: imaging the analgesic benefit of the opioid remifentanyl. *Science Translational Medicine*. 2011;3(70):70ra14. <https://doi.org/10.1126/scitranslmed.3001244>
 - 100 Zunhammer M, et al. Meta-analysis of neural systems underlying placebo analgesia from individual participant fMRI data. *Nature Communications*. 2021;12:1391. <https://doi.org/10.1038/s41467-021-21179-3>
 - 101 Tekampe J, van Middendorp H, Meeuwis SH, van Leusden JW, Pacheco-López G, Evers AWM. Conditioning immune and endocrine parameters in humans: a systematic review. *Psychotherapy and Psychosomatics*. 2017;86:99–107. <https://doi.org/10.1159/000449470>
 - 102 Nebe S, et al. Characterizing human habits in the laboratory. *Collabra: Psychology*. 2024;10. <https://doi.org/10.1525/collabra.92949>
 - 103 Haas JW, et al. Frequency of adverse events in the placebo arms of COVID-19 vaccine trials: a systematic review and meta-analysis. *JAMA Network Open*. 2022;5(1):e2143955. <https://doi.org/10.1001/jamanetworkopen.2021.43955>
 - 104 Morris MC, Compas BE, Garber J. Relations among posttraumatic stress disorder, comorbid major depression, and HPA function: a systematic review and meta-analysis. *Clinical Psychology Review*. 2012;32(4):301–315. <https://pmc.ncbi.nlm.nih.gov/articles/PMC3340453/>
 - 105 Schumacher S, et al. HPA axis regulation in posttraumatic stress disorder: a meta-analysis focusing on potential moderators. *Neuroscience and Biobehavioral Reviews*. 2019;100:35–57. <https://doi.org/10.1016/j.neubiorev.2019.02.005>
 - 106 Peruzzolo TL, et al. Inflammatory and oxidative stress markers in post-traumatic stress disorder: a systematic review and meta-analysis. *Molecular Psychiatry*. 2022. <https://doi.org/10.1038/s41380-022-01564-0>
 - 107 Koenen KC, et al. Posttraumatic stress disorder in the World Mental Health Surveys. *Psychological Medicine*. 2017;47(13):2260–2274. <https://doi.org/10.1017/S0033291717000708>
 - 108 Gilbertson MW, et al. Smaller hippocampal volume predicts pathologic vulnerability to psychological trauma. *Nature Neuroscience*. 2002;5:1242–1247. <https://pubmed.ncbi.nlm.nih.gov/12379862/>
 - 109 Hinojosa CA, et al. Longitudinal structural neuroimaging of trauma and PTSD: vulnerability and acquired change. 2024 review. <https://pmc.ncbi.nlm.nih.gov/articles/PM>

C11449801/

- 110 National Center for PTSD, US Department of Veterans Affairs. Clinician's guide to medications for PTSD. Updated resource. https://www.ptsd.va.gov/professional/treat/txessentials/clinician_guide_meds.asp
- 111 Fang H, et al. Assessment of the effectiveness of exercise interventions in post-traumatic stress disorder: a systematic review and meta-analysis. *Frontiers in Psychology*. 2026. <https://doi.org/10.3389/fpsyg.2025.1702199>
- 112 Talbot LS, et al. Cognitive behavioral therapy for insomnia in posttraumatic stress disorder: a randomized controlled trial. *Sleep*. 2014;37(2):327–341. <https://doi.org/10.5665/sleep.3408>
- 113 Shao R, et al. Effects of slow-paced breathing on cardiovascular and emotion functions: a meta-analysis. *Mindfulness*. 2024. <https://doi.org/10.1007/s12671-023-02294-2>
- 114 Li J, et al. Effects of mindfulness-based interventions on symptoms in military veterans with PTSD: a systematic review and meta-analysis. *Health Psychology Open*. 2024. <https://doi.org/10.1177/20551029241302969>
- 115 Berman Z, et al. Neurofeedback for post-traumatic stress disorder: a systematic review and meta-analysis. 2025. <https://pmc.ncbi.nlm.nih.gov/articles/PMC12708586/>
- 116 US Food and Drug Administration. 510(k) Premarket Notification K222101, Prism EEG neurofeedback device. 2023. <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K222101>
- 117 Brown R, et al. Repetitive transcranial magnetic stimulation for post-traumatic stress disorder in adults. *Cochrane Database of Systematic Reviews*. 2024;CD015040. <https://doi.org/10.1002/14651858.CD015040.pub2>
- 118 US Food and Drug Administration. 510(k) Summary K260402, MeRT adjunctive treatment for PTSD. 3 June 2026. https://www.accessdata.fda.gov/cdrh_docs/pdf26/K260402.pdf
- 119 US Food and Drug Administration. De Novo Classification Request DEN250013, Modius Spero. May 2026. <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/denovo.cfm?id=DEN250013>
- 120 Colvonen PJ, et al. Electrical vestibular system stimulation versus sham for post-traumatic stress disorder: a randomized controlled trial. *Nature Mental Health*. 2026. <https://doi.org/10.1038/s44220-026-00714-5>
- 121 Callens J, Sienaert P. Electroconvulsive therapy for post-traumatic stress disorder: a systematic review. 2024. <https://pubmed.ncbi.nlm.nih.gov/39178058/>
- 122 Koek RJ, et al. Deep brain stimulation for refractory post-traumatic stress disorder: clinical pilot evidence and ethical considerations. 2024. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11419692/>
- 123 Mitchell JM, et al. MDMA-assisted therapy for severe PTSD: a randomized, double-blind, placebo-controlled phase 3 study. *Nature Medicine*. 2021;27:1025–1033. <https://doi.org/10.1038/s41591-021-01336-3>
- 124 National Institute for Health and Care Excellence. Post-traumatic stress disorder: NICE guideline NG116. 2018, updated surveillance. <https://www.nice.org.uk/guidance/ng116>
- 125 Schnurr PP, et al. Comparison of Prolonged Exposure vs Cognitive Processing Therapy

- for treatment of PTSD among US veterans: a randomized clinical trial. *JAMA Network Open*. 2022;5(1):e2136921. <https://doi.org/10.1001/jamanetworkopen.2021.36921>
- 126** Lee CW, Cuijpers P. A meta-analysis of the contribution of eye movements in processing emotional memories. *Journal of Behavior Therapy and Experimental Psychiatry*. 2013;44(2):231–239. <https://pubmed.ncbi.nlm.nih.gov/23266601/>
- 127** Hoskins M, et al. Pharmacological therapy for post-traumatic stress disorder: a systematic review and meta-analysis. *European Journal of Psychotraumatology*. 2021. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8725683/>
- 128** Schnurr PP, et al. The 2023 VA/DoD clinical practice guideline for management of PTSD and acute stress disorder: synopsis. *Annals of Internal Medicine*. 2024. <https://doi.org/10.7326/M23-2757>

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