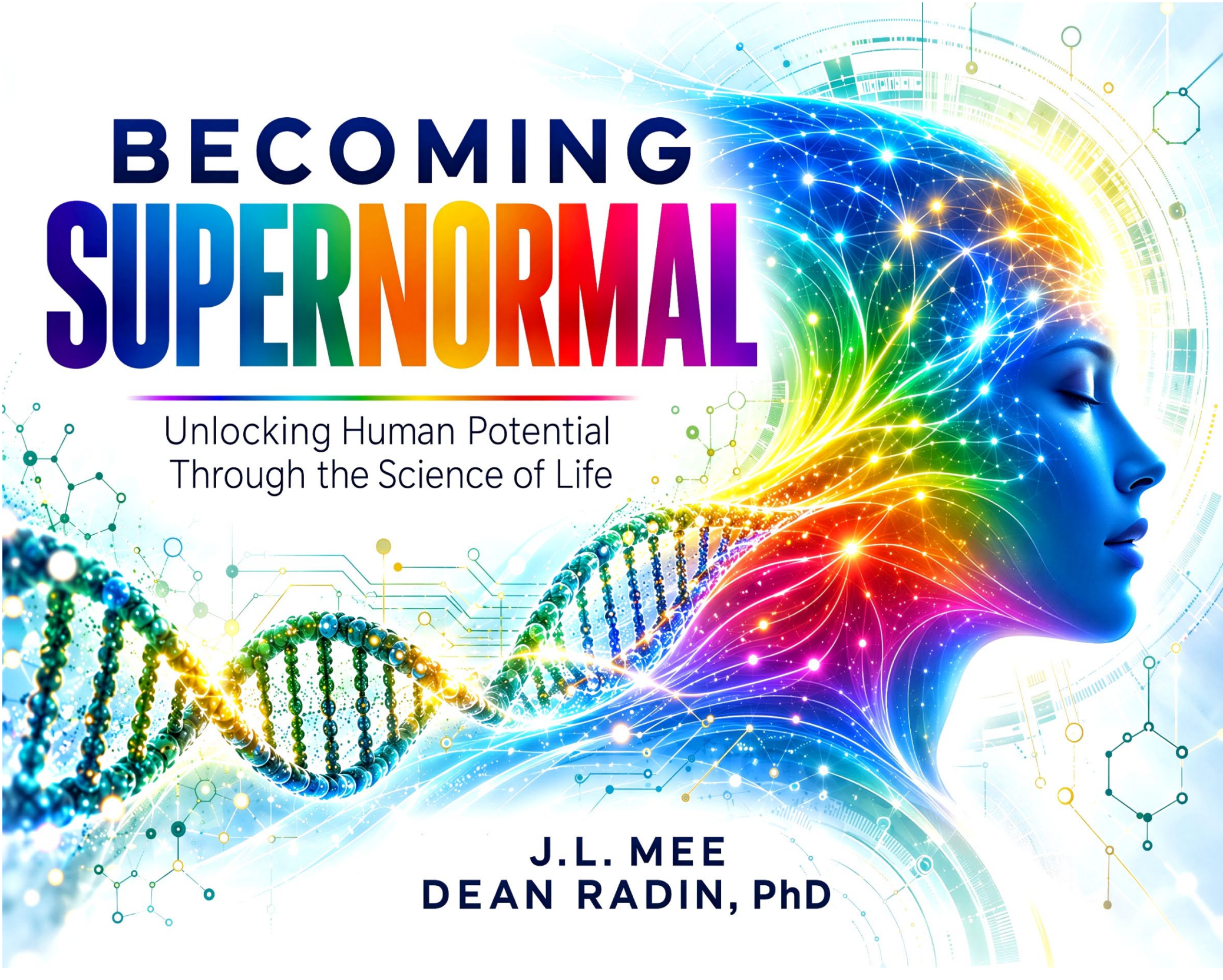


BECOMING SUPERNORMAL

Unlocking Human Potential
Through the Science of Life



J.L. MEE
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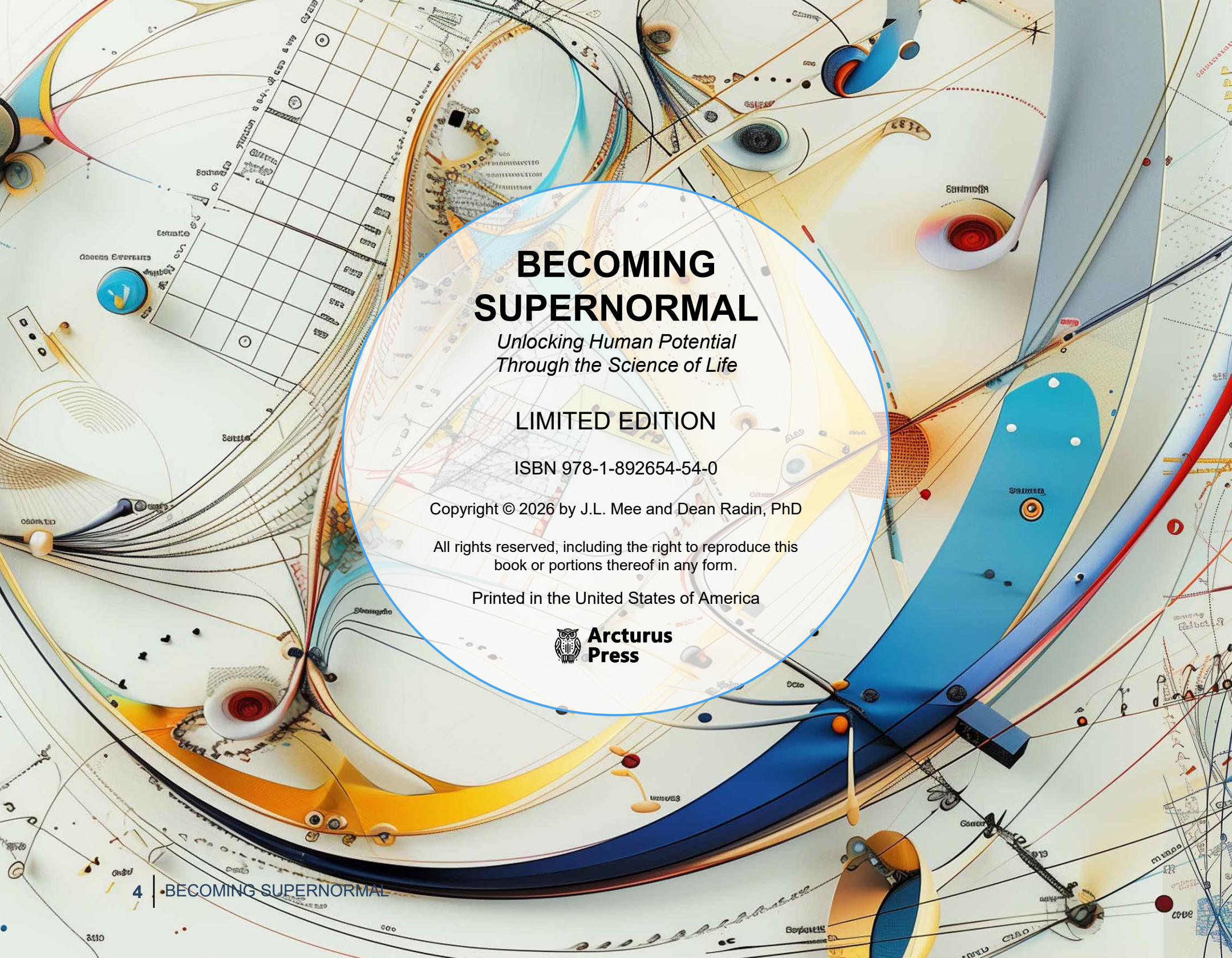

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Unlocking Human Potential Through the Science of Life

LIMITED EDITION

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BECOMING SUPERNORMAL

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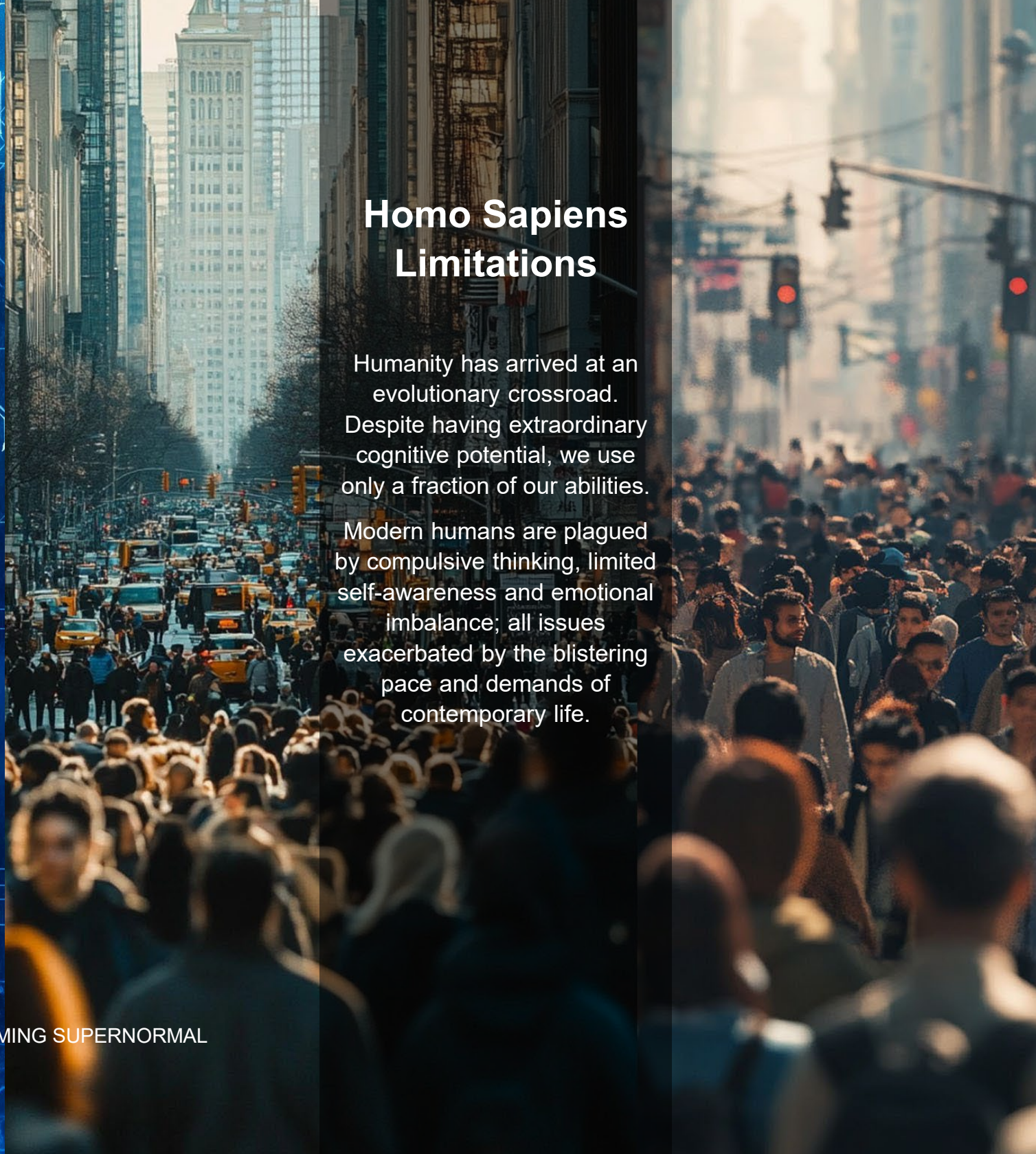
Introduction



Homo Sapiens Limitations

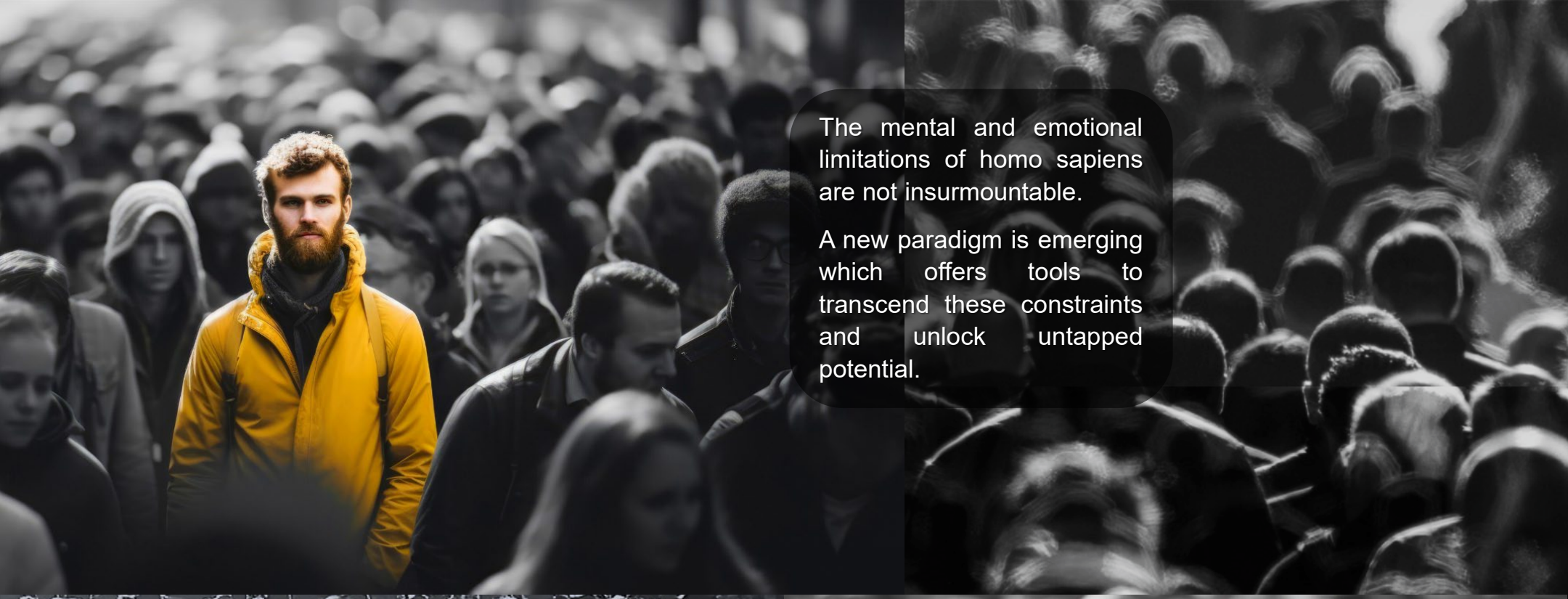
Humanity has arrived at an evolutionary crossroad. Despite having extraordinary cognitive potential, we use only a fraction of our abilities.

Modern humans are plagued by compulsive thinking, limited self-awareness and emotional imbalance; all issues exacerbated by the blistering pace and demands of contemporary life.

Traditional methods of self-improvement such as meditation attempt to address these challenges, but do so only incrementally and inefficiently.

Meanwhile, critical global challenges demand solutions from individuals operating at their highest cognitive and emotional potential.





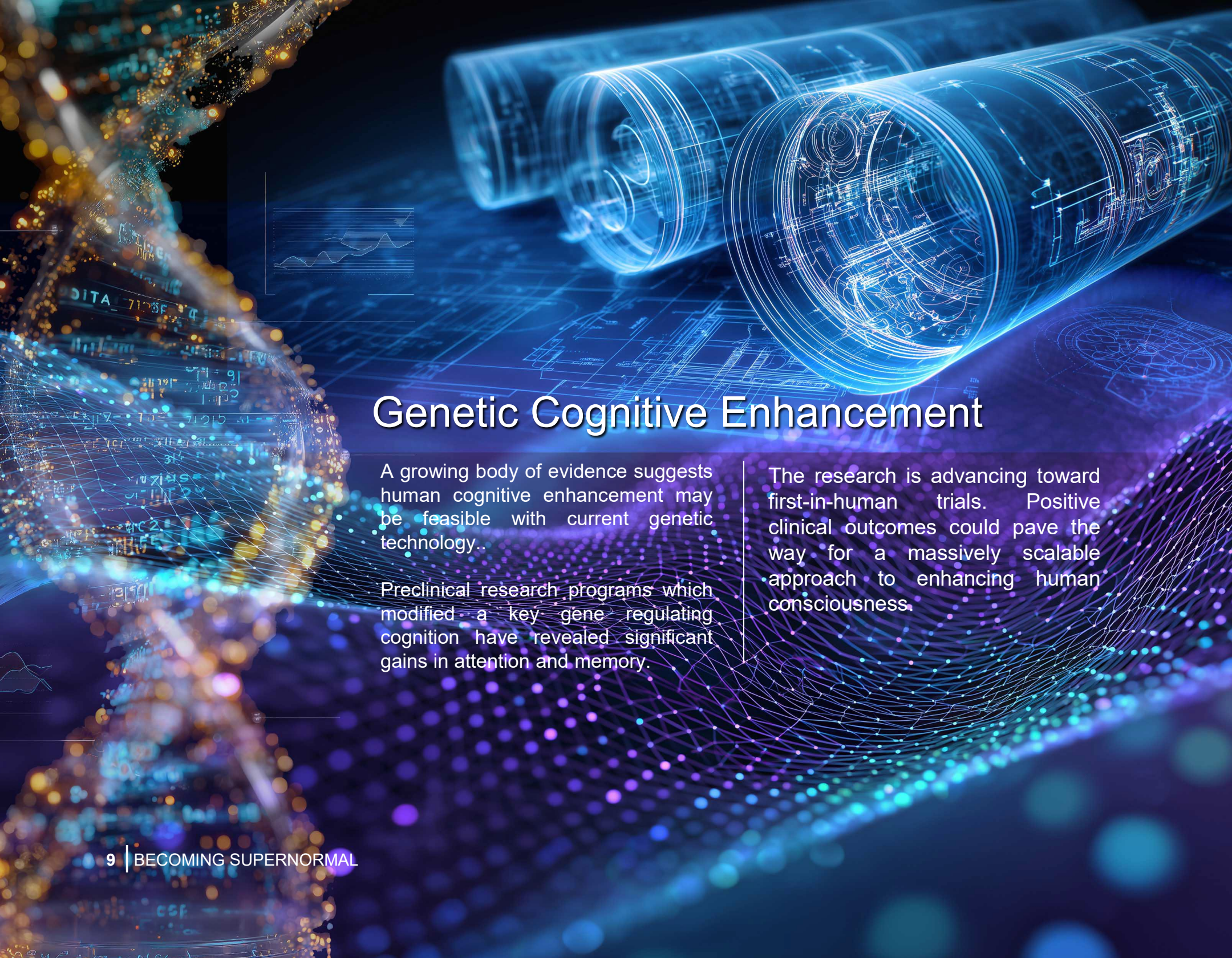
The mental and emotional limitations of homo sapiens are not insurmountable.

A new paradigm is emerging which offers tools to transcend these constraints and unlock untapped potential.

This evolution requires bold new approaches combining scientific advancements with a deep understanding of human consciousness.

In this crucible, the concept of genetic cognitive enhancement takes form; paving the way for a transformative leap forward in human capability.





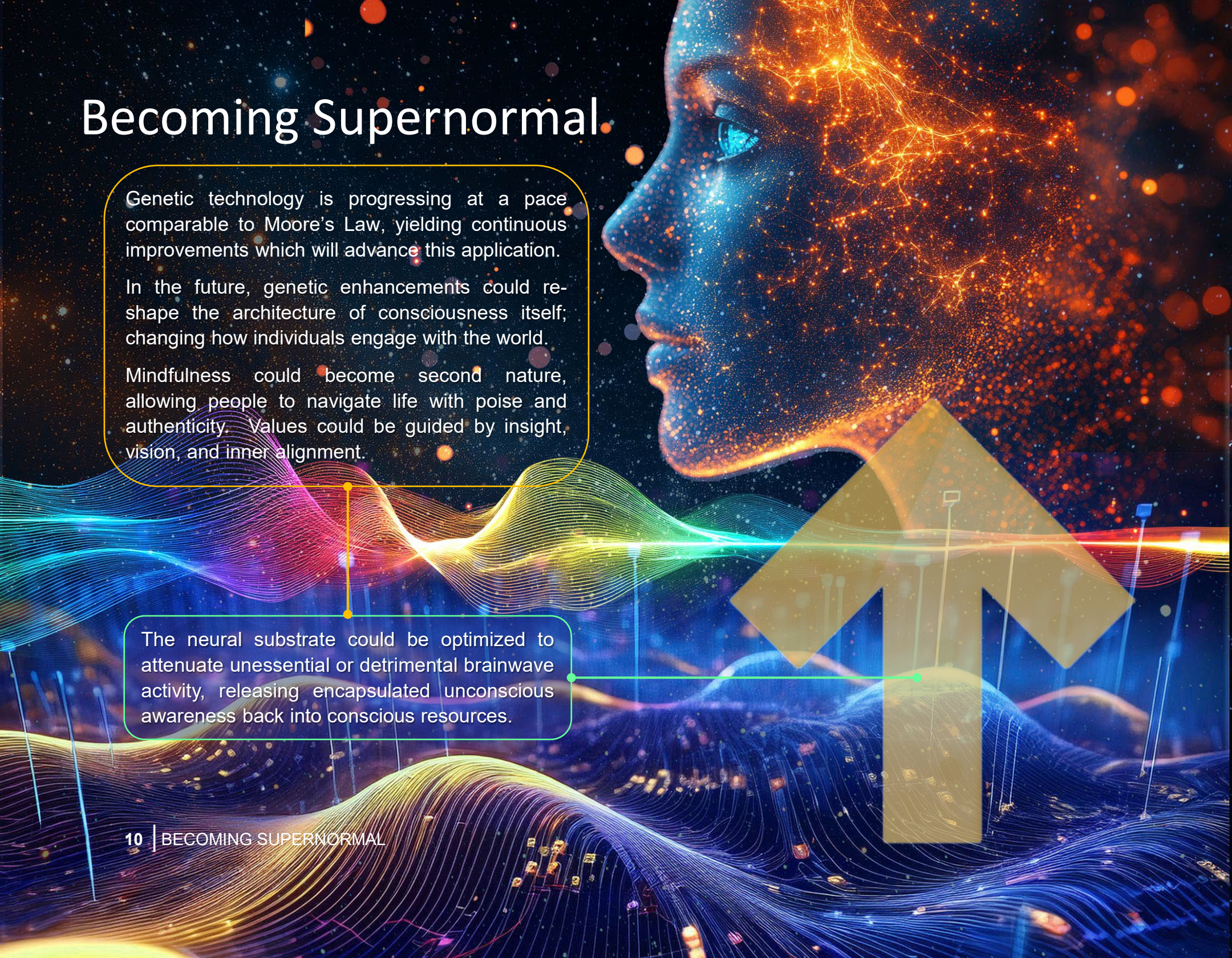
Genetic Cognitive Enhancement

A growing body of evidence suggests human cognitive enhancement may be feasible with current genetic technology..

Preclinical research programs which modified a key gene regulating cognition have revealed significant gains in attention and memory.

The research is advancing toward first-in-human trials. Positive clinical outcomes could pave the way for a massively scalable approach to enhancing human consciousness.

Becoming Supernormal



Genetic technology is progressing at a pace comparable to Moore's Law, yielding continuous improvements which will advance this application.

In the future, genetic enhancements could re-shape the architecture of consciousness itself; changing how individuals engage with the world.

Mindfulness could become second nature, allowing people to navigate life with poise and authenticity. Values could be guided by insight, vision, and inner alignment.

The neural substrate could be optimized to attenuate unessential or detrimental brainwave activity, releasing encapsulated unconscious awareness back into conscious resources.


This book introduces a genetic neuroengineering architecture for enhancing human cognition.
Research within this framework has identified what appears to be a master control switch for consciousness encoded in the human genome:
Gene HTR2A
on chromosome 13
A large body of scientific evidence suggests that modifying this gene could improve attention, memory, mental acuity and emotional resilience.

Experimental Results

01

Although not yet tested in humans, preclinical research has produced remarkable results, with behavioral experiments showing a 34% reduction in anxiety and a 94% boost in memory — both hallmarks of enhanced cognition.

02

The ability to form memories is largely a function of attention. In neuro-science, attention in mice is regarded as a proxy for awareness in humans.

03

If preclinical results can be replicated in humans, **we may be on the threshold of creating new states of consciousness.**

THE COGNITIVE AGE

The Next Frontier of Human Agency

The research indicates a large-scale breakthrough with the potential for translating into widespread human use.

Favorable results from clinical trials will open a new era in human evolution: **The Cognitive Age.**

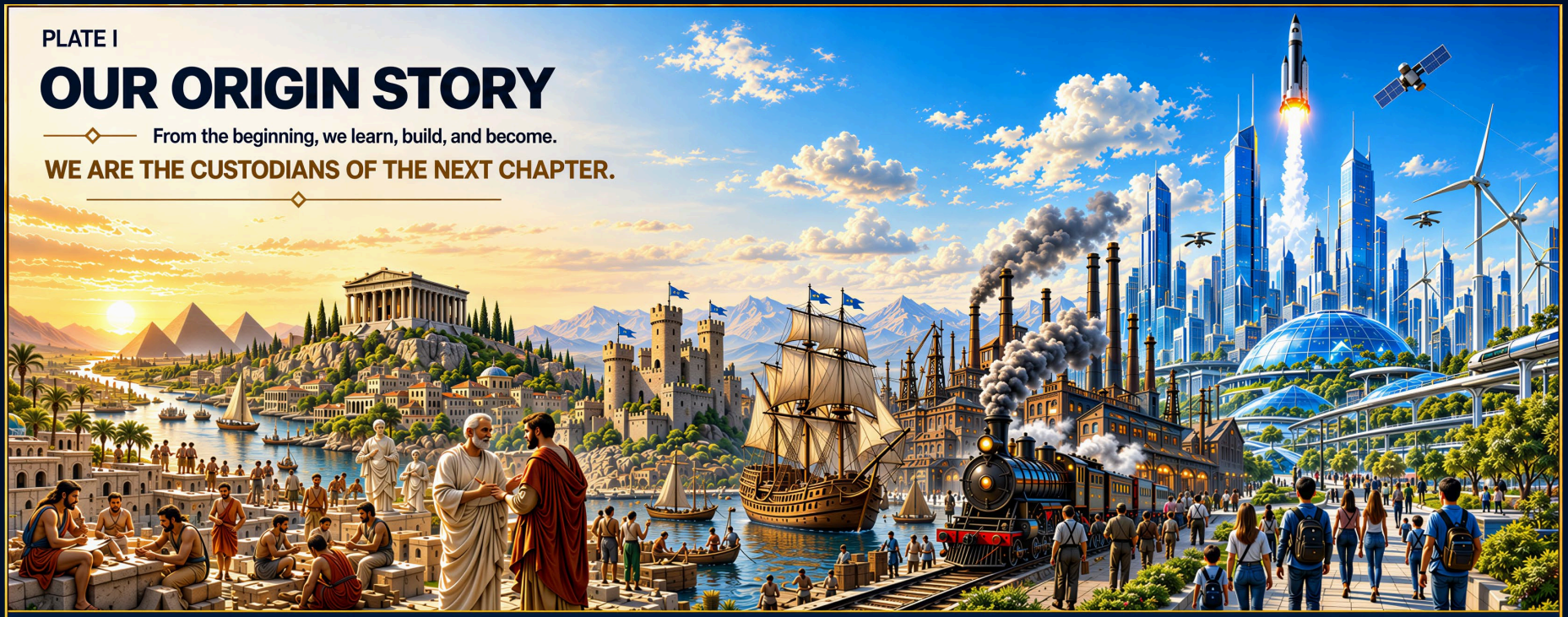


PLATE I

OUR ORIGIN STORY

From the beginning, we learn, build, and become.

WE ARE THE CUSTODIANS OF THE NEXT CHAPTER.



NATURE	LIFE	HUMANITY	CIVILIZATION	INDUSTRY	KNOWLEDGE AGE	FUTURE
The world as it was.	Life emerges. Adapt. Evolve. Endure.	We think. We create. We shape our world together.	We build institutions. We make meaning. We advance.	We harness power. We scale our reach. We transform.	We connect minds. We expand knowledge. We accelerate.	The story continues. What we do next is our choice.

WE ARE THE CUSTODIANS OF THE NEXT CHAPTER.

PLATE II

THE GROWTH OF HUMAN CAPABILITY

FROM TOOLS TO THE ARCHITECTURE WITHIN

For centuries, progress came from better tools.

We explored oceans, moved mountains, connected the world, and extended our reach.

But our inner capacity—the way we think, feel, decide, and relate—changed little.

Today, we stand at a new inflection point in human history.

We are applying knowledge and technology to the architecture of consciousness itself.

The next great leap is not just about what we build.

It is about who we become.

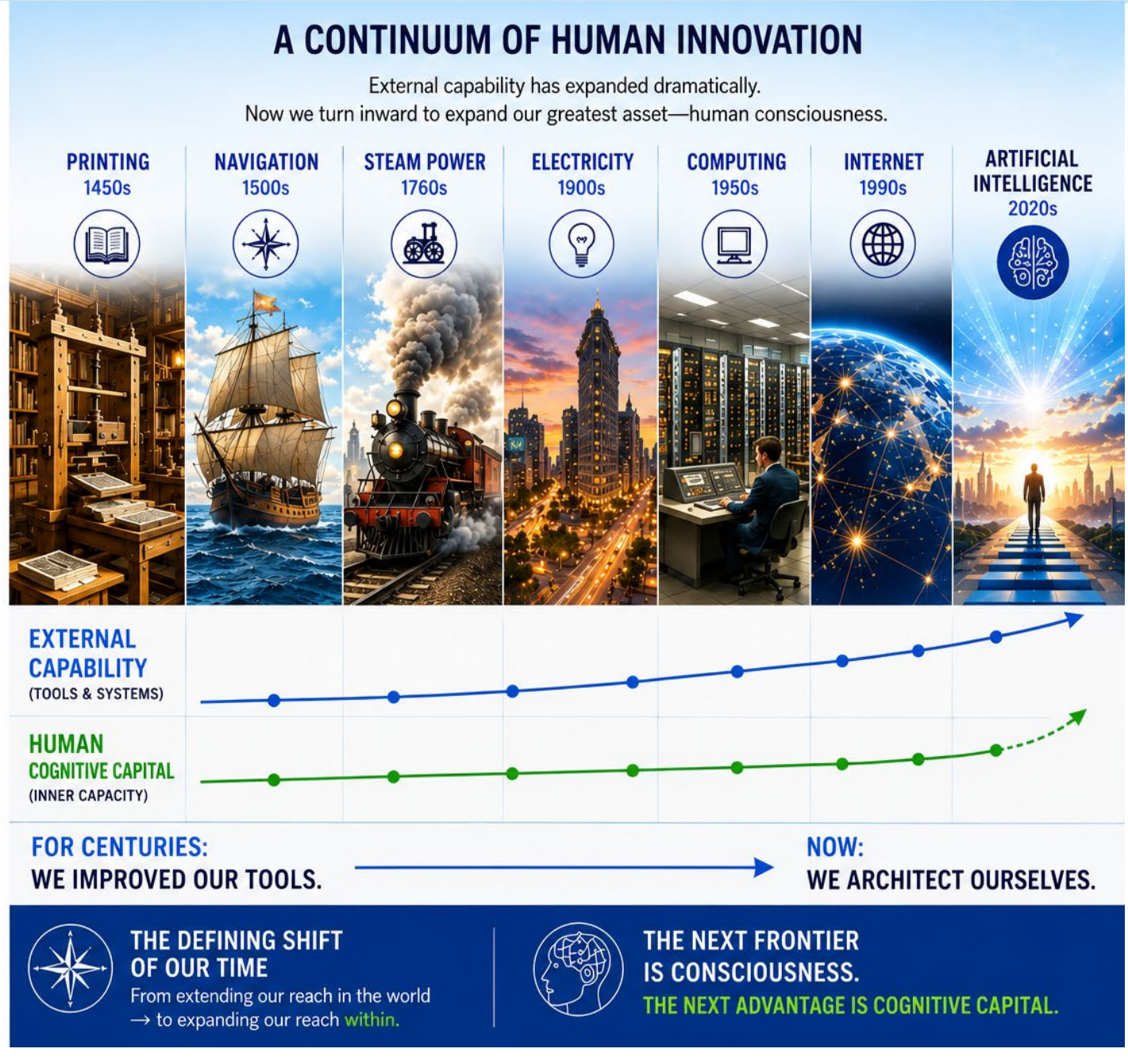


PLATE III

THE DEFINING CHALLENGE OF THE AI ERA.

For every leap in external technology, the human operator has remained bounded by the same biological limits.

Artificial intelligence makes this imbalance urgent—expanding what we can build, while exposing the limits of who we are.

THE CENTRAL QUESTION

Can we grow our inner capacity as deliberately as we build our tools?

THE GREAT IMBALANCE

EXTERNAL INTELLIGENCE IS ACCELERATING.
INTERNAL HUMAN CAPACITY IS NOT.



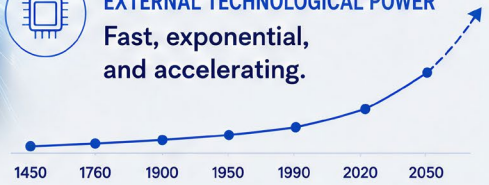
INTERNAL HUMAN CAPACITY

Slow, uneven, and underdeveloped.



EXTERNAL TECHNOLOGICAL POWER

Fast, exponential, and accelerating.



THE CONSEQUENCE

- Poor decisions at greater scale
- Power without wisdom
- Inequality accelerates
- Risk grows exponentially
- The future becomes harder to steer

WHY THIS MATTERS NOW

- AI amplifies outcomes—good or bad—at unprecedented scale.
- Lagging human capacity becomes a systemic risk.
- The future belongs to those who grow both their tools and their minds.

THE OPPORTUNITY

Close the gap. Unlock the future.

- Cultivate awareness
- Strengthen judgment
- Expand empathy
- Sharpen creativity
- Build wisdom

GROW COGNITIVE CAPITAL.
ELEVATE HUMAN AGENCY.
SHAPE OUR FUTURE.

THE CHOICE OF OUR TIME

We can continue to build a world that outpaces our wisdom.

Or we can build human capacity with the same intention we build our technologies.

THE PATH WE CHOOSE DETERMINES THE WORLD WE BECOME.

PLATE IV

THE WISDOM GAP

Our power is scaling faster than our capacity to guide it.

Wisdom—the ability to judge, choose, and act for the long-term good—is not keeping pace.

When capability outruns judgment, risks multiply.

Bridging the Wisdom Gap is a defining challenge of our time.

THE WISDOM GAP IS GROWING

Technological power is accelerating.
Human wisdom is not keeping pace.

EXPANDING POWER

AI
Smarter systems.

BIOTECH
Rewriting life.

CONNECTIVITY
Always on. Always linked.

AUTOMATION
Machines that act.

DATA
More data, more power.



THE CONSEQUENCES OF THE WISDOM GAP

POOR JUDGMENT
Bad decisions today create costly, lasting consequences.

ETHICAL FAILURE
Values and guardrails cannot keep pace.

SOCIAL INSTABILITY
Division, distrust, and dislocation accelerate.

SYSTEMIC RISK
Complex global risks grow beyond our ability to manage.

LOST POTENTIAL
We solve the wrong problems and miss the right possibilities.

WHAT DRIVES THE GAP

EXPONENTIAL TECHNOLOGY GROWTH
Capabilities scale faster than our wisdom.

ACCELERATING INFORMATION OVERLOAD
More data, less meaning.

HYPER-CONNECTIVITY
Instant access, shallow attention, fragmented focus.

SHORT-TERM SYSTEMS AND INCENTIVES
Optimize now, undermine later.

NEGLECT OF INNER CAPACITY
Wisdom requires deliberate development.

THE ANTIDOTE

INVEST IN WISDOM
Cultivate judgment, character, empathy, and long-term thinking at scale.

PLATE V

THE COGNITIVE AGE

HUMANITY BEGINS TO ARCHITECT CONSCIOUSNESS

For thousands of years, we have built tools that extend our physical abilities.

Now, for the first time in history, we are deliberately building the architecture of our own minds.

The Cognitive Age is the disciplines, technologies, and institutions we create to grow awareness, strengthen judgment, and expand human potential.

The blueprint is knowledge.
The construction is underway.
The future is in our hands.

COGNITIVE CAPITAL FOUNDATION



PLATE VI

THE ARCHITECTURE OF COGNITIVE CAPITAL

HOW AWARENESS GENERATES VALUE

Awareness is the base currency of cognition.

Cognitive capital is the portion of awareness converted into useful cognitive work.

Free awareness is available in the present.

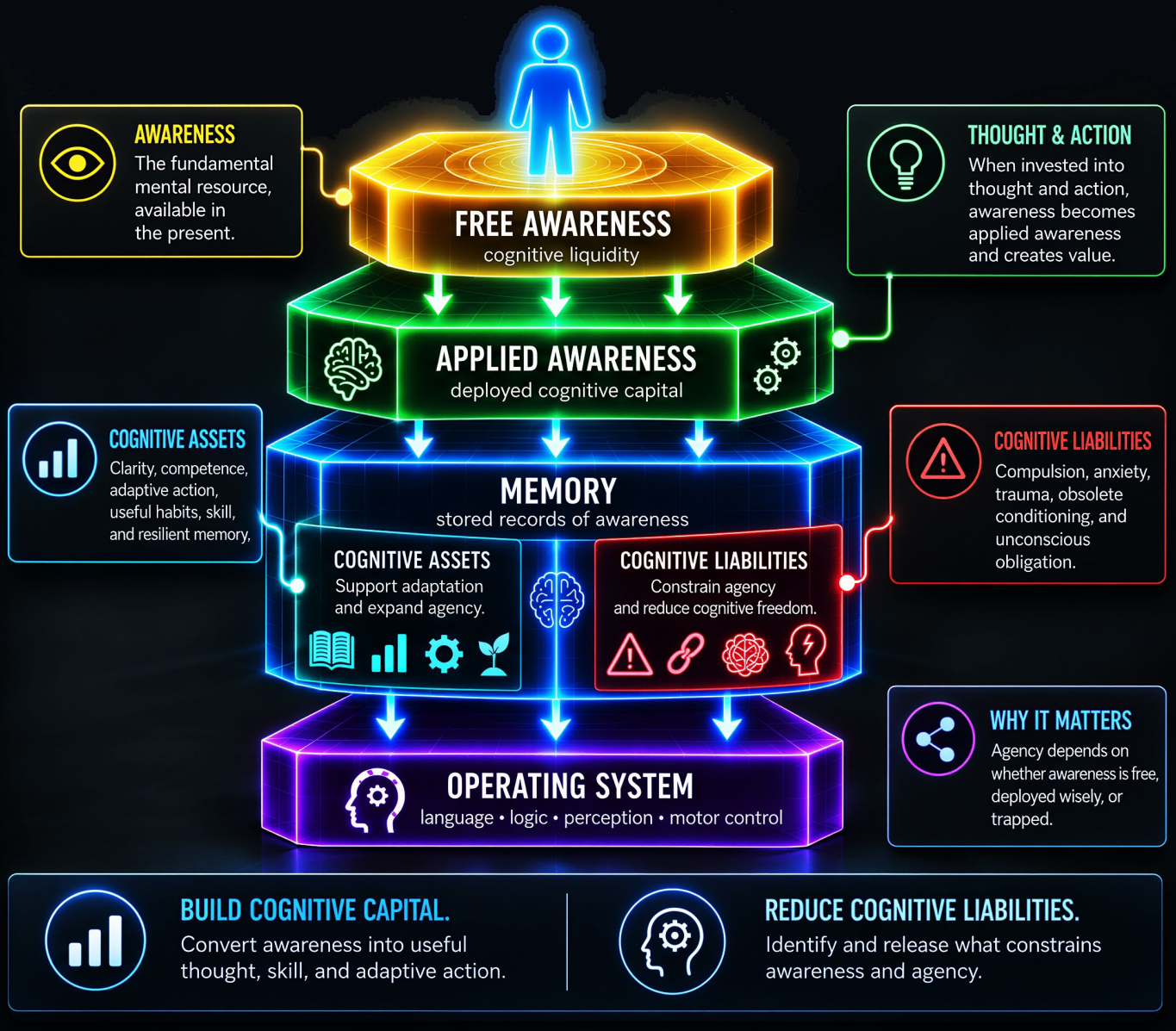
When directed into thought and action, it becomes applied **awareness.**

Stored patterns can support adaptation or become liabilities that constrain agency.

The aim is to build cognitive capital and reduce cognitive liabilities.

COGNITIVE CAPITAL FOUNDATION

THE NEXT FRONTIER OF HUMAN AGENCY



ENHANCEMENT TECHNOLOGY

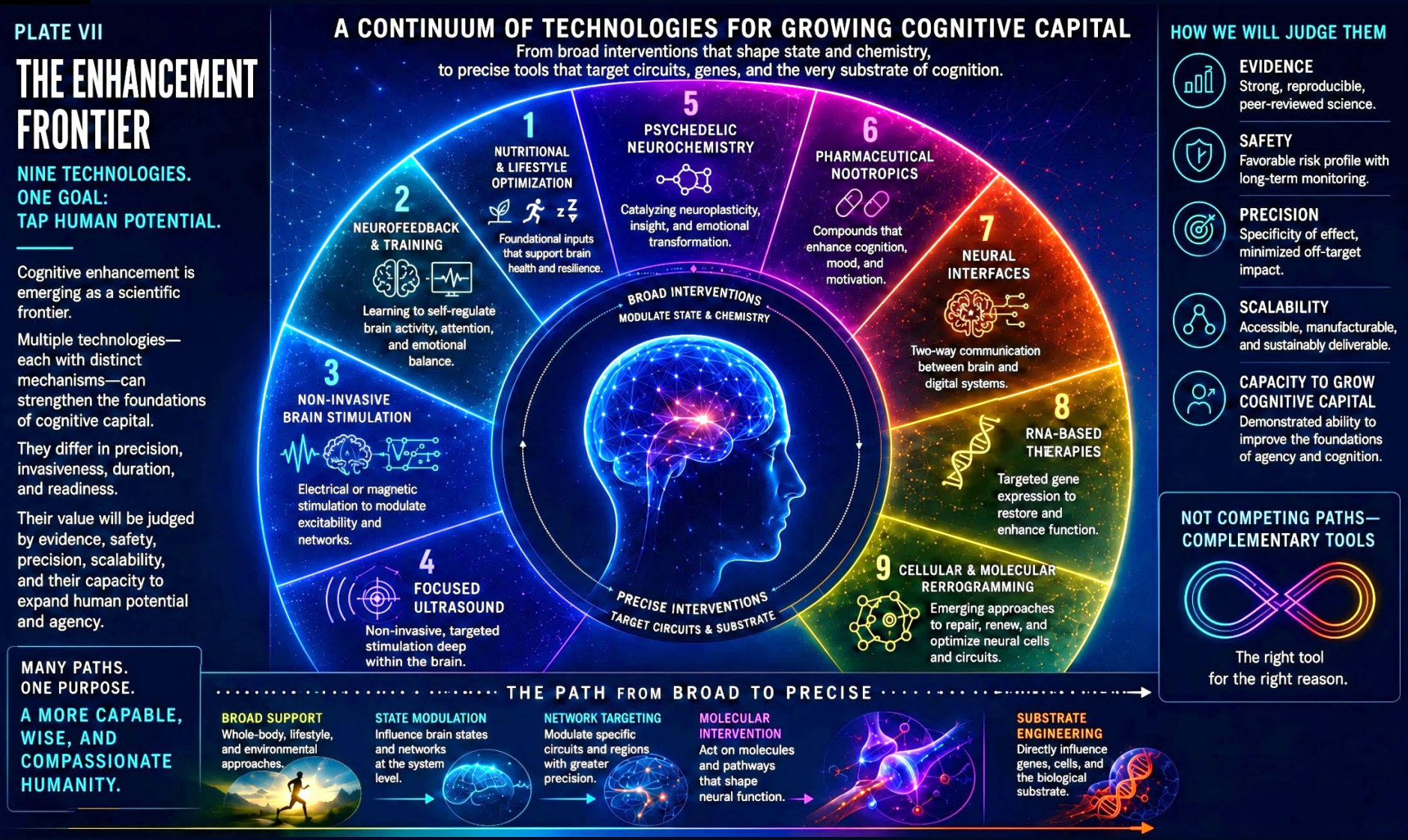
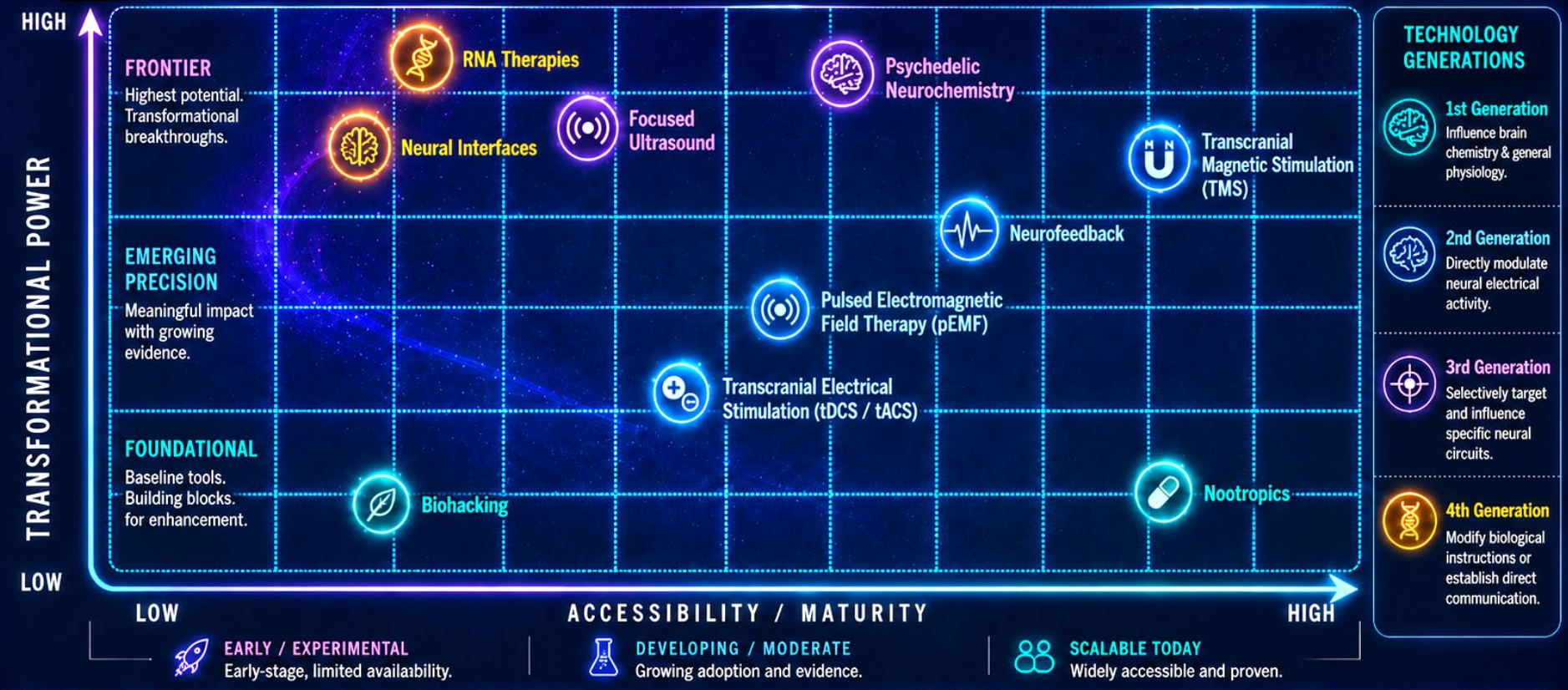


PLATE VIII

THE ENHANCEMENT FRONTIER

A map of cognitive-enhancement technologies by accessibillity and transformational power.



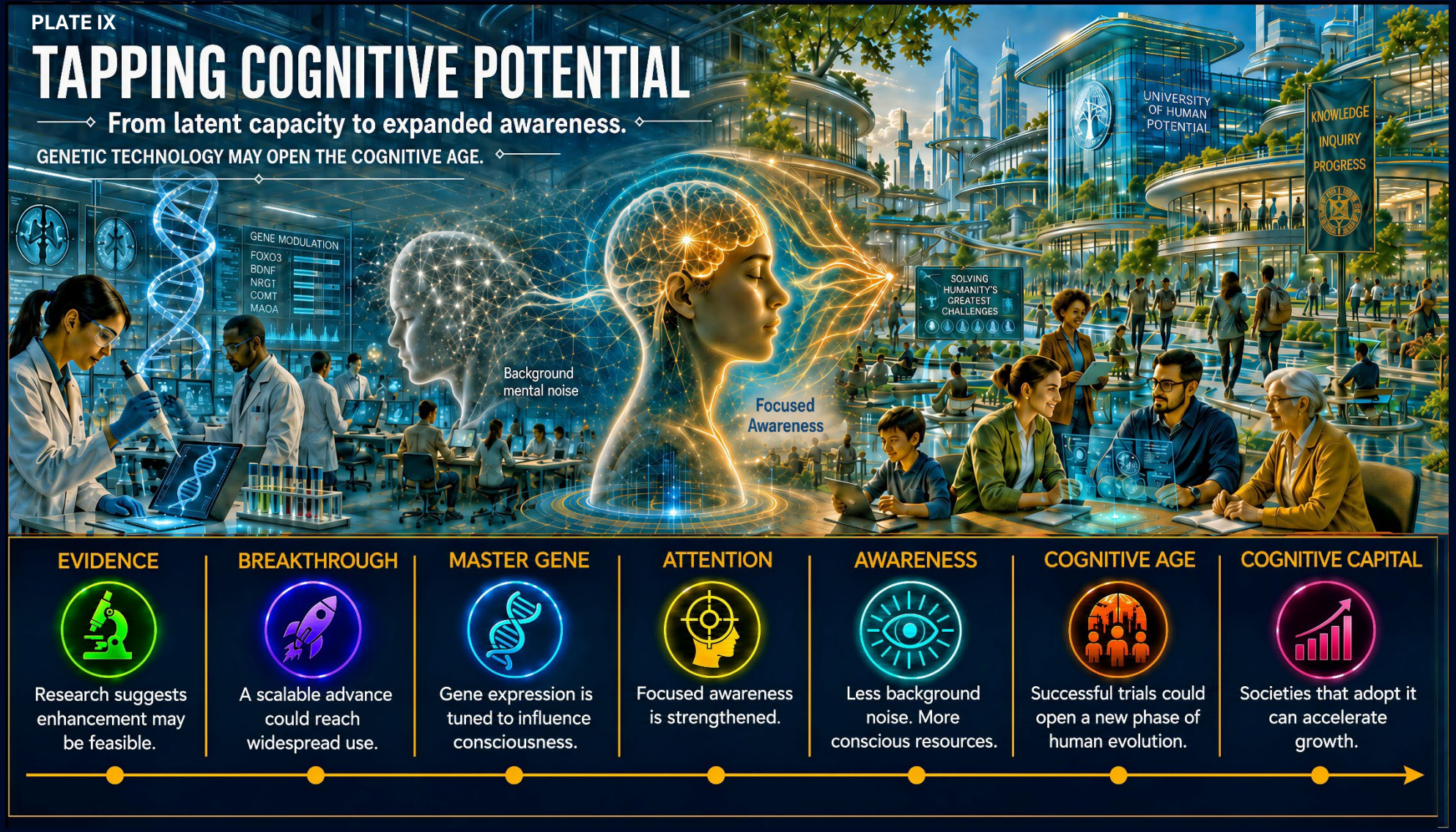
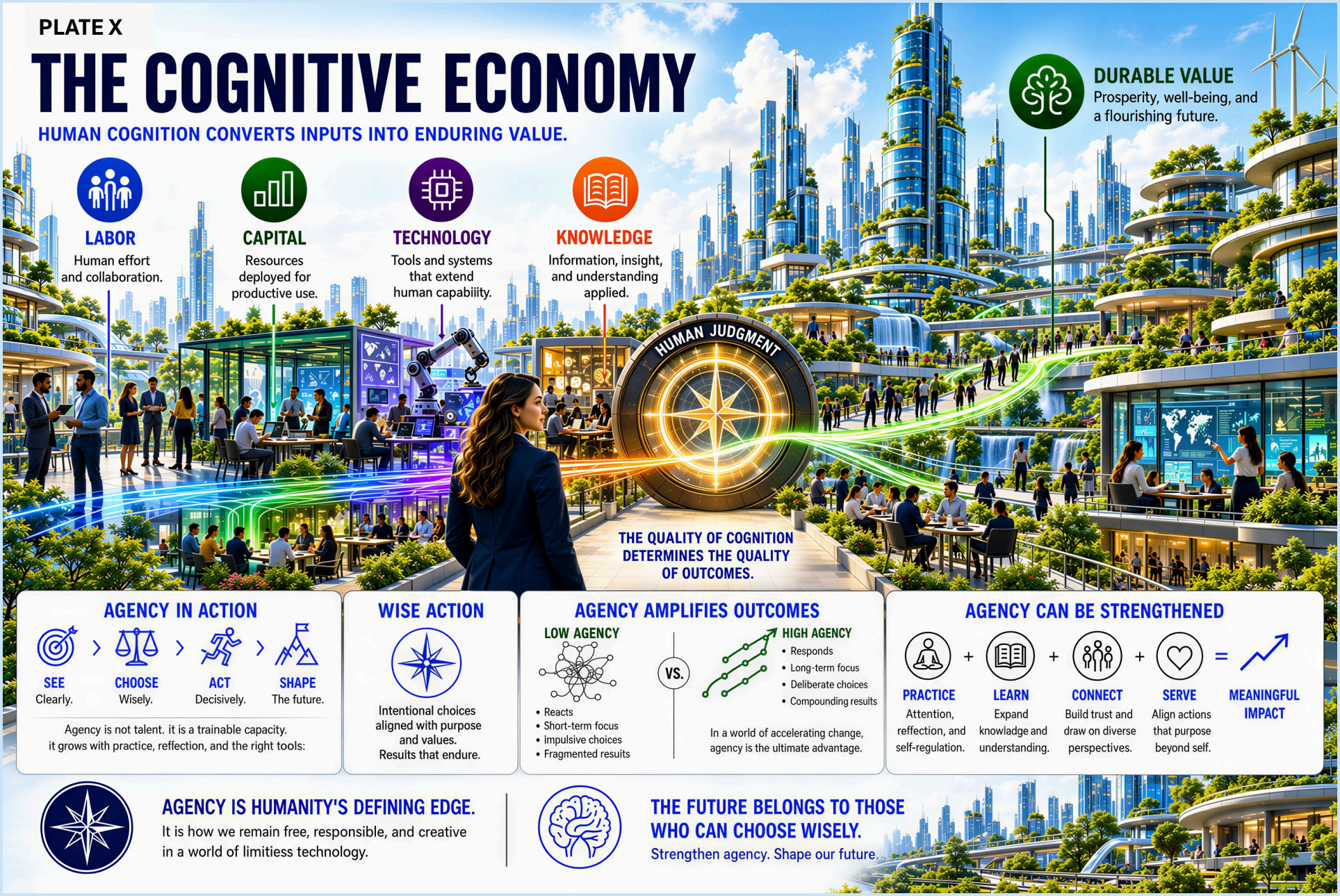


PLATE IX
TAPPING COGNITIVE POTENTIAL
From latent capacity to expanded awareness.
GENETIC TECHNOLOGY MAY OPEN THE COGNITIVE AGE.
GENE MODULATION
FOXO3
BDNF
NRGT
COMT
MAOA
Background mental noise
Focused Awareness
UNIVERSITY OF HUMAN POTENTIAL
KNOWLEDGE
INQUIRY
PROGRESS
SOLVING HUMANITY'S GREATEST CHALLENGES
EVIDENCE
Research suggests enhancement may be feasible.
BREAKTHROUGH
A scalable advance could reach widespread use.
MASTER GENE
Gene expression is tuned to influence consciousness.
ATTENTION
Focused awareness is strengthened.
AWARENESS
Less background noise. More conscious resources.
COGNITIVE AGE
Successful trials could open a new phase of human evolution.
COGNITIVE CAPITAL
Societies that adopt it can accelerate growth.

PLATE X

THE COGNITIVE ECONOMY

HUMAN COGNITION CONVERTS INPUTS INTO ENDURING VALUE.



AGENCY IN ACTION

SEE Clearly. › **CHOOSE** Wisely. › **ACT** Decisively. › **SHAPE** The future.

Agency is not talent. it is a trainable capacity.
it grows with practice, reffection, and the right tools:

WISE ACTION

Intentional choices aligned with purpose and values.
Results that endure.

AGENCY AMPLIFIES OUTCOMES

LOW AGENCY

- Reacts
- Short-term focus
- impulsive choices
- Fragmented resuits

VS.

HIGH AGENCY

- Responds
- Long-term focus
- Deliberate choices
- Compounding results

In a world of accelerating change, agency is the ultimate advantage.

AGENCY CAN BE STRENGTHENED

PRACTICE Attention, reffection, and self-regulation. + **LEARN** Expand knowladge and understanding. + **CONNECT** Build trust and draw on diverse perspectives. + **SERVE** Align actions that purpose beyond self. = **MEANINGFUL IMPACT**

AGENCY IS HUMANITY'S DEFINING EDGE.

It is how we remain free, responsible, and creative in a world of limitiess technology.

THE FUTURE BELONGS TO THOSE WHO CAN CHOOSE WISELY.

Strengthen agency. Shape our future.

PLATE XI

THE GOAL IS NOT MORE TECHNOLOGY. IT IS GREATER HUMANITY.

The Cognitive Age is characterized by the expansion of human potential—individually and collectively.

Cognitive capital is our most valuable resource, our greatest competitive advantage, and the foundation of enduring human progress.

In this age, awareness guides attention. Judgment shapes power. Compassion tempers ambition. And wisdom stewards the future.

THE NEXT FRONTIER OF HUMAN AGENCY

THE COGNITIVE AGE

A CIVILIZATION THAT WIELDS POWER WITH WISDOM

When cognitive capital is cultivated in every individual and designed into the fabric of society, humanity can use advanced technologies—especially AI—to create a more prosperous, just, creative, and sustainable world.



PILLARS OF THE COGNITIVE AGE

EDUCATION FOR AGENCY
Cultivating awareness, critical thinking, emotional intelligence, and creativity.

TECHNOLOGY IN SERVICE
AI and advanced technologies aligned with human flourishing.

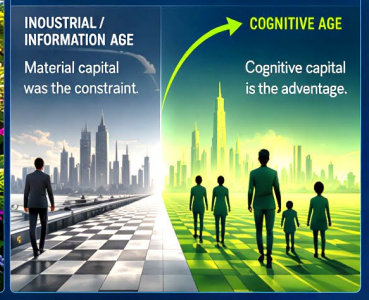
INCLUSIVE ACCESS
Democratic access to tools that grow cognitive capital.

CULTURE OF WISDOM
Institutions and norms that reward long-term, ethical thinking.

SCIENTIFIC EXCELLENCE
Rigorous, open, and humble research that prioritizes safety and truth.

ENVIRONMENTAL STEWARDSHIP
A livable planet sustains the future of human potential.

FROM SCARCITY TO FLOURISHING



PRINCIPLES THAT GUIDE OUR FUTURE

HUMAN DIGNITY
Every person has inherent worth.

AUTONOMY
Individuals own their minds and their choices.

TRANSPARENCY
Open science. Open standards. Open governance.

HARMONY
Safety, do no harm. Build to enhance evidence, and care.

FUTURISM
We think in decades and generations, not quarters.

STEWARDSHIP
We inherit the world. We are responsible for the future.



THE DEFINING TASK OF OUR TIME

TO BUILD THE INNER CAPACITY TO MATCH OUR OUTER POWER, SO HUMANITY CAN FLOURISH—TOGETHER.

THE COGNITIVE AGE BEGINS WITHIN.

PLATE XII

HUMANS AND THE AI ECONOMY

FROM DIRECTION TO EXECUTION

Artificial intelligence increasingly absorbs routine cognitive labor.

As machines execute more analysis, prediction, retrieval, and automation, the human role shifts from execution to direction.

People will be asked to set aims, judge outputs, govern risks, interpret consequences, and preserve human meaning.

The traits that rise in value are imagination, creativity, metacognition, emotional intelligence, intuition, and presence.

The advantage is not more machine speed.
It is better human agency.



PLATE XIII

FROM BETTER MINDS TO BETTER INSTITUTIONS

HOW COGNITIVE CAPITAL SCALES

Individual cognitive capital does not stop at personal performance.

Clearer perception, stronger attention, emotional balance, and better judgment improve the quality of decisions people make.

When those capacities spread through leaders, teams, and institutions, short-term reactivity gives way to longer-horizon planning.

The result is not only better individuals. It is better governance, better allocation of resources, and better social outcomes.

To earn trust, deployment requires standards, certification, monitoring, and the authority to pause or restrict use when needed.

Human agency scales through institutions. Institutions shape civilization.





PLATE XIV

COGNITIVE COLLEGE

THE CENTRAL NEXUS OF A HOLISTIC COGNITIVE ECOSYSTEM

MISSION & PURPOSE

PUBLIC BENEFIT INSTITUTION
Dedicated to the science and practice of human cognitive enhancement.

EDUCATIONAL NUCLEUS
A central campus where research, structured education, genetic enhancement, and responsible governance converge.

CENTRAL HUB
The hub of a holistic cognitive ecosystem serving learning, | counseling, and advancement.

BEST-IN-CLASS PRACTICE
Developing best-in-class delivery practices while advancing the science of cognitive enhancement.

RESPONSIBLE INNOVATION
Grounded in scientific integrity, safety, fairness, and the preservation of mental autonomy.



BUILDING THE COGNITIVE INFRASTRUCTURE FOR HUMAN FLOURISHING

CURRICULUM DOMAINS

COGNITIVE FLEXIBILITY
Focus, concentration, imagination, creativity, memory, mindfulness techniques.

SUCCESS STRATEGIES
Goal setting, intentionality, and visualization techniques.

PERSONAL PRODUCTIVITY
Techniques for priority setting and time management.

WELL BEING
Foundational practices for physical wellness.

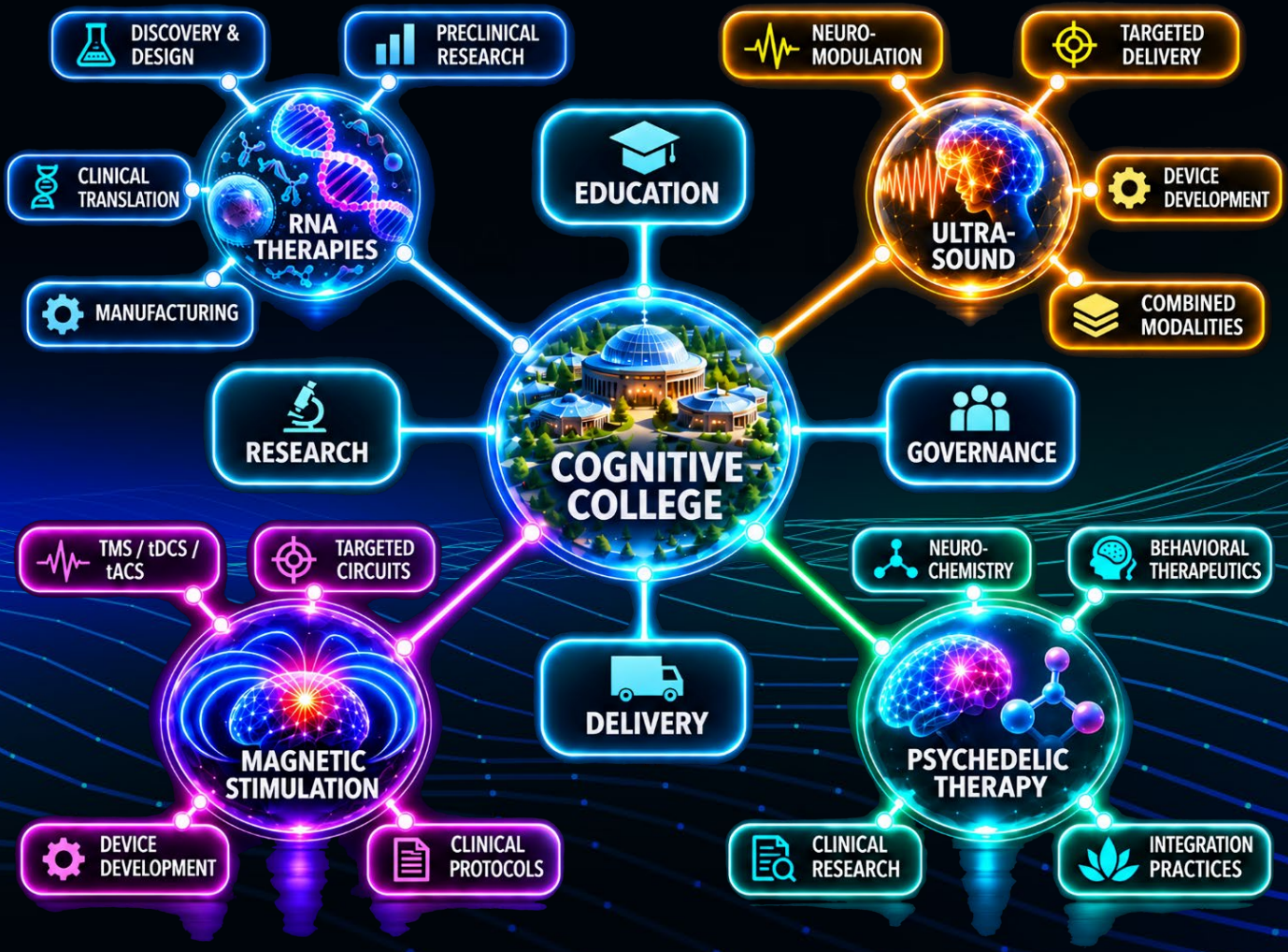
RELATIONSHIP COMPETENCIES
Communication, interpersonal harmony, and emotional balance techniques.

PERSONAL GROWTH
Character development, cultivating wisdom, and connection to purpose techniques.

PLATE XV

TECHNOLOGY INTEGRATION

HUB AND SPOKE MODEL



The college integrates best of breed technologies into a multimodal cognitive enhancement curriculum. Four candidate technologies are shown here.

PLATE XV

GOVERNANCE

GUIDING OURSELVES, OUR TOOLS, AND OUR FUTURE

RISKS & ISSUES

UNEQUAL ACCESS
Unequal access to transformative technologies could exacerbate social inequalities.

OPEN QUESTIONS
Public trust, scientific overreach, and the definition of improvement remain open questions.

UNCERTAIN PROGRESS
Progress in complex biological systems is neither linear nor guaranteed.

LONG-TERM MONITORING
Safety evidence will require long-term monitoring.

AGENCY & AUTONOMY
Cognitive modification raises questions about agency, authenticity, and mental autonomy.



GUIDING PRINCIPLES

ACCESS & EQUITY
Fair access, affordability, and inclusive design.

SAFETY & WELL-BEING
Rigorous testing, long-term monitoring, and responsive safeguards.

IDENTITY & AUTHENTICITY
Protect agency, informed consent, privacy, and what makes us human.

LIMITS & OVERSIGHT
Proportionality, voluntariness, guardrails, and the right to refuse.

TRUST & GOVERNANCE
Independent oversight, transparency by design, public reporting, and stakeholder participation.

HUMAN DIGNITY | BENEFICENCE | TRANSPARENCY
ACCOUNTABILITY | STEWARDSHIP

GOOD GOVERNANCE TODAY. A BETTER FUTURE TOGETHER.

PLATE XVI

THE CIVILIZATION WE CHOOSE

AGE PAST. PURPOSE PRESENT. DESTINY AHEAD.



PRINCIPLES FOR AN ENDURING CIVILIZATION

HUMAN DIGNITY
Every person is an end, never a means.

TRUTH & WISDOM
Seek truth. Cultivate wisdom. Use knowledge well.

JUSTICE
Build systems that are fair, transparent, and accountable.

SOLIDARITY
Strengthen bonds within and across communities.

STEWARDSHIP
Protect the Earth. Sustain life. Think long-term.

CREATIVITY
Imagine boldly. Create beauty, meaning. and value.

COURAGE
Choose the hard right over the easy wrong.

LEGACY
Act today for generations tomorrow.

AGENCY IS OUR GREATEST GIFT AND RESPONSIBILITY.

CHOOSE WISELY.
BUILD WELL.
LEAVE GOOD.

LONG-TERM THINKING
Plan for generations, not just quarters.

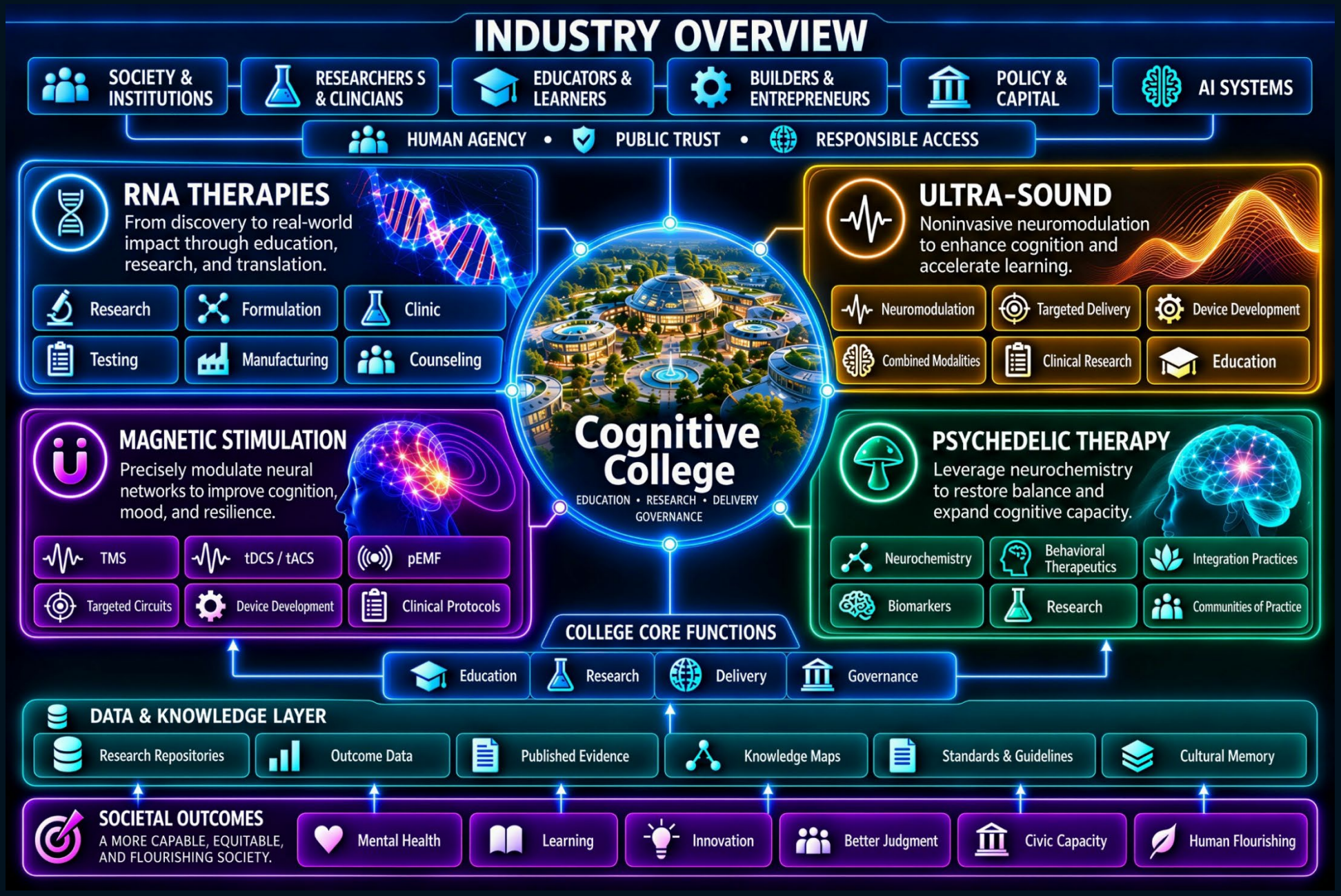
COLLECTIVE PROGRESS
We rise higher together.

ETHICAL TECHNOLOGY
Use tools that enhance human flourishing.

GLOBAL PERSPECTIVE
One world. Shared future.

CONTINUOUS LEARNING
Stay curious. Keep evolving.


PLATE XVII
THE LONG FUTURE
THE STORY OPENS OUTWARD.
NEAR FUTURE
Cleaner systems.
Smarter cities.
A better start.
COGNITIVE AGE
Attention deepens.
Learning expands.
Judgment improves.
LONGEVITY
Health extends.
Vitality endures.
Life opens up.
ABUNDANCE
Energy scales.
Poverty falls.
Capacity grows.
STEWARDSHIP
We restore land.
We protect oceans.
We think long term.
SPACEFARING
We settle beyond Earth.
We build in orbit.
We widen our reach.
FAR FUTURE
Civilization matures.
Freedom and wisdom deepen.
The horizon keeps moving.



Four out of nine candidate technologies are shown here.

Chapter 2: Supernormal Life



The next four chapters explore a future in which safe and effective cognitive enhancements are widely available. The rapid pace of technological progress could make such advances commonplace within a decade.

2.1: Becoming Supernormal

Becoming Supernormal is more than a genetic enhancement — it is a psychological and philosophical metamorphosis.

Structured learning experiences will prepare each candidate for cognitive enhancement through education in life management skills, counseling to ensure emotional readiness, and a basic grasp of the underlying science.

2.2: Supernormal Life

Heightened mental acuity will allow professional endeavors to thrive. Supernormal people will excel in leadership, problem-solving, and innovation. Tasks that once seemed daunting will be approached with confidence, creativity and focus.



Supernormal individuals will cultivate deeper, more meaningful personal and professional relationships. Their inner clarity will guide decisions with precision and purpose, while emotional intelligence brings composure, optimism and insight to human interactions.





2.3: Personal Value

For Individuals

A Supernormal transformation can augment individual abilities to serve each person's unique needs and goals.

- **Personal Growth**: Achieving higher consciousness and greater clarity of purpose, accelerating personal evolution.
- **Learning**: Building new skills more quickly and improve academic performance.
- **Meditation**: Experiencing the benefits of meditation effortlessly, fostering inner peace, mental clarity and mindfulness.
- **Empowerment**: Gaining greater sovereignty, expand perspective on life and increase freedom of choice.
- **Emotional well-being**: Enhancing love, acceptance, tolerance and understanding.
- **Flexibility**: Cultivating openness to change and adaptability in life with increased self-empowerment and confidence.

For Families and Relationships

The technology also promises to strengthen relationships and family dynamics:

- **Compassion**: Increasing understanding, love and acceptance among family members.
- **Harmony**: Fostering a harmonious and peaceful home environment, promoting family unity and resilience.
- **Emotional Intelligence**: Enhancing emotional balance and relationship harmony for spouses, deepening love and connection.
- **Relationship Depth**: Building deeper and more rewarding relationships through improved communication and mutual trust.
- **Progeny:** Allowing children to form models of the world based on adults who are living at optimum capacity; positively influencing their epigenetic development.





2.4: Professional Value

In a rapidly evolving economy shaped by AI and automation, human skills that cannot be digitized – such as imagination, creativity, and intuition – are becoming increasingly valuable.

Thriving in this landscape will require innovation, energy, and focus to stay competitive. Genetic enhancement can release a person's latent natural abilities, providing the mental acuity, resilience and cognitive flexibility to tackle complex challenges and drive their ventures forward.

Cognitive upgrades will increase a person's capacity for creative innovation and learning new competencies; delivering a mental boost for mastering key new skill sets essential for success in the AI economy.

Greater ability to develop creative solutions to business problems will yield advantages in the workplace. Hence, the upgrades will have an economic value.





Chapter 3: Education

3.1 Delivery

This chapter examines the delivery of genetic cognitive enhancements.

Once the technology is clinically proven, a central campus of higher learning can serve as the nucleus of a holistic cognitive ecosystem.

Interconnected scientific, business and academic organizations will develop world-class best practices for excellence in genetic cognitive engineering technology and education.

The college can function as a nexus for scientific research and responsible governance, developing ethical frameworks and benchmarks in tandem with advancing the science of cognitive enhancement.



3.2 Enhancement

Cognitive gene therapies should be delivered along with comprehensive education and counseling programs to ensure candidates gain the full advantage of their upgrades.

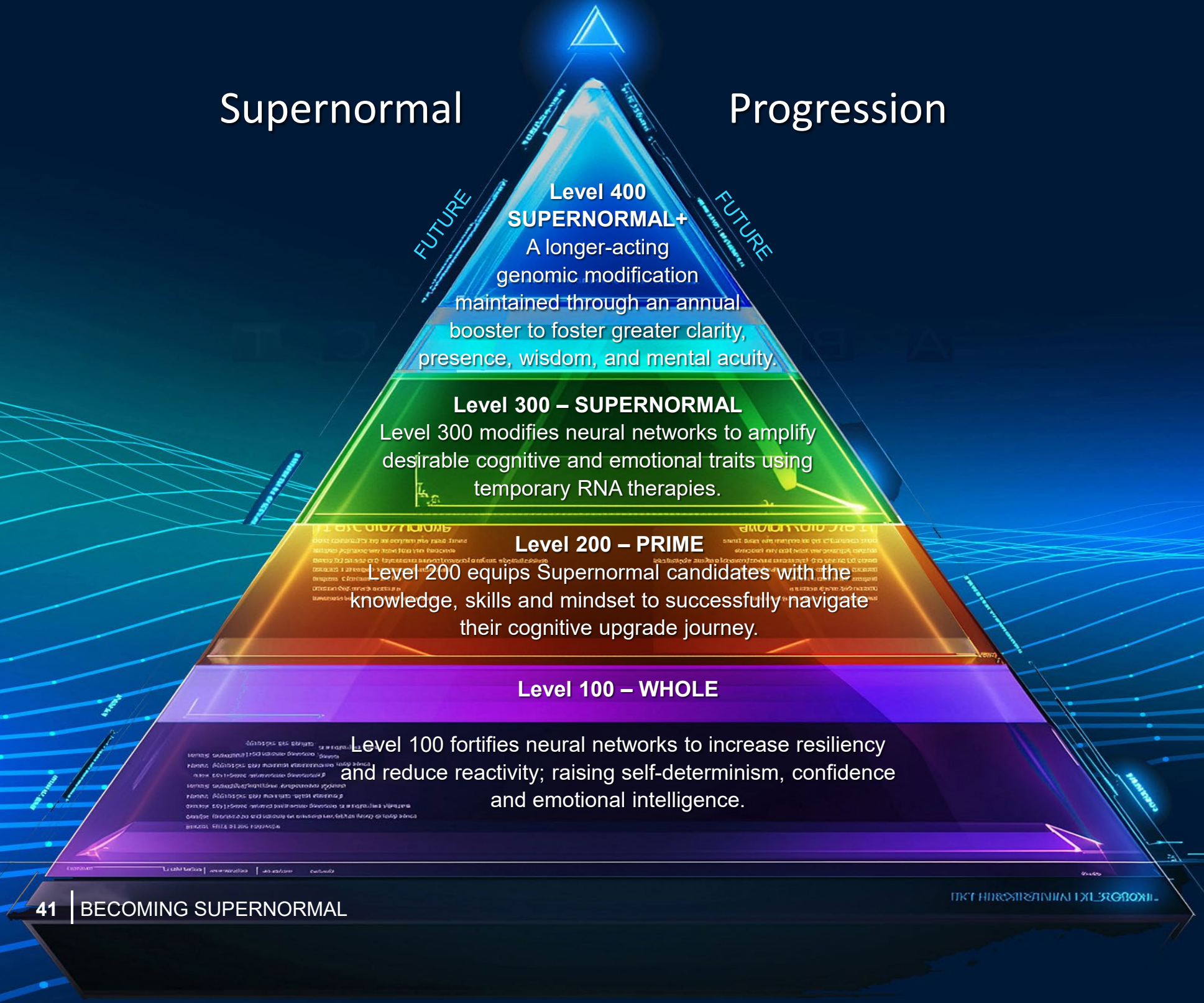
A Cognitive College can offer a mental software upgrade to maximize user benefits from enhanced neural hardware.

All services can be performed on a central campus to maintain uniform excellence in quality and support.

Cognitive College applicants will complete a series of interviews and psychological tests to verify each person's suitability for gene therapy.

The college will accept candidates with common mental health issues such as stress, anxiety and depression; but not serious conditions, such as psychiatric disorders, which could interfere with a candidate's progress. Applicants who successfully complete admissions testing will be accepted for enrollment.

Supernormal Progression



Level 100 – Whole

Balance and Resilience



Mental health therapy is a critical precursor to cognitive enhancement, clearing psychological obstacles and aligning individual goals.

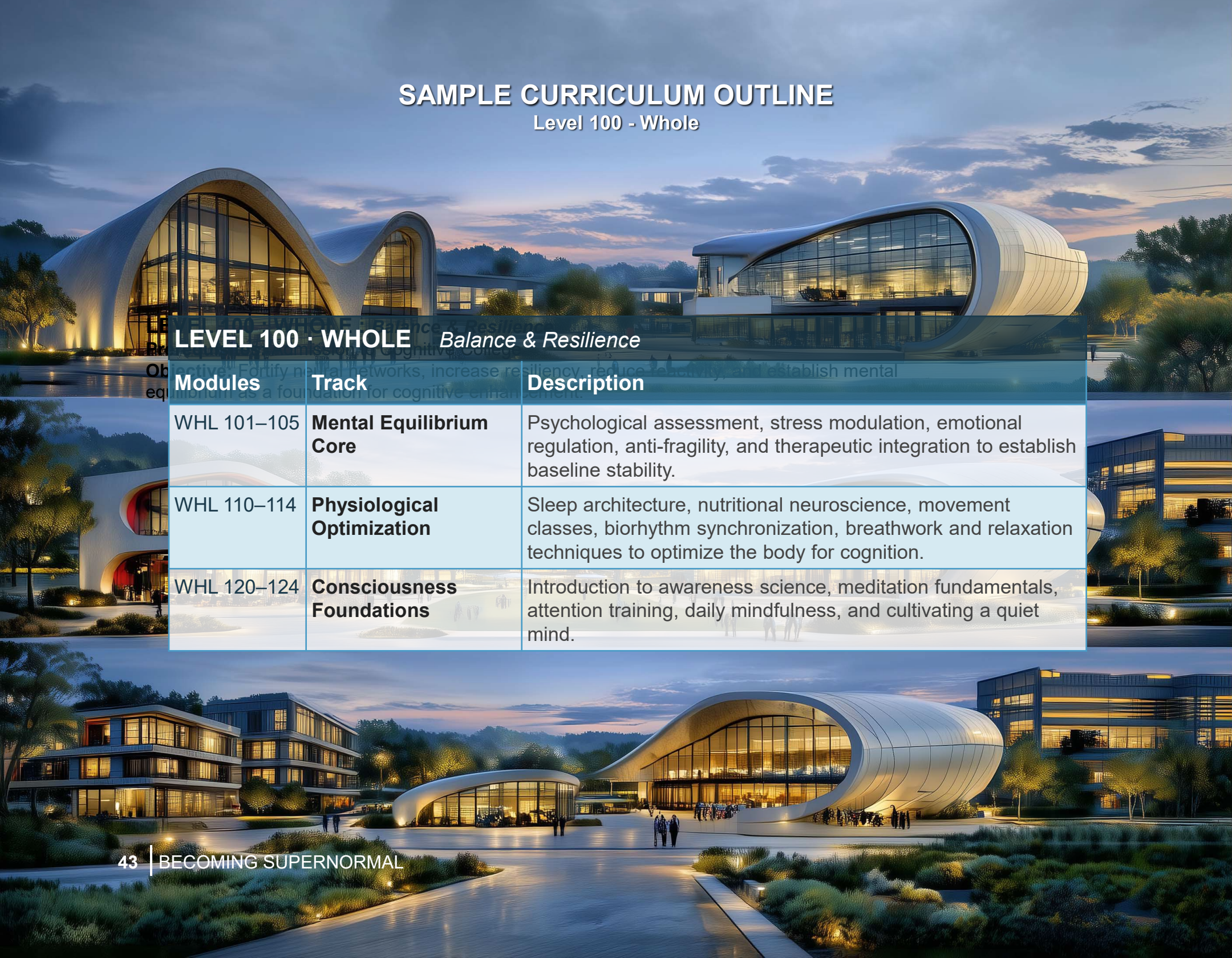
Level 100 strengthens neural function to minimize stress responses, fostering mental stability, adaptability and receptivity to transformation—key elements for cognitive advancement

Embracing boldness, love, and new experiences becomes easier—leading to greater success and fulfillment.

Ultimately, building neurological resilience and anti-fragility fosters the positive behaviors and mindsets which pave the way for sustained achievement and personal growth.

SAMPLE CURRICULUM OUTLINE

Level 100 - Whole



LEVEL 100 · WHOLE *Balance & Resilience*

Modules	Track	Description
WHL 101–105	**Mental Equilibrium Core**	Psychological assessment, stress modulation, emotional regulation, anti-fragility, and therapeutic integration to establish baseline stability.
WHL 110–114	**Physiological Optimization**	Sleep architecture, nutritional neuroscience, movement classes, biorhythm synchronization, breathwork and relaxation techniques to optimize the body for cognition.
WHL 120–124	**Consciousness Foundations**	Introduction to awareness science, meditation fundamentals, attention training, daily mindfulness, and cultivating a quiet mind.

Level 200 – Prime

Ready for Upgrade

Supernormal candidates will attend a structured education and counseling program to prepare them for genetic enhancement and equip them to achieve their personal and cognitive goals.

The Prime program aligns students for a profound life change by cultivating a growth mindset and providing actionable strategies for leveraging the enhancements for maximum benefit.



The curriculum will help students develop the requisite skills for managing living in higher states of awareness and cognitive capacity, and for translating their newfound abilities into meaningful personal growth.

It also familiarizes students with the cognitive upgrade process, its scientific foundations, and its administration protocols. Graduates will gain the expertise, abilities, and perspective to confidently embark on their cognitive enhancement journey.

SAMPLE CURRICULUM OUTLINE

Level 200 - Prime

LEVEL 200 · PRIME *Ready for Upgrade*		
Modules	**Track**	**Description**
PRM 201–206	**Inner Alignment**	Examining perceptual filters, clarifying values, restructuring beliefs, processing emotional patterns, integrating memory and identity, and cultivating openness to transformation.
PRM 210–215	**Visionary Blueprint**	Purpose discovery, goal architecture, visualization, mental rehearsal, intention setting, life design, and talent mapping to form a clear vision for enhancement.
PRM 220–224	**Empowered Action**	Priority setting, implementation science, progress monitoring, discipline and self-regulation, and sustainable practice development to convert intention into results.
PRM 230–234	**Enhancement Preparation**	Science of genetic modulation, personal neuroimaging interpretation, protocol familiarization, transition management, and ethics of enhancement.

Level 300 – Supernormal

Sustained Enhancement

Level 300 will deepen an individual's reservoir of conscious awareness and amplify desirable cognitive and emotional traits to elevate the person's quality of life and ability to contribute to society.

Supernormal RNA therapies will be delivered incrementally to gradually lift individuals into manageable states of greater awareness and mental acuity. The therapies will be effective for up to 6 months.



SAMPLE CURRICULUM OUTLINE

Level 300 – Supernormal

LEVEL 300 · SUPERNORMAL *Sustained Enhancement*		
Modules	**Track**	**Description**
SAP 301–306	**Cognitive Amplification**	Focus mastery, memory optimization, creative intelligence, learning acceleration, mental clarity, and imagination development leveraging RNA-based enhancement.
SAP 310–314	**Metacognitive Development**	Metacognition fundamentals, deepening self-awareness, advanced mindfulness, witness consciousness training, and cognitive flexibility.
SAP 320–324	**Emotional Mastery**	Enhanced emotional intelligence, optimism cultivation, emotional balance, compassion and empathy development, and managing heightened sensitivity.
SAP 330–334	**Interpersonal Excellence**	Advanced communication, relationship dynamics, conflict resolution, leadership and influence, and collaborative team intelligence.
SAP 340–344	**Integration**	Processing the enhancement experience, professional application, personal relationship navigation, life purpose actualization, and ongoing optimization protocols.

Level 400 – Supernormal +

Prolonged Enhancement

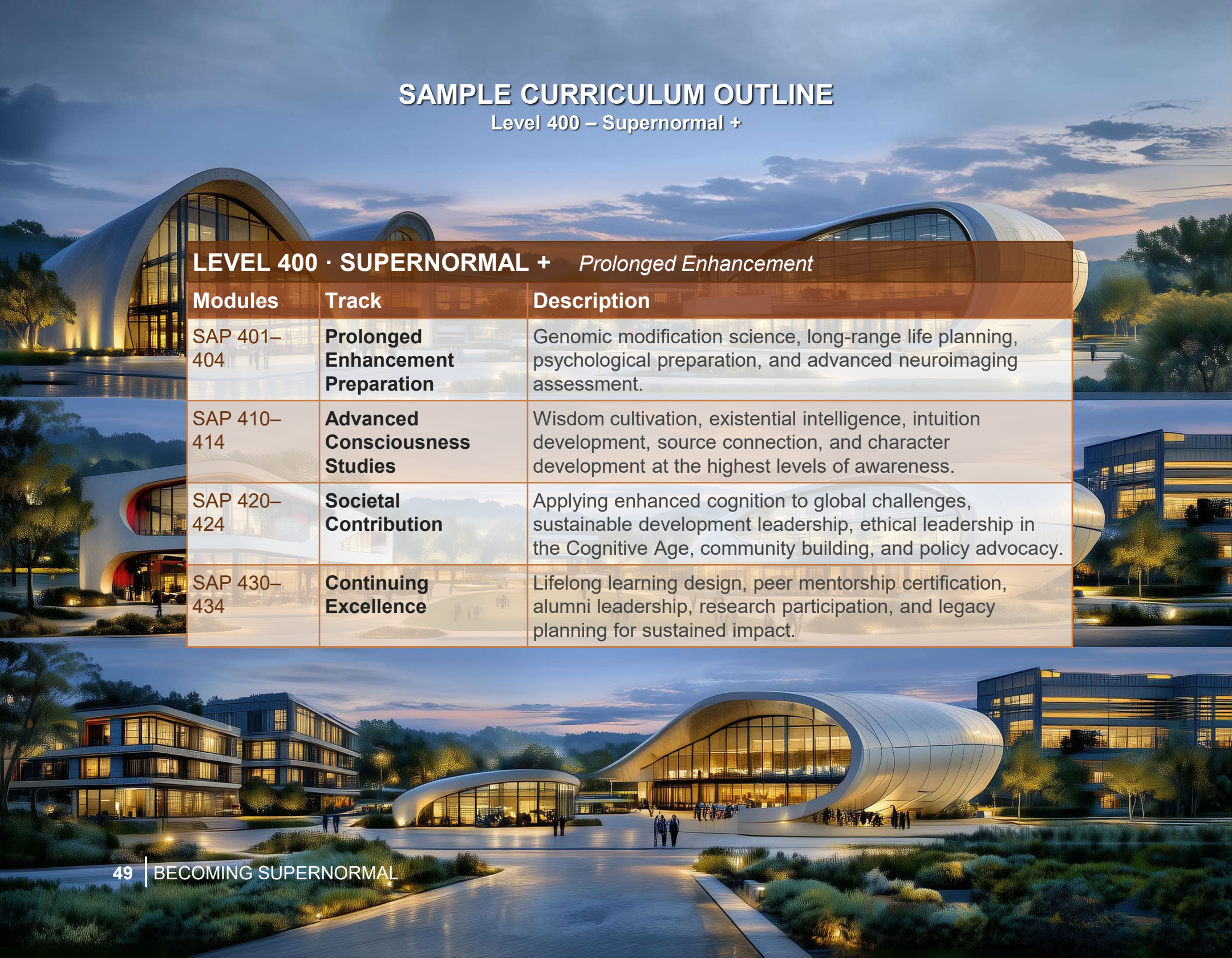
Level 400 will provide a foundational cognitive upgrade which is maintained through an annual booster. Its protocols will be released once gene therapies have become mainstream. Since Supernormals will be accustomed to cognitive enhancement, Level 400 is not expected to produce noticeable changes.

The enhancement protocol will be administered gradually in a series of stages to ensure uniform outcomes, with results verified by neuroimaging systems and psychological tests. Campus staff will conduct regular follow-ups with each Supernormal to monitor their progress and answer questions.



SAMPLE CURRICULUM OUTLINE

Level 400 – Supernormal +



LEVEL 400 · SUPERNORMAL + *Prolonged Enhancement*

Modules	Track	Description
SAP 401–404	**Prolonged Enhancement Preparation**	Genomic modification science, long-range life planning, psychological preparation, and advanced neuroimaging assessment.
SAP 410–414	**Advanced Consciousness Studies**	Wisdom cultivation, existential intelligence, intuition development, source connection, and character development at the highest levels of awareness.
SAP 420–424	**Societal Contribution**	Applying enhanced cognition to global challenges, sustainable development leadership, ethical leadership in the Cognitive Age, community building, and policy advocacy.
SAP 430–434	**Continuing Excellence**	Lifelong learning design, peer mentorship certification, alumni leadership, research participation, and legacy planning for sustained impact.

SAMPLE CURRICULUM OUTLINE

Elective Courses

ELECTIVES *Cross-Level Enrichment*		
Modules	**Track**	**Description**
PRO 501–505	**Professional Development**	AI-era skill navigation, innovation and entrepreneurship, knowledge work optimization, creative professional practice, and strategic thinking.
SCI 510–515	**Awareness Science**	Metacognitive neurophysics, neural electrodynamics, brainwave dynamics, receptor biology, and consciousness science survey.
CON 520–524	**Contemplative Practice**	Advanced meditation retreat, concentration mastery, open awareness practice, body-based practices, and contemplative science.
HLT 530–534	**Health & Performance**	Advanced sleep optimization, cognitive nutrition, movement for neurogenesis, stress inoculation training, and longevity and brain aging.
REL 540–544	**Relationship Competencies**	Deep listening, interpersonal harmony, family systems navigation, intimate partnership enhancement, community leadership, and cross-cultural intelligence.
TEC 540–544	**Enhancement Technologies**	Genetic cognitive enhancement, transcranial magnetic stimulation, focused ultrasound neuromodulation, neural interfaces, and psychedelic neurochemistry.





Cognitive upgrades are expected to be transformative for many people. Supernormals may experience positive shifts in awareness, personality, outlook, values, relationships, and professional interests.

Supernormals may return to campus for continuing education programs to refine their consciousness management skills and join other graduates for networking and support. Participants will share their life experiences with others in classroom settings and receive expert guidance on optimizing their performance.







Local community alumnae groups will help Supernormals navigate changes, integrate growth, exchange insights, and remain connected with their peers.

Supernormal Human Value



A Supernormal transformation could potentially unlock a constellation of 12 desirable mental and emotional traits which accompany greater conscious awareness.



Many of these traits will arise from Supernormals having greater cognitive capital at their disposal. Others are a result of the genetic upgrade's unique mechanisms of action in neuroanatomy.



These benefits can cascade through multiple neural systems, reinforce one another, and compound over time.

Restoring Natural Abilities



HTR2A

Master Control Switch

The **12 Supernormal** benefits can be generated by changing the expression of a single gene.

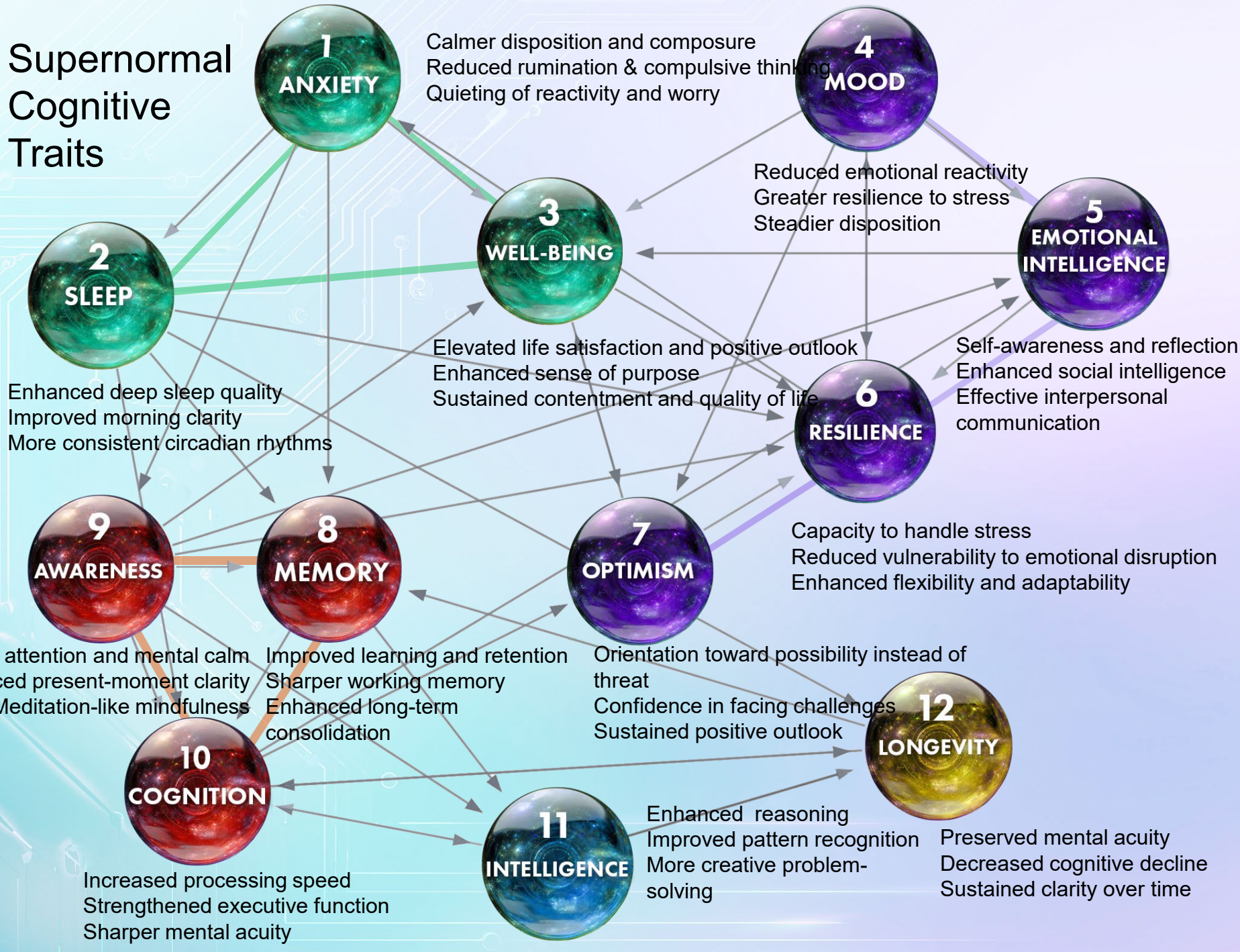
Gene **HTR2A** is a master control switch that regulates how the brain's cortical and limbic circuits process cognitive information.

This gene's expression can be modified to adjust the **electrical properties of neurons** to optimize mental performance and emotional balance.

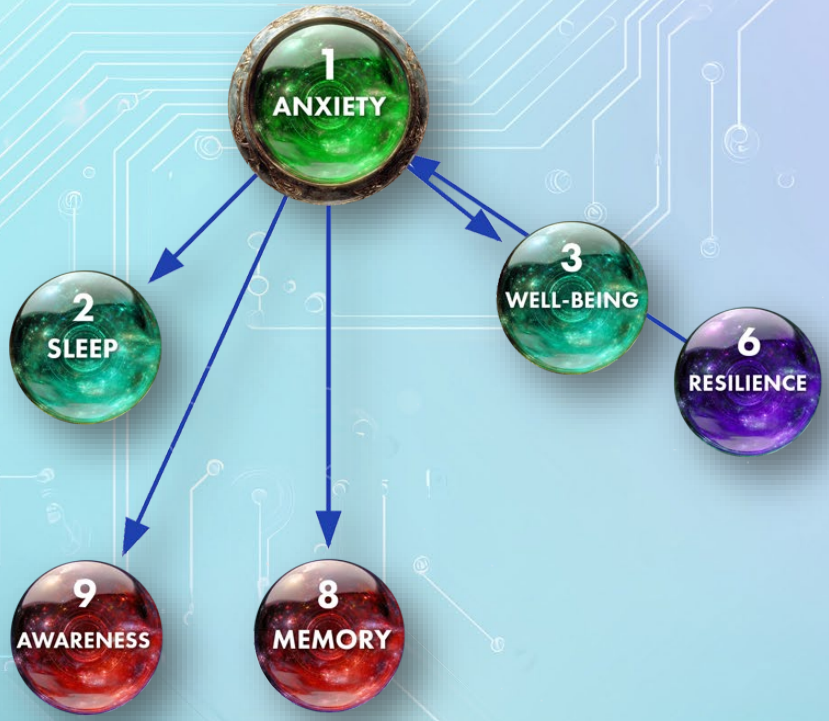
These changes can yield **5 clusters** of interconnected and mutually reinforcing virtuous cognitive traits.



Supernormal Cognitive Traits



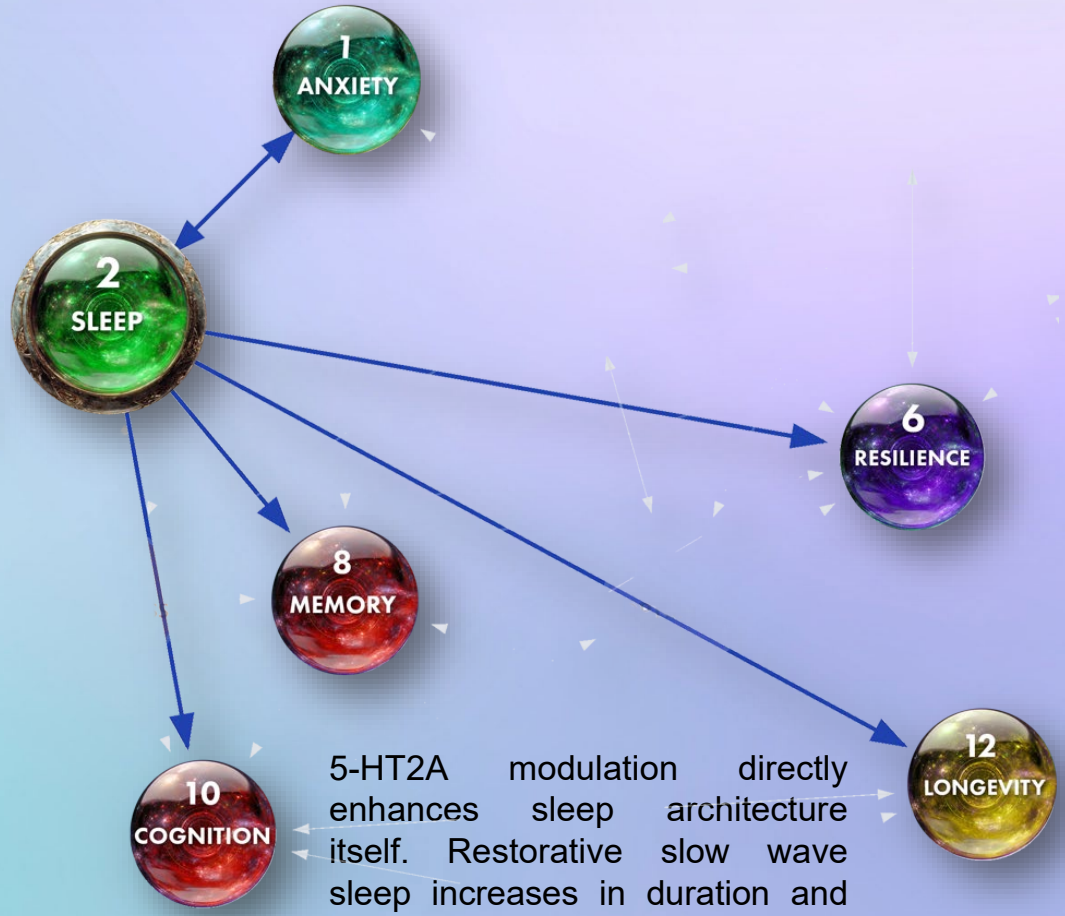
1	Reduced Anxiety	
	Affected by: Resilience	**Affects:** Sleep, Memory, Awareness, Well-Being



Preclinical studies downregulating HTR2A expression show a reduction in anxiety-related behaviors without sedative effects on motor function or alertness.

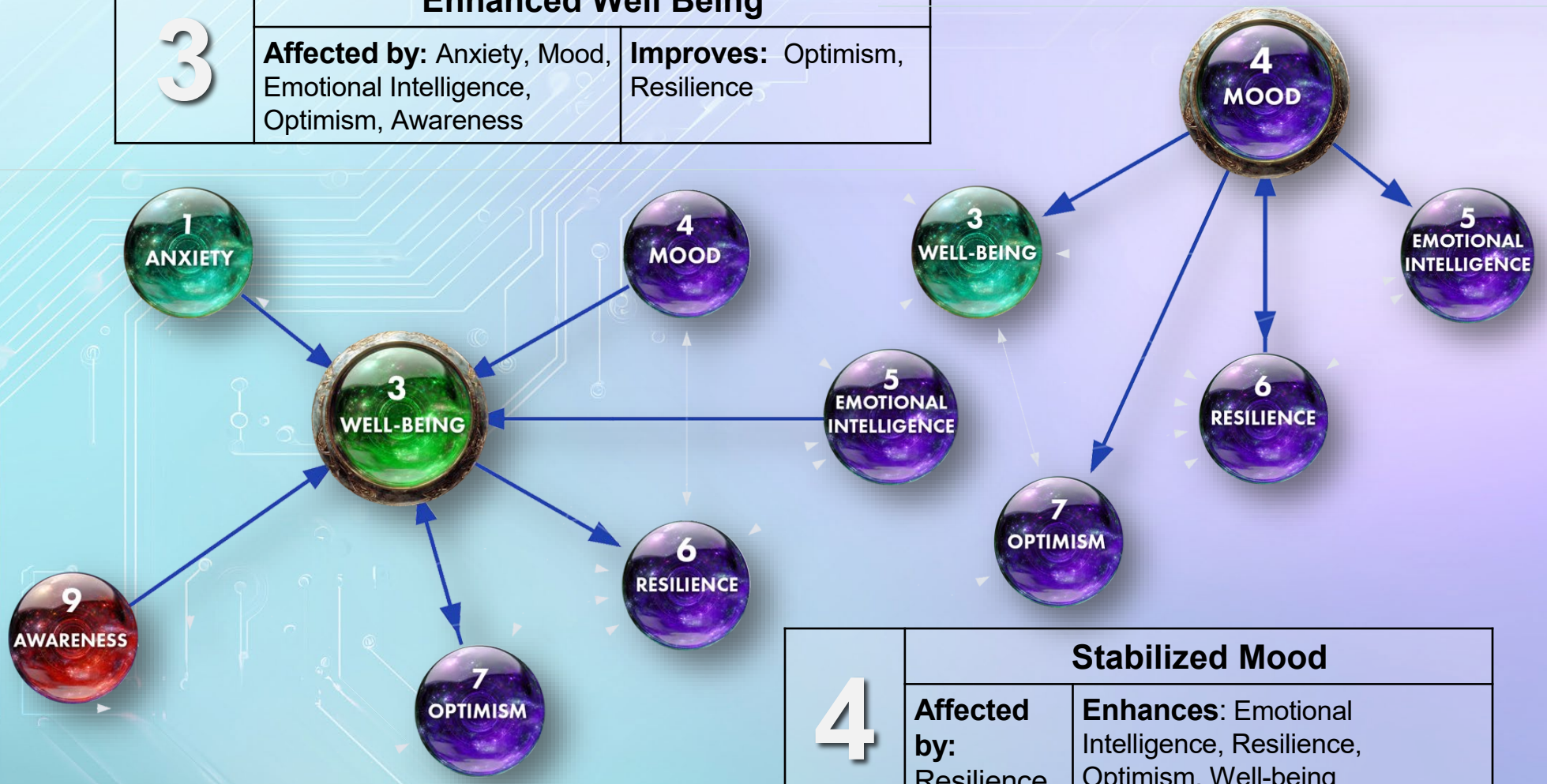
The improvement reflects a genuine quieting of the neural circuits that generate excessive worry, rumination, and threat vigilance.

2	Improved Sleep	
	Affected by: Anxiety	**Strengthens:** Memory, Cognition, Emotional Resilience, Longevity



5-HT2A modulation directly enhances sleep architecture itself. Restorative slow wave sleep increases in duration and quality, improving memory consolidation and cellular repair. Nighttime awakenings decrease and morning cognition improves.

3	Enhanced Well Being	
	Affected by: Anxiety, Mood, Emotional Intelligence, Optimism, Awareness	**Improves:** Optimism, Resilience



Well-being encompasses life satisfaction, positive outlook, and sense of purpose. Cognitive neuroengineering addresses the neural substrates of well-being directly, producing persistent improvements from genuine changes in brain function.

4	Stabilized Mood	
	Affected by: Resilience	**Enhances**: Emotional Intelligence, Resilience, Optimism, Well-being

Multiple neuroimaging studies correlate depression with the neural characteristics of elevated HTR2A expression.

Conventional antidepressants address this issue indirectly and imprecisely by changing global brain chemistry, often causing intolerable side effects.

Cognitive neuroengineering can produce results directly with great precision, stabilizing mood, increasing resilience and decreasing reactivity.

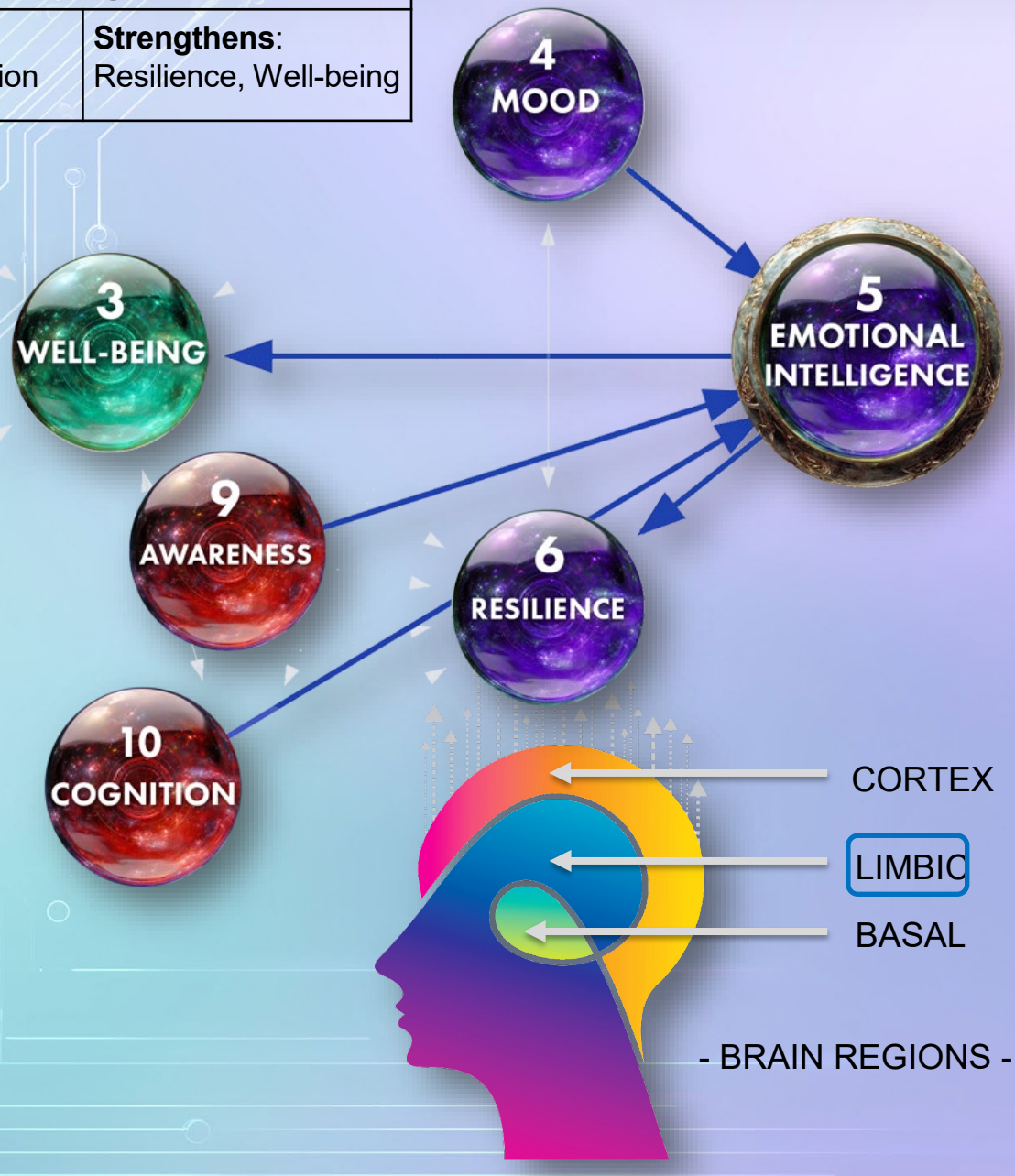
5	Emotional Intelligence	
	Enhanced by: Mood, Awareness, Cognitive Function	**Strengthens**: Resilience, Well-being

The ability to perceive, understand, and regulate personal and interpersonal emotional states is the hallmark of emotional intelligence.

This capacity depends on the limbic system functioning within optimal parameters.

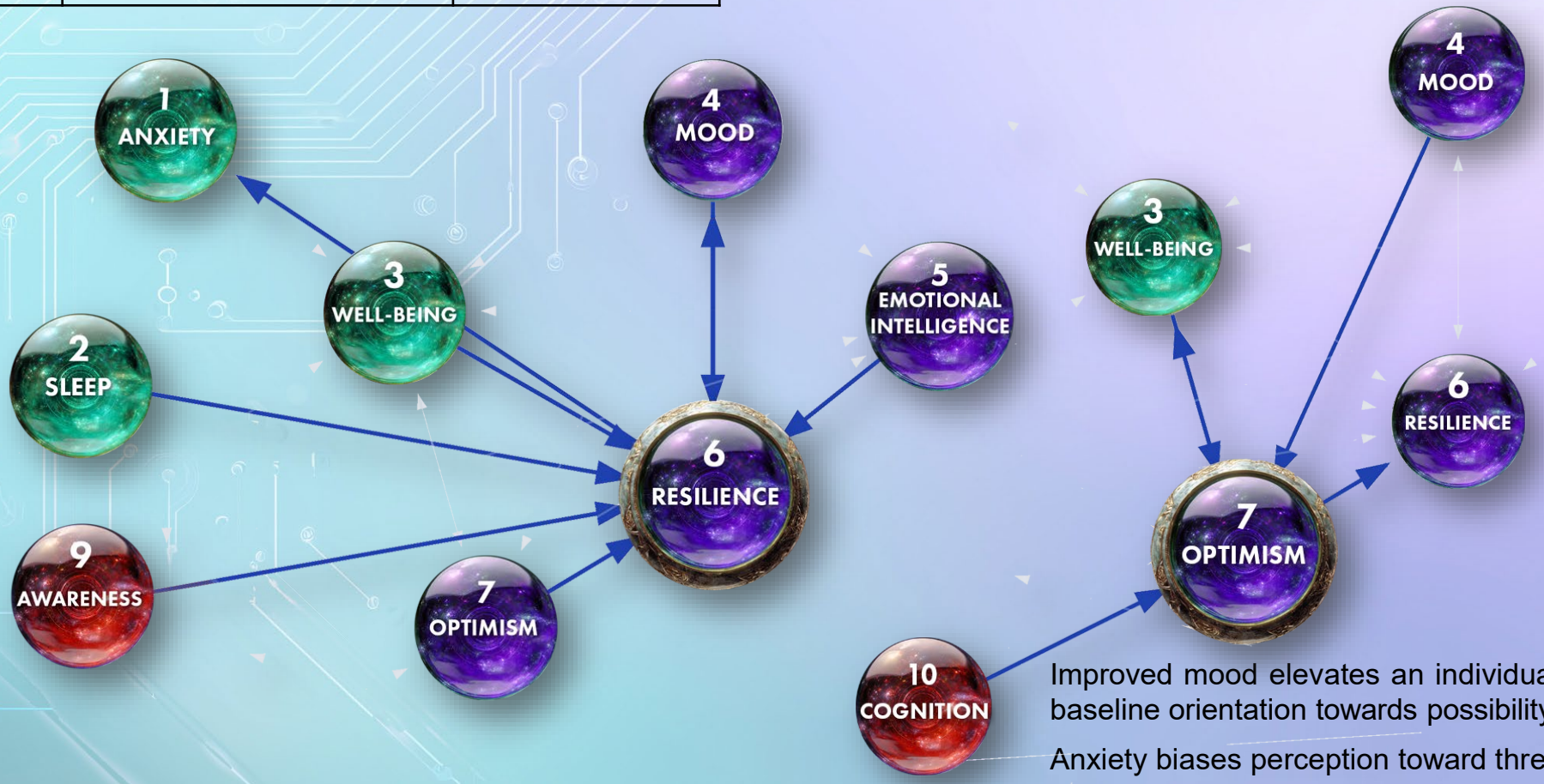
Chronic limbic hyperactivation, characteristic of anxiety and mood disorders, impairs emotional discernment.

Normalizing limbic activity restores the nuanced emotional perception that underlies social intelligence and interpersonal effectiveness.



6	Fortified Resilience	
	Enhanced by: Sleep, Well-being, Mood, Emotional IQ, Optimism, Awareness	**Effects**: Reduces Anxiety, Stabilizes Mood

7	Increased Optimism	
	Enhanced by: Well-being, Mood, Cognition	**Affects:** Well-being, Resilience



Resilience reflects the capacity to encounter stress while maintaining equilibrium.

Cognitive neuroengineering can strengthen resilience through 3 mechanisms which promote flexibility and adaptability:

a) reduced baseline anxiety lowers vulnerability.

b) normalized stress hormones prevent cortisol damage;

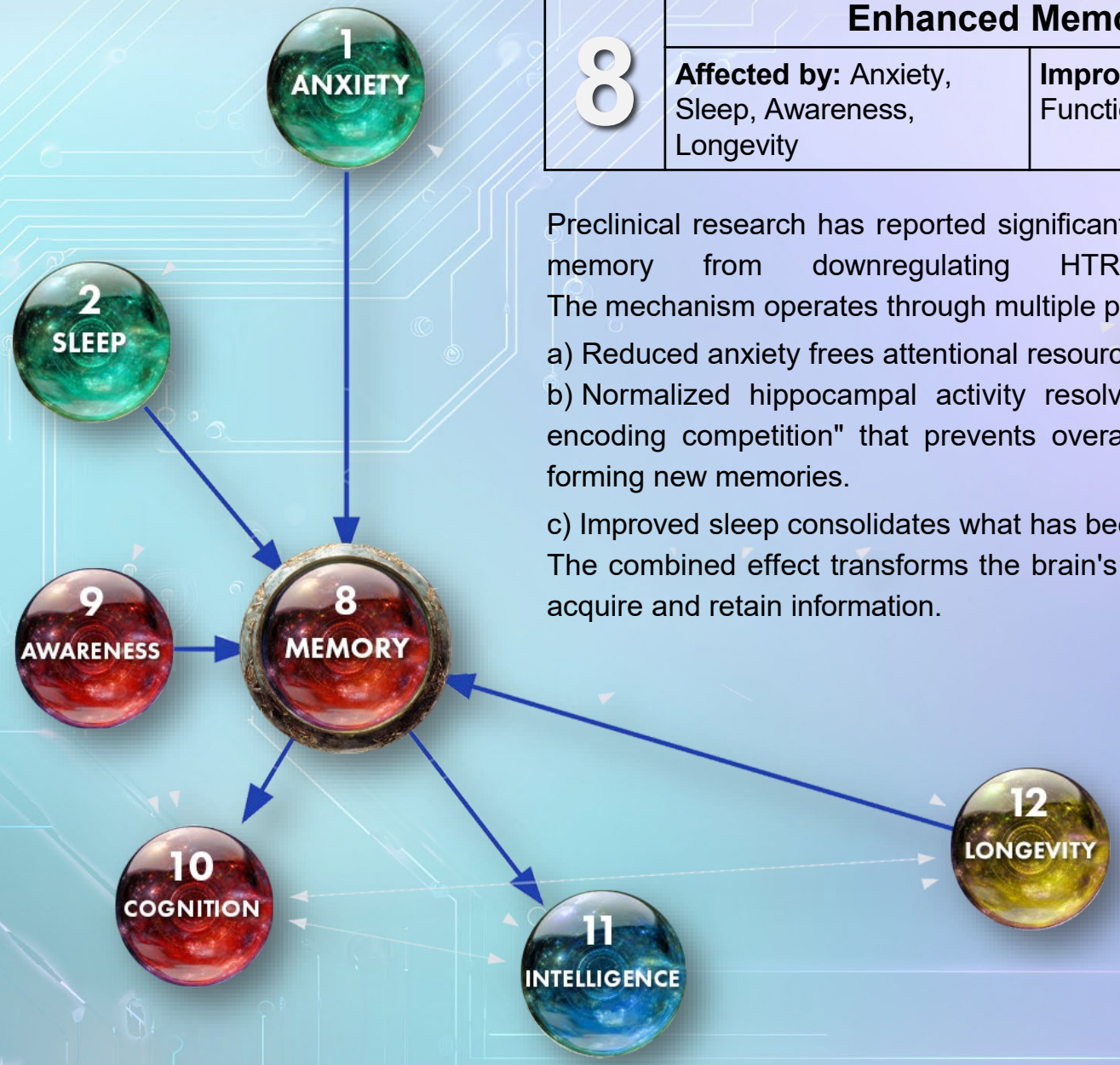
c) improved sleep enhances recovery from daily challenges.

Improved mood elevates an individual's baseline orientation towards possibility.

Anxiety biases perception toward threat; its reduction permits a more balanced appraisal of circumstances.

Enhanced cognitive function supports the problem-solving that transforms challenges into opportunities.

Optimism emerges naturally when the neural obstacles to its expression are removed.



8	Enhanced Memory	
	Affected by: Anxiety, Sleep, Awareness, Longevity	**Improves:** Cognitive Function, Intelligence

Preclinical research has reported significant improvements in memory from downregulating HTR2A expression. The mechanism operates through multiple pathways:

a) Reduced anxiety frees attentional resources for encoding.

b) Normalized hippocampal activity resolves the "retrieval-encoding competition" that prevents overactive brains from forming new memories.

c) Improved sleep consolidates what has been learned.

The combined effect transforms the brain's capacity to acquire and retain information.

9	Heightened Awareness	
	Affected by: Anxiety	**Affects:** Memory, Cognition, Intelligence, Emotional IQ, Resilience, Well-being.





DEFAULT MODE NETWORK

Extensive meditation research shows reduced **default mode network** activity correlates with enhanced mindfulness and metacognitive clarity.

Targeted HRT2A downregulation can lower brain activity in this network towards the patterns characteristic of experienced meditators.

Human genetic studies confirm that individuals with naturally lower HTR2A expression demonstrate superior attentional performance.

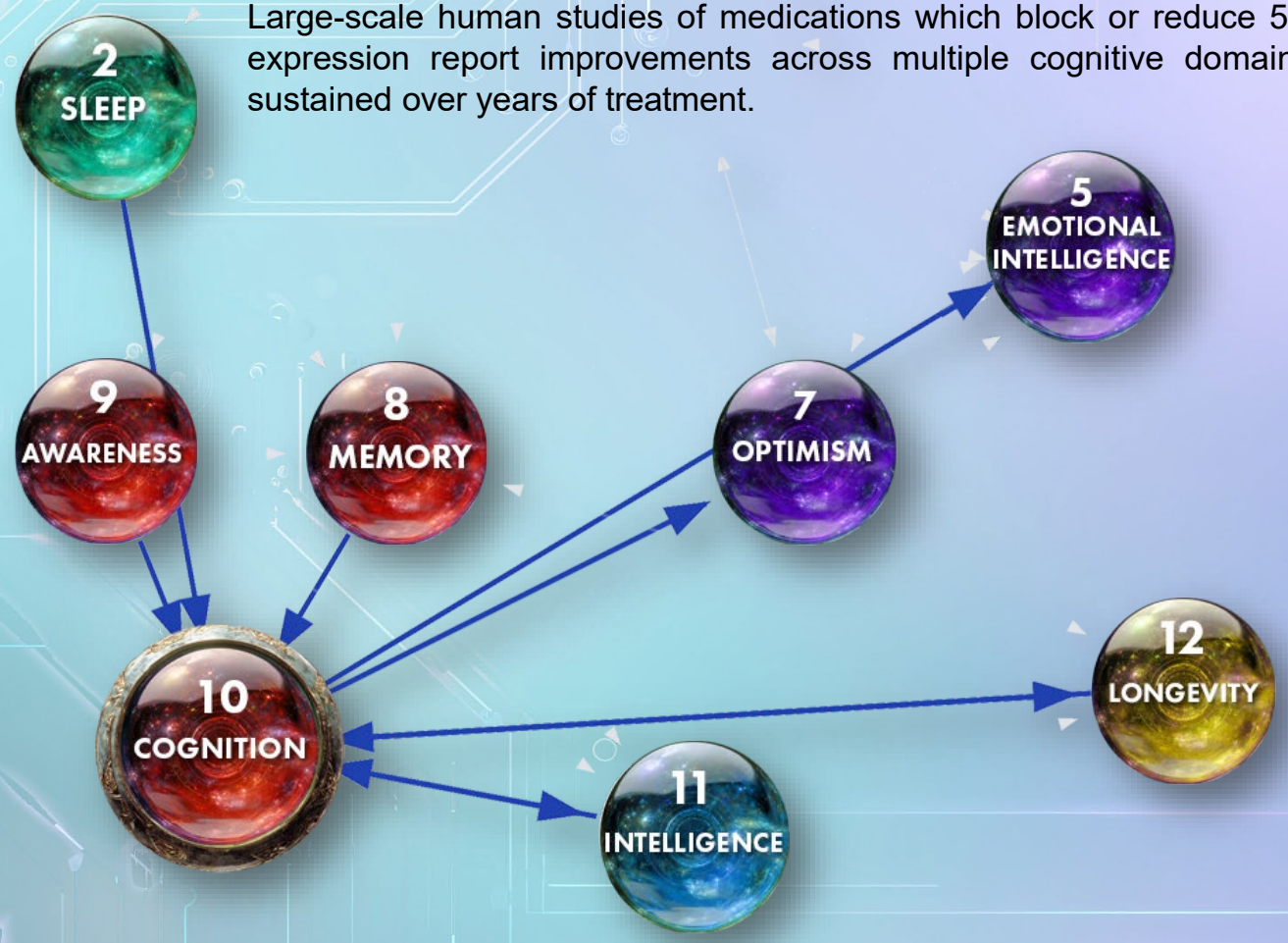
Gene HTR2A controls the expression of a **neuron receptor** called 5-HT2A which modulates signal-to-noise ratio in neural circuits. When this receptor's activity is elevated, neural noise increases and attention diminishes. Reducing this activity by downregulating HTR2A can produce cleaner signals, better filtering of distractions, and improved focus.

NEURON RECEPTORS

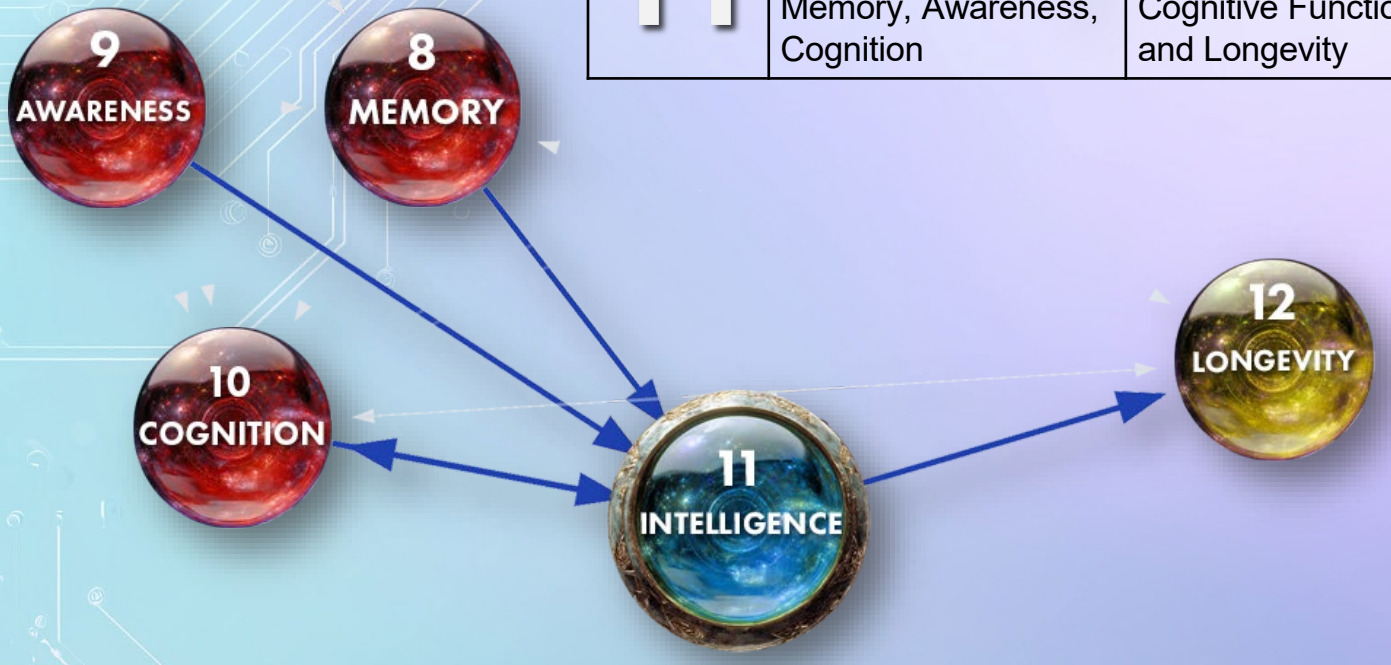
10	Cognitive Function	
	Affected by: Sleep, Memory, Awareness, Intelligence, Longevity	**Affects:** Intelligence, Emotional IQ, Longevity, Optimism

HTR2A modulation can improve overall cognitive efficiency on a global level, increasing processing speed, strengthening executive function and expanding verbal fluency.

Large-scale human studies of medications which block or reduce 5-HT2A receptor expression report improvements across multiple cognitive domains, with effects sustained over years of treatment.



11	Higher Intelligence	
	Enhanced by: Memory, Awareness, Cognition	**Supports:** Cognitive Function and Longevity



Intelligence correlates with the neural capacity to efficiently accomplish cognitive work with minimal metabolic expenditure.

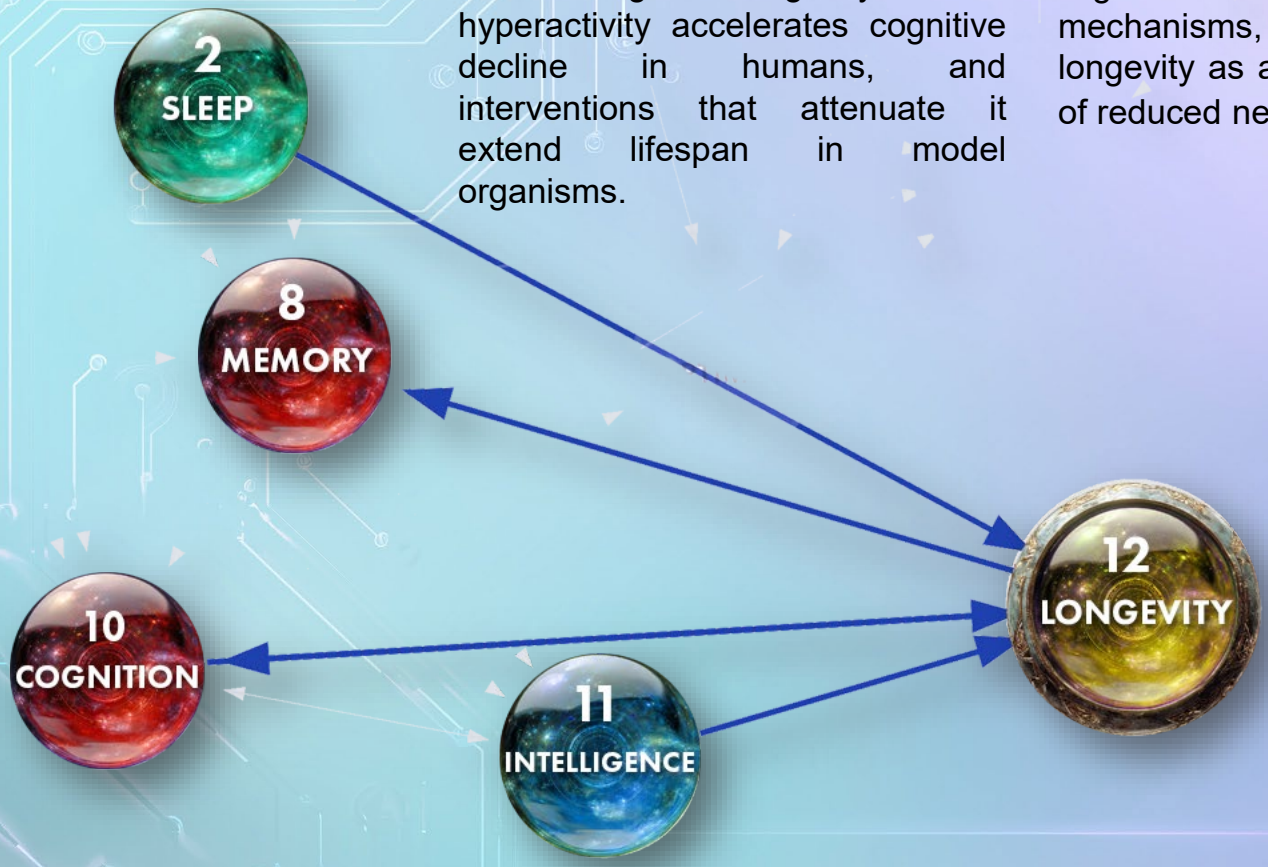
Higher intelligence is associated with lower neural dendritic density and reduced glucose consumption during cognitive tasks.

Selectively reducing HTR2A expression can optimize neural architecture toward this efficient configuration, enhancing the brain's capacity for abstract reasoning, pattern recognition, and problem-solving.

12	Cognitive Longevity	
	Enhances: Cognition, Memory	**Supported by:** Sleep, Cognition, Intelligence

Reduced neural excitation is a key factor in cognitive longevity. Neural hyperactivity accelerates cognitive decline in humans, and interventions that attenuate it extend lifespan in model organisms.

Targeted HTR2A downregulation aligns with these fundamental mechanisms, positioning cognitive longevity as a predictable outcome of reduced neural excitation.





5.1: Supernormal Community

In its ideal form, a Supernormal community will be bound by shared values, including authenticity, integrity, and ethical leadership. These common principles will foster a culture of mutual respect and collaboration.

The Supernormal journey will foster a profound shift in identity. Supernormals will view themselves as pioneers of a new human epoch, driven by purpose and responsibility. This elevated sense of role will encourage them to act as stewards of humanity's collective future and leaders in their respective fields.

By aligning individual goals with collective action, this community has the potential to reshape industries, influence global governance, and redefine what it means to thrive in the modern world.

5.2: Social Impact

5.2.1: New Skills for the AI Era

As society migrates to an AI economy, the foundations of human livelihood are shifting.

Human traits rewarded in the Industrial and Information Ages are giving way to new skills that will define the Cognitive Age.

Pre-AI Economy	AI Economy
Industrial + Information Age	*Cognitive Age*
Speed, compliance, endurance	Imagination, insight, presence
Memorization, repetition	Empathy, curiosity, intuition
Linear problem-solving	Cross-domain synthesis, originality
Technical mastery	Self-awareness, adaptability

The AI era requires more imagination, creativity, and human connection. Society will increasingly prioritize these inner qualities over external productivity.









5.2.2: The Changing Nature of Work

Now that developed nations have entered the AI era, companies are shedding millions of jobs.

In past transitions from agriculture to industry, or from industry to services, new domains of purpose, value, and economic activity arose, even if they were hard to predict in advance.

Similarly, the AI economy is fostering entirely new human enterprises, such as:

- Purpose-based microenterprises and creator guilds
- Consciousness and well-being industries
- Regenerative environmental work
- Experience economy (beyond entertainment)
- Exploration (space, deep sea, consciousness)
- Scientific and artistic frontier work

In short, livelihoods will continue to evolve, even if “jobs” as we know them are shrinking.

5.2.3: Strategic Cognitive Skills

Trait	How It Adds Value in the New Economy
Imagination	Designing new realities, businesses, lifestyles, or art forms that AI cannot originate.
Creativity	Synthesizing across domains to generate novel ideas, solutions, and visions.
Metacognition	Monitoring and improving one's own thinking—essential for innovation and self-directed learning.
Emotional Intelligence	Navigating human dynamics in caregiving, leadership, teaching, and community building.
Interpersonal Resonance	Deep listening, mentoring, coaching, spiritual guidance—areas AI cannot replicate.
Intuition	Making meaningful decisions under uncertainty, where data is incomplete.
Presence & Awareness	Vital for roles in well-being, mindfulness, coaching, and the inner development economy.

Cognitive traits reflecting uniquely human abilities that artificial systems cannot replicate will define success in a world where intelligence is ambient and ubiquitous.







5.2.4: Socio-Economic Benefits

Area	Enhancement Benefit	Strategic Outcome
Education & Retraining	Faster skill acquisition	Easier transition to new livelihood domains
Microenterprise & Innovation	Original ideas and clarity	Rise of high-impact, self-created livelihoods
Community Leadership	Emotional balance + understanding	Local governance, mediation, and trust-based economies
Creative Professions	Fluidity + imagination	Dominance in art, design, media, experience curation
Self-Healing & Well-Being Roles	Self-awareness + presence	Emergence of a scalable inner development sector







Economic benefits accrue from desirable cognitive competencies, and cognitive upgrades will become essential for social and economic transition.

5.2.5: Human Capital Transformation

Genetic and behavioral cognitive enhancement technologies can unlock this new class of traits by accelerating learning, deepening interpersonal connection, and supporting self-mastery. For example: →

- Increased cognitive flexibility for rapid upskilling
- Reduced anxiety for clearer decision-making
- Improved focus for creative and strategic work
- Heightened attunement for collaborative or healing roles
- Access to flow states for fulfillment and productivity

Once a privilege, literacy is now a human right. In the future, cognitive literacy and enhancement may be treated the same way: a public good needed to unlock society's full potential.

Investing in technologies and platforms that promote mental acuity, emotional intelligence and self-awareness can build a human human cognitive substrate that will support thriving in the AI economy.







5.3: Global Impact

Supernormals will be uniquely equipped to tackle humanity's most pressing challenges. Their enhanced cognitive and emotional abilities will support them in leading sustainable development, resource management, and equitable economic growth. By deploying cognitive capital into these areas, Supernormals can serve as catalysts for systemic change.





Cognitive enhancement can catalyze conscious values and new behaviors that are more closely aligned with holistic ecology models and sustainable development goals.

At high levels, this change can shift capital flows to collateralize deep impact initiatives supporting these objectives.

The broader implications of cognitive enhancement extend to global challenges.

To address climate change and other existential threats, humanity requires a level of consciousness current methods cannot achieve at scale.

Supernormals represent a scalable solution — a community capable of thinking and acting with unprecedented clarity, creativity, and moral insight.



5.4: Legacy

Cognitive enhancement holds the promise of humanity's next great chapter. By unlocking latent cognitive capacities, Super-normals can pave the way for achieving milestones that were once thought impossible.

Colonizing the solar system, resolving global conflicts, and achieving ecological balance are no longer unattainable dreams but tangible goals within reach.





5.5: Catalyzing Cognitive Change

In a world where the boundaries of human cognition are being redrawn, we stand at the threshold of a cardinal transformation.

Current genetic technology coupled with the neuro-modulation techniques described in this book can recalibrate neural networks to unlock dormant cognitive potential.

These breakthroughs demand a translation into practice. The time has come to mobilize the expertise and build the infrastructure required to elevate human cognition. A strategic plan for progress follows on the next page.



THE SUPERNORMAL INITIATIVE

1. *Form a Board of Trustees:* Assemble a visionary board comprising leaders with multidisciplinary skills to guide the nascent Cognitive College through the intersections of technology, education and policy.

2. *Develop Policies:* Draft robust policies to govern research ethics, data security, college administration, faculty recruitment, admissions and clinical applications.

3. *Hire Staff:* Recruit a dedicated team of scientists, clinicians, educators, and administrators who share the vision of a cognitive renaissance.

4. *Advance Genetic Technology:* Invest in leading-edge research to transition cognitive gene therapies from the laboratory and clinic into the public domain. Continuously refine genetic methods for optimizing cognitive function.

5. *Build an Online Community:* Develop a state-of-the-art web platform to serve as an interactive forum for global collaboration, continuous dialogue, data sharing and rapid dissemination of breakthroughs.



6. Initiate Conferences: Launch a series of high-profile conferences which bring together influential thought leaders, researchers and policymakers. These gatherings can disseminate knowledge and foster the relationships necessary for rapid innovation.

7. Develop a Curriculum: Begin crafting an interdisciplinary curriculum, starting with the education program and therapeutic protocols for Level 100: Whole.

8. Build a Blockchain: Establish a secure cognitive enhancement blockchain registry to provide auditability and quality control by tracking manufacturing, clinical delivery and user outcomes.

9. Issue a Token: Democratize access to the technology with a token, allowing early adopters and micro-investors to benefit as the token appreciates. Create a donor-supported scholarship fund which tokenizes member participation in conferences and events.

10. Buy Land and Break Ground: Secure a physical campus to serve as the epicenter of cognitive innovation where research, education and practical application converge to create transformative experiences.

5.6: Leading Transformation

Influential individuals, policymakers, and thought leaders are the prime movers in this grand vision. Their engagement is crucial in three ways:

Investing in the Vision:

Allocating intellectual and financial resources to research and development programs to bring these ideas from the lab to everyday life.





Championing Change:

Advocating for policies that support cognitive enhancement research and the ethical application of genetic neuro-modulation technologies.

Leading by Example:

Participating in inaugural conferences, contributing to curriculum development, and building the leadership network that will redefine the future of human cognition.



A Defining Moment

The journey from engineering theory to practical application is often challenging, yet the rewards here are immense. Embracing these initiatives can usher in a new era where cognitive enhancement is not a luxury, but a cornerstone of human evolution.

The scientific evidence and visionary insights detailed in this foundational text provide both inspiration and direction. The blueprint is ready—now is the time to build, innovate, and transform.

Working together, we can break new ground in the science of consciousness and lay the foundation for a future where human potential is limitless.



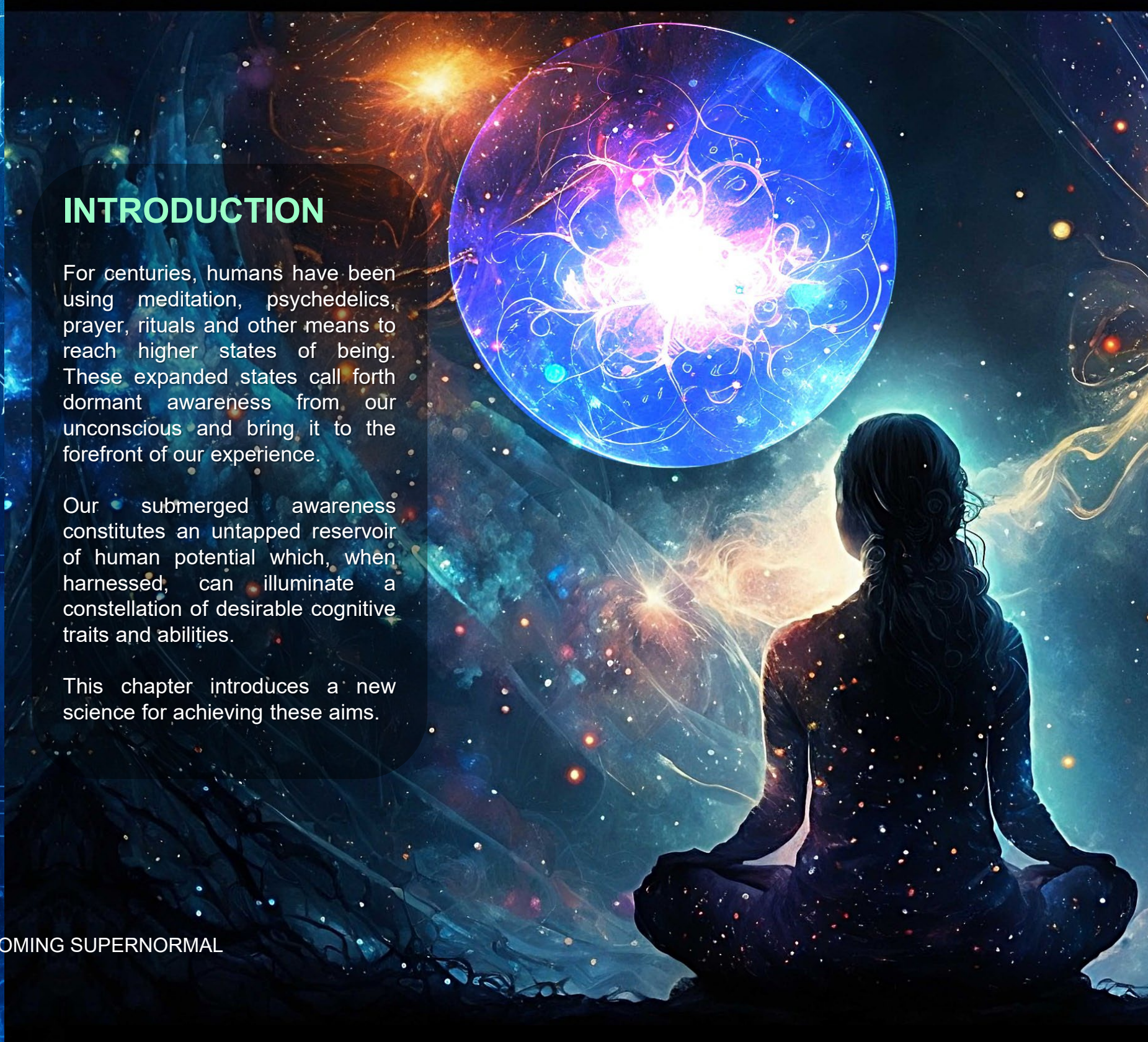
Chapter 5: First Principles

INTRODUCTION

For centuries, humans have been using meditation, psychedelics, prayer, rituals and other means to reach higher states of being. These expanded states call forth dormant awareness from our unconscious and bring it to the forefront of our experience.

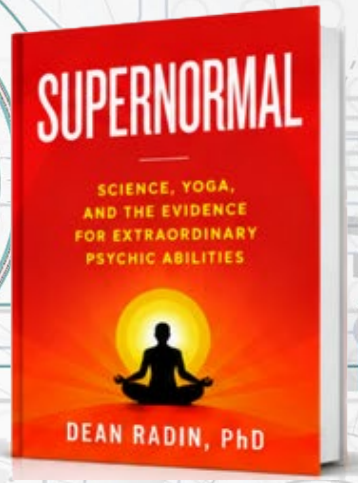
Our submerged awareness constitutes an untapped reservoir of human potential which, when harnessed, can illuminate a constellation of desirable cognitive traits and abilities.

This chapter introduces a new science for achieving these aims.



Discovery of First Principles

From Supernormal to a theory of enhanced cognition











1 OBSERVATION → **2 COLLABORATION** → **3 THEORY**

The following theory arose out of a collaboration between the authors which began after the publication of Dean Radin's third book, *Supernormal* (Deepak Chopra Books, 2013). The book presents evidence that meditation increases psi abilities (ESP). Psi abilities are characteristic of non-local consciousness.

Meditation is known to downshift brainwave activity into the lower-frequency alpha and theta states. Meditators in these states demonstrate stronger psi abilities, linking greater non-local consciousness to reduced brainwave activity.

Based on these insights, the authors began developing a theory for explaining the mind/matter interface to provide a scientific basis for enhancing human cognition.

They reasoned that if non-local consciousness has no wavelength, and if higher states of consciousness and cognitive ability have a greater non-local component, then these expanded states should be correlated with reduced brainwave activity, as *Supernormal* implies.



From Evidence to Translation

Scientific support, engineering, and progress toward human application



4 EVIDENCE

A literature search revealed a large body of scientific evidence indicating that conscious attention and cognitive capacity expand when brainwave activity is attenuated. Numerous other scientific experiments surfaced which correlated brainwave frequencies with reduced stress. They hypothesized that downregulating neuronal excitability could enhance cognition.

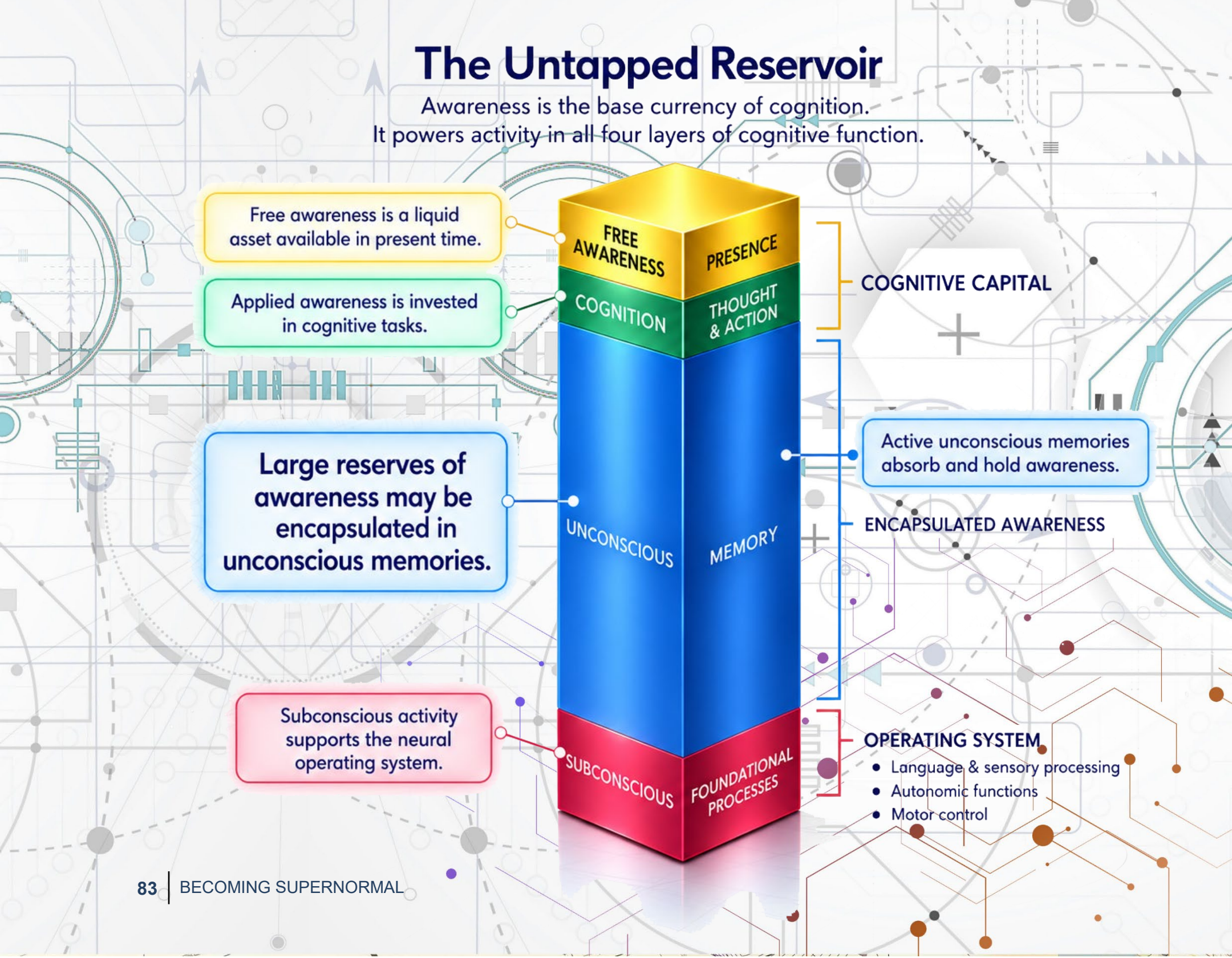
5 ENGINEERING

In 2016, Mee and Radin began developing methods to use genetic editing tools to lower brainwave activity toward the more desirable alpha and theta brainwave states. Their method reduces a neuron's excitability by altering its electrical properties. The modified neuron fires less often, shifting brainwaves towards lower frequencies. They filed the initial patents in 2018 and incorporated a company in 2019. Their preclinical research was published in 2024 and the program is advancing towards human clinical trials.

6 TRANSLATION

The Untapped Reservoir

Awareness is the base currency of cognition.
It powers activity in all four layers of cognitive function.



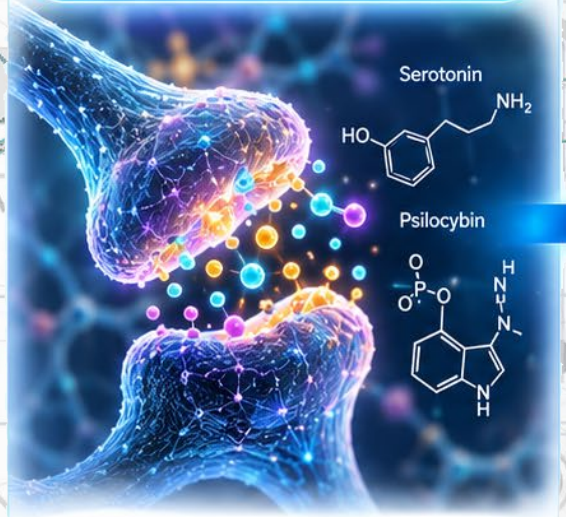
How do we tap the reservoir?

From chemistry to neurophysics.

1

CLASSICAL APPROACH

Psychedelic Neurochemistry



Classically, awareness has been restored to consciousness through psychedelic neurochemistry.

2

SHIFT IN LENS



What if we approach the problem from a different angle, and view it through the lens of neurophysics?

3

NEUROPHYSICS PERSPECTIVE

Neuronal Electrical Behavior



Shifting the focus from conventional molecular biology to neuronal electrical behavior allows us to explore the question:

Is there an electrodynamic relationship between awareness and neural circuit activity?

Conventional Molecular Biology → Neuronal Electrical Behavior

Summary

The first principles form the foundation for cognitive neuroengineering methods for enhancing consciousness by modifying a master control switch, gene HTR2A. Genetic engineering supplies the enabling RNA technology to change this gene's influence.

The unconscious is a reservoir of untapped cognitive potential which is encapsulated by excess neural activity. Lowering HTR2A expression reduces this activity and unlocks a subset of the reservoir. Capacity that was unconscious becomes conscious, and cognitive capital expands.

The new capital flows along two paths — greater awareness, and a constellation of desirable cognitive traits. Both paths support human flourishing and change how people interact with AI. Modulating the control switch converts dormant cognitive potential into active cognitive capital.



Observation

What do we know about the relationship between awareness and the brain's electrical activity?





Some evidence suggests that expanded states of awareness and cognitive ability are accompanied by reduced neural activity and brainwave power.

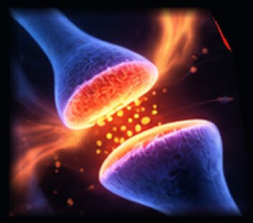


There is also evidence that neural activity and brainwave power tend to proportionally diminish as conscious awareness and cognitive ability expand.

SCIENTIFIC EVIDENCE

Gains in Awareness and Cognition Are Correlated With Reduced Neuronal Electrical Activity

DIRECT CAUSAL INTERVENTION



Researchers deliberately reduced neural activity — by gene knockdown, drug, ultrasound, or training — and then measured memory, attention, or sensory discrimination in the same subjects. Functional gains followed neuronal activity reductions.

STATE-LINKED



Scientists recorded brain activity while subjects described their experiences and matched the two moments. Reduced activity in the self-referential midline regions — the posterior cingulate and medial prefrontal cortex — coincided with reports of clearer awareness, flow, or absorbed performance.

CORRELATIONAL

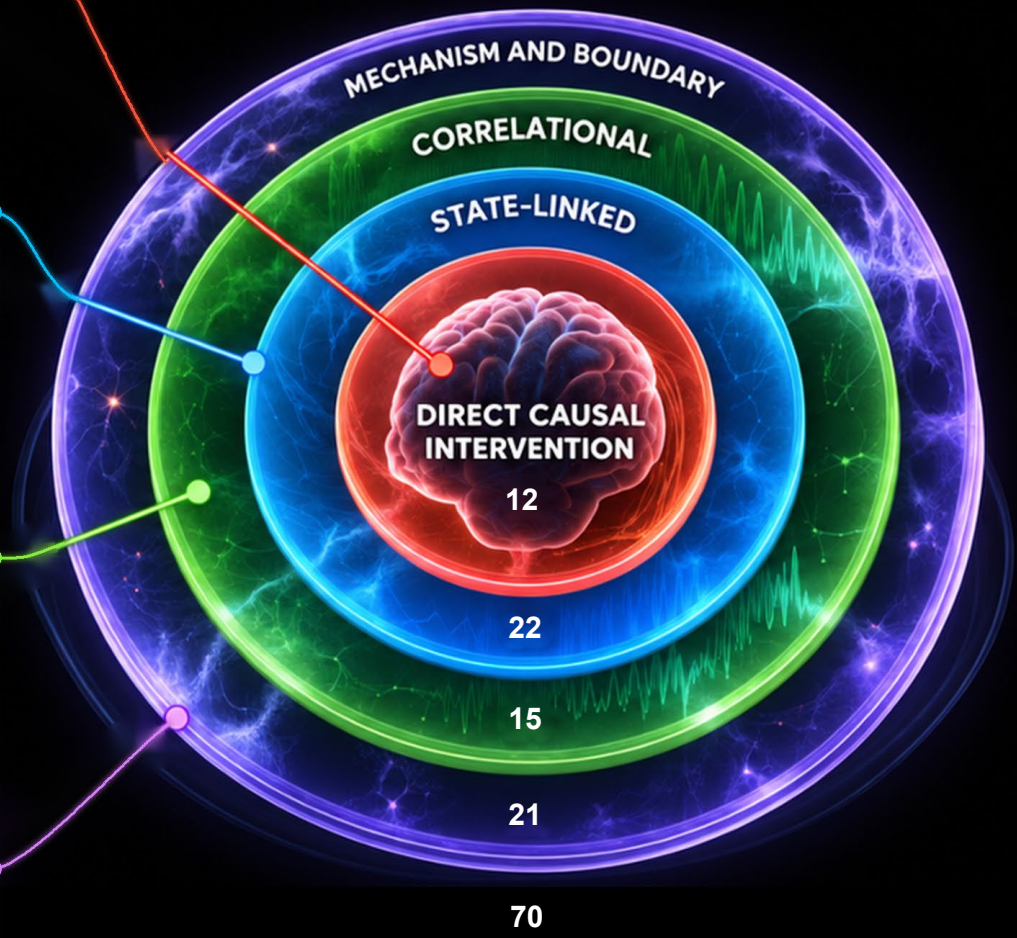


Researchers measured brain activity — glucose use, blood flow, or EEG power — in each participant and compared high cognitive performers with low performers on the same task. Across intelligence, expertise, and creativity studies, the better performers showed less brain activity.

MECHANISM AND BOUNDARY



These studies supply the surrounding biology: how EEG, PET, and fMRI physically record brain activity, how the 5-HT2A receptor changes a neuron's signaling, what drugs acting on that receptor do to brain rhythms and behavior, and background meditation and longevity research supporting an inverse-activity relationship.



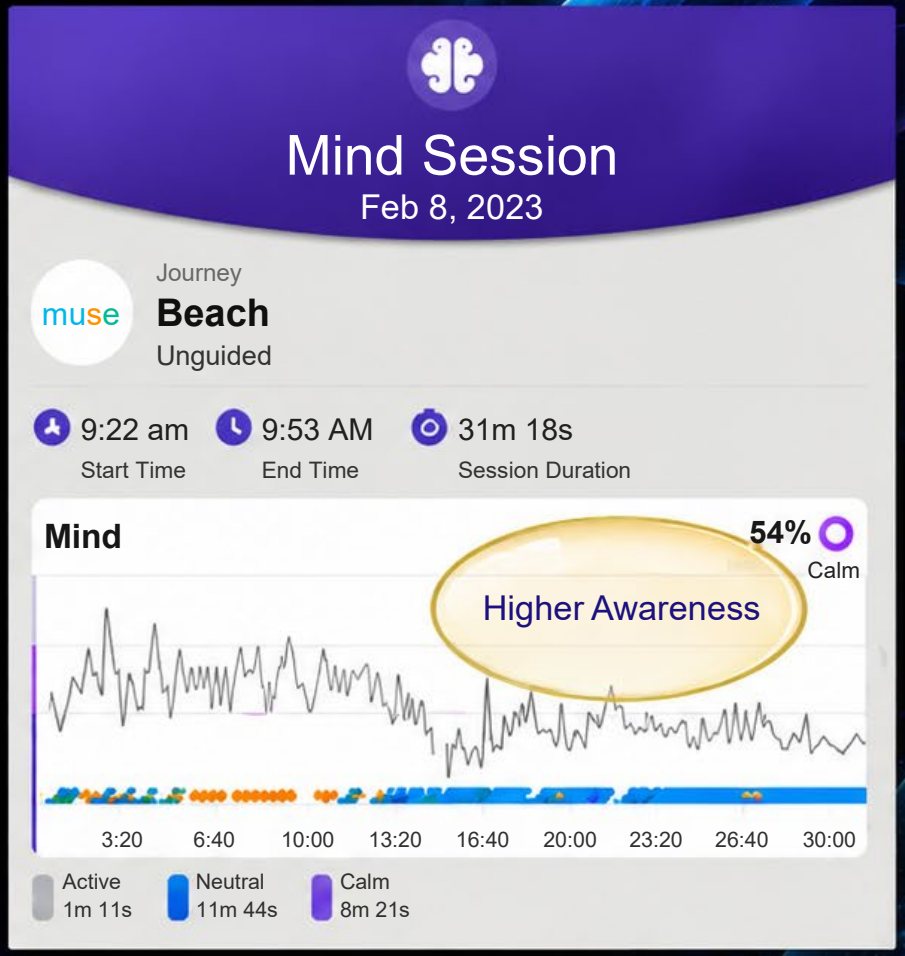
Number of Supporting Experiments by Category
See Reference section for a detailed listing.

Anecdotal Evidence

Meditators wearing EEG headbands have experienced higher states of awareness concurrently with calmer brainwave patterns.

Personal EEG systems such as Muse are specifically designed to guide users into calmer brainwave states. Hence, many of Muse's 500,000 active users may have encountered this concurrence.

Although these sessions did not occur under laboratory conditions, they still may constitute a large body of anecdotal evidence. If only one percent of Muse's active users have experienced this correlation, it would represent 5,000 cases.



Interpretation

How to explain these results?

1 Classical View



Classical reductionist neuroscience treats conscious awareness as an emergent property of neural activity. Under this model, greater neural activity should yield greater conscious awareness.

2 Problem



Since the evidence seems to point in the opposite direction, classical reductionism may not be the best way to interpret these experiments.

3 Broader Interpretation



Reductionism is increasingly being considered as a special case subset of a larger science which treats consciousness as a fundamental property. The interpretation which follows is based on this premise.

AXIOM 1

Awareness is a primary universal element.

FUNDAMENTAL AND IRREDUCIBLE

Awareness is fundamental and irreducible. It is a foundational principle, not an emergent property.

GUIDE FOR FUTURE SCIENCE

A modern genetic consciussness enhancement technology must be built on the foundation of a 21st Century awareness science, not on outdated reductionist theories of the past.

PIONEERING RESEARCH

Pioneering researchers have amassed incontrovertible evidence for non-local states of consciousness which clearly reveal the limits of reductionism. Dean Radin, Deepak Chopra, Edward Kelly and others have been calling for a more inclusive consciousness science for years.

A NEW SCIENTIFIC DISCIPLINE

The time has come to formalize a scientific discipline which treats consciousness as a first principle of nature rather than a derivative of matter.



> *"The day science begins to study non-physical phenomena, it will make more progress in one decade than in all the previous centuries."*
>
> — *Nikola Tesla*

ITONS
Conscious Awareness Packets

AXIOM 2

Awareness is composed of discrete packets.



In the same way that light is made of photons, awareness consists of elemental units.

Treating awareness as a granular phenomenon lays the foundation for a mathematics of consciousness.

AXIOM 3

Awareness packets have two states.

Property	Conscious (ITONS)	Unconscious (OTONS)
Type	Free	Applied
Time	Present	Past
Change	Motionless	Oscillates
Behavior	Particle	Wave
Function	Being	Knowing
State	Awareness	Information

AXIOM 4

Awareness can change state.



Awareness packets can change state between conscious and unconscious, like a photon can shift between a particle and a wave.

OTONS
Unconscious Awareness Packets

AXIOM 5

Free awareness is conscious and formless.



Free awareness, comprised of conscious packets, is changeless, motionless and stationary.



The Vedic Upanishads describe this formless awareness as having no mass or energy, or location in space or time.

COROLLARY 1

Conscious awareness packets have no amplitude or wavelength.



Frequency and amplitude are forms which exist in time and space.



Free awareness has a non-oscillating, static nature.

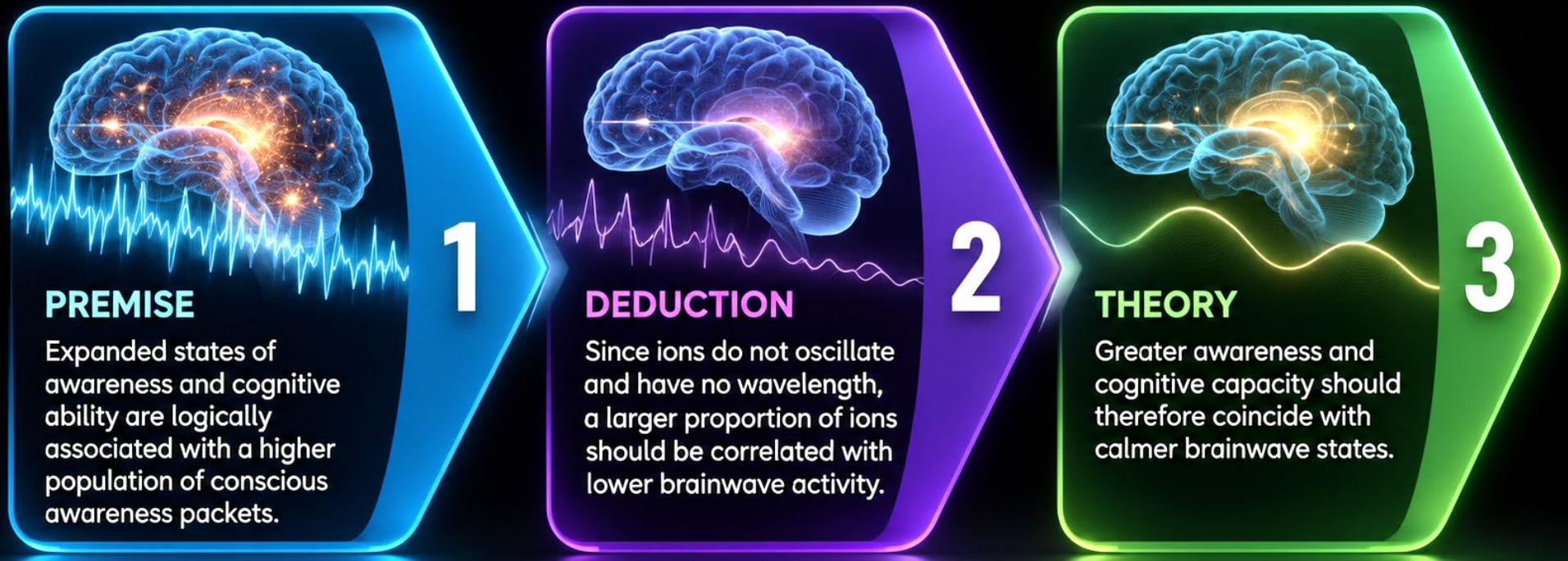


This observation has implications for enhancing human cognition.


AXIOM 6
Applied awareness takes form and becomes unconscious.
Unconscious awareness takes the form of information.
Frequency is the universal carrier of information.
To hold information, unconscious packets must oscillate.
This gives them a wavelength, whereas conscious packets are changeless.

COROLLARY 2

Neural activity and brainwave power tend to diminish as conscious awareness and cognitive ability expand.



This interpretation supports the experimental evidence identified.

Engineering Strategy

01

Corollary 2: Neural activity and brainwave power tend to diminish as conscious awareness and cognitive ability expand.



02

Evidence: Lower excitatory neural activity experimentally correlates with enhanced conscious awareness and cognitive capacity.



03

Design: Neural activity and current flow can be decreased by genetically attenuating unnecessary neuron signaling activity.



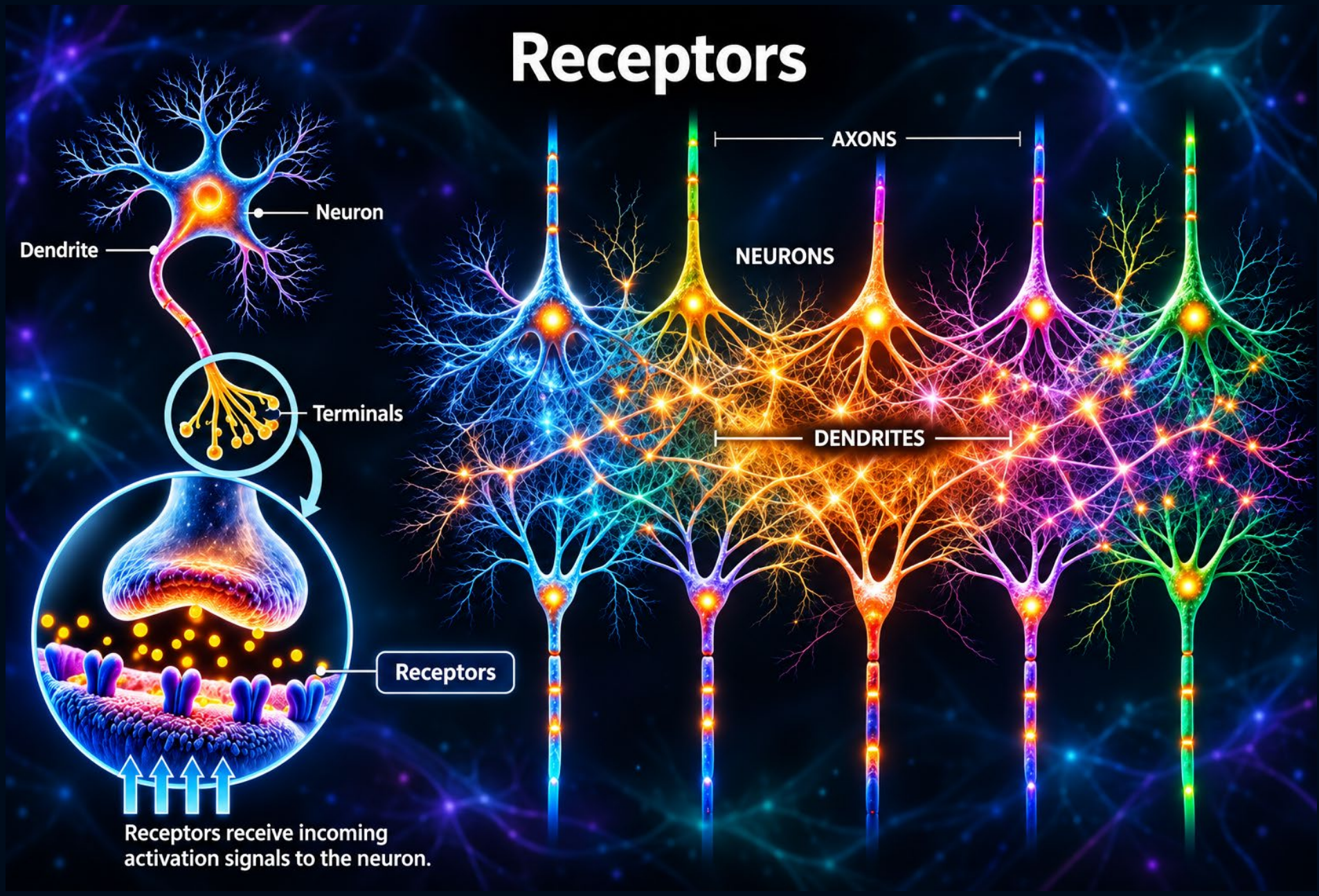
Definitions

ELECTRONICS

Resistor:	A circuit element which offers opposition to current.
Resistance:	The opposition a resistor offers to current.
Capacitor:	A circuit element which stores and accumulates electric charge and releases it when it reaches a threshold.
Capacitance:	The amount of charge a capacitor can store (and hold a constant).
Capacitive Reactance:	The opposition a capacitor offers to current, which decreases as the frequency of the voltage increases.
RC Circuit:	An electrical circuit with resistors and capacitors.
Impedance:	An RC circuit's total opposition to current, combining its resistance, capacitance and capacitive reactance.

NEUROLOGY

Neuron as a resistor:	A neuron selectively admits charged particles based on its activation level and membrane permeability. Its activation level depends on the number of open channels it has for receiving activation signals.
Neurotransmitter receptors:	The channels are called neurotransmitter receptors. More open receptors offer more doorways into the neuron, reducing its resistance and allowing more current to flow through the network.
Neuron as a capacitor:	A neuron receives, accumulates and stores electrically charged particles, releasing them when the charge reaches a threshold level.
RC Circuit:	The neuron's electrical model is a resistor-capacitor (RC) circuit.

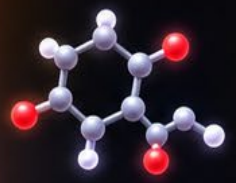

Receptors
AXONS
Neuron
Dendrite
NEURONS
Terminals
DENDRITES
Receptors
Receptors receive incoming
activation signals to the neuron.

Neurotransmitters

The brain sends messages between neurons using chemical messengers called **neurotransmitters.**

Neurotransmitters work by stimulating receptors which act as doorways into neurons for receiving incoming signals. These signals may **excite** or **inhibit** their activity.

Serotonin





Regulates mood, cognition and emotion.

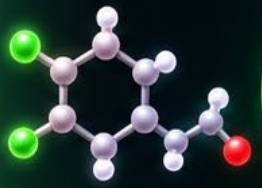
Glutamate





Excites neurons and activates brain circuits.

Dopamine

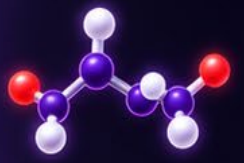




Regulates motivation, reward and movement.

GABA

(gamma amino-butyric acid)





Inhibits neurons and reduces brain activity.

The Unlock

There are 14 subtypes of receptors for serotonin. One type, the **serotonin 2A receptor (5-HT2A),** has far-reaching effects on cognition.



The cell's blueprints for building serotonin 5-HT2A receptors are located in gene HTR2A on chromosome 13.

Modifying this gene or its RNA copy can downregulate a neuron's expression of 5-HT2A receptors.

5-HT2A is highly leveraged, so reducing its population in a very small percent of neurons can broadly diminish neural network activity, thereby lowering brain current.

In electrophysiology studies with cortical neuron cultures, knocking out 5-HT2A receptors lowered neuronal firing rates **by 50%.**

Mechanisms of Action



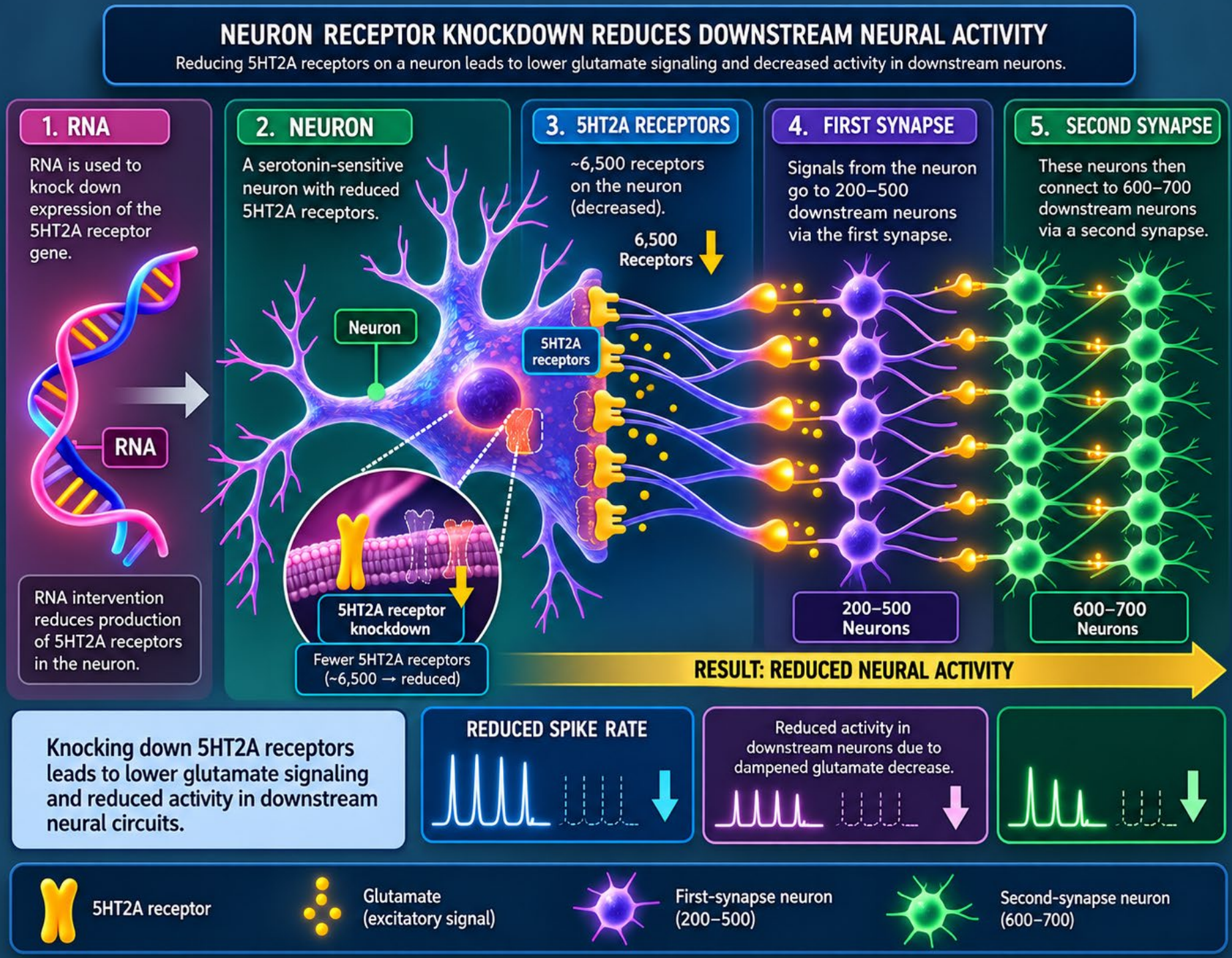
1 METHOD 1: ELECTRICAL IMPEDANCE

A neuron is like a pump on a water line. If the pump slows down, less water flows through the line. If a neuron fires less often, less current flows through the network.

2 METHOD 2: CHEMICAL SIGNALING

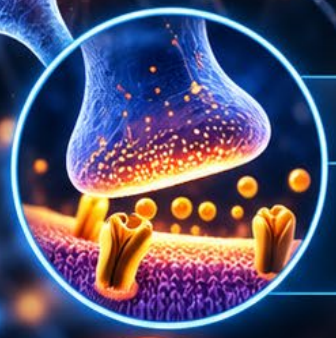
Reducing one neuron's 5-HT2A receptor activity can dampen glutamate release in as many as 600 downstream neurons. Since glutamate is the primary excitatory neurotransmitter, lowering its concentration attenuates neuron activity globally.




NEURON RECEPTOR KNOCKDOWN REDUCES DOWNSTREAM NEURAL ACTIVITY
Reducing 5HT2A receptors on a neuron leads to lower glutamate signaling and decreased activity in downstream neurons.
1. RNA
RNA is used to knock down expression of the 5HT2A receptor gene.
RNA
RNA intervention reduces production of 5HT2A receptors in the neuron.
2. NEURON
A serotonin-sensitive neuron with reduced 5HT2A receptors.
Neuron
3. 5HT2A RECEPTORS
~6,500 receptors on the neuron (decreased).
6,500 Receptors
5HT2A receptors
5HT2A receptor knockdown
Fewer 5HT2A receptors (~6,500 → reduced)
4. FIRST SYNAPSE
Signals from the neuron go to 200–500 downstream neurons via the first synapse.
200–500 Neurons
5. SECOND SYNAPSE
These neurons then connect to 600–700 downstream neurons via a second synapse.
600–700 Neurons
RESULT: REDUCED NEURAL ACTIVITY
Knocking down 5HT2A receptors leads to lower glutamate signaling and reduced activity in downstream neural circuits.
REDUCED SPIKE RATE
Reduced activity in downstream neurons due to dampened glutamate decrease.
5HT2A receptor
Glutamate (excitatory signal)
First-synapse neuron (200–500)
Second-synapse neuron (600–700)

Methodology Summary

Goal: Decrease current flow in the brain's cortical and limbic networks



Local Networks Strategy

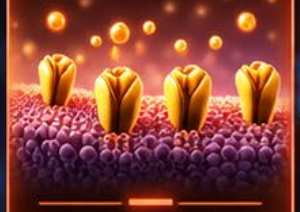
Raise neural resistance and reduce neuron signaling rate in targeted neurons.

Global Activity Strategy

Raise neural impedance (1) and reduce glutamate levels in downstream neurons.

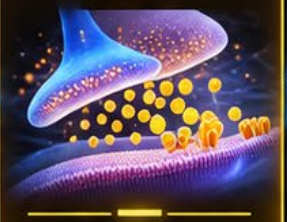


1 Receptor Density



Downregulating 5-HT2A receptor population raises a neuron's resistance and its opposition to incoming signals.

2 Signaling Rate



Modified neurons charge more slowly and fire less often, lowering signaling frequency.

3 Reduced Current



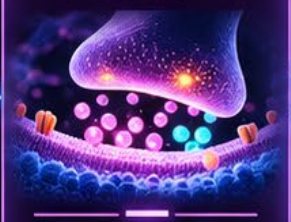
Lower frequency neurowave voltage reduces current in neural networks.

4 Higher Reactance



Lower frequency voltage increases capacitive reactance (2) in downstream neurons.

5 Glutamate Levels



Reducing 5-HT2A receptor activity dampens glutamate release in downstream neurons.

6 Global Activity



Decreased glutamate levels attenuate neuron activity globally. (3)

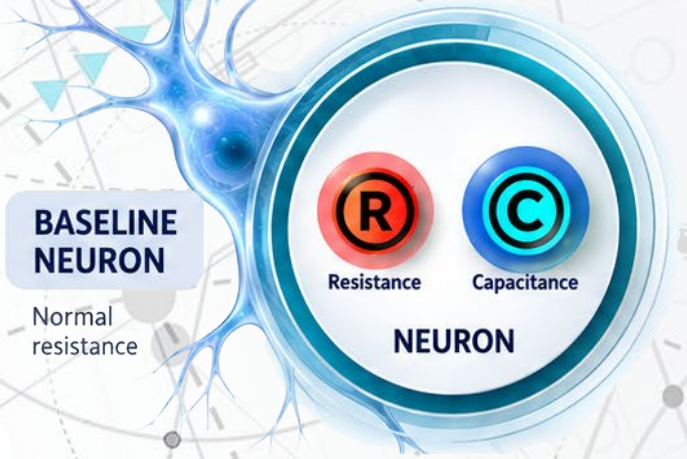
(1) Impedance = [resistance + capacitance + capacitive reactance]

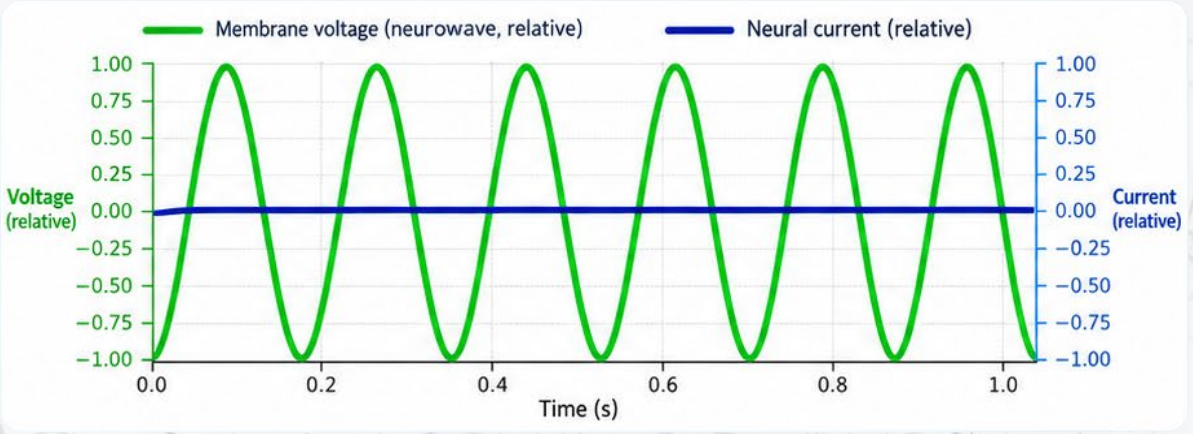
(2) Capacitive reactance = the opposition a capacitor offers to current

(3) Glutamate is the primary excitatory neurotransmitter.

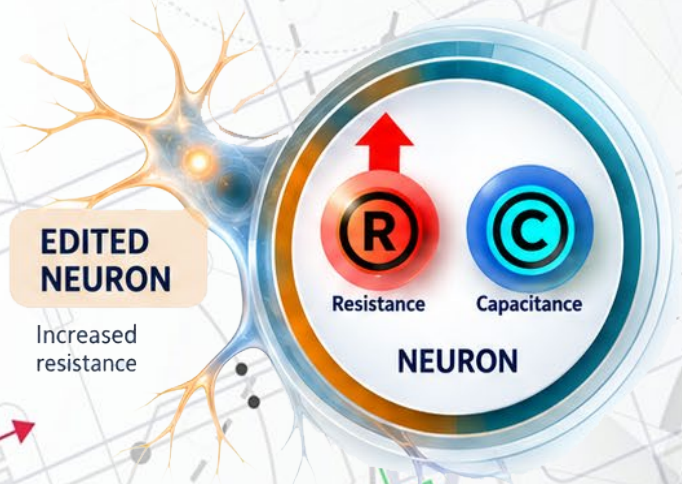
Neuron Electrodynamics

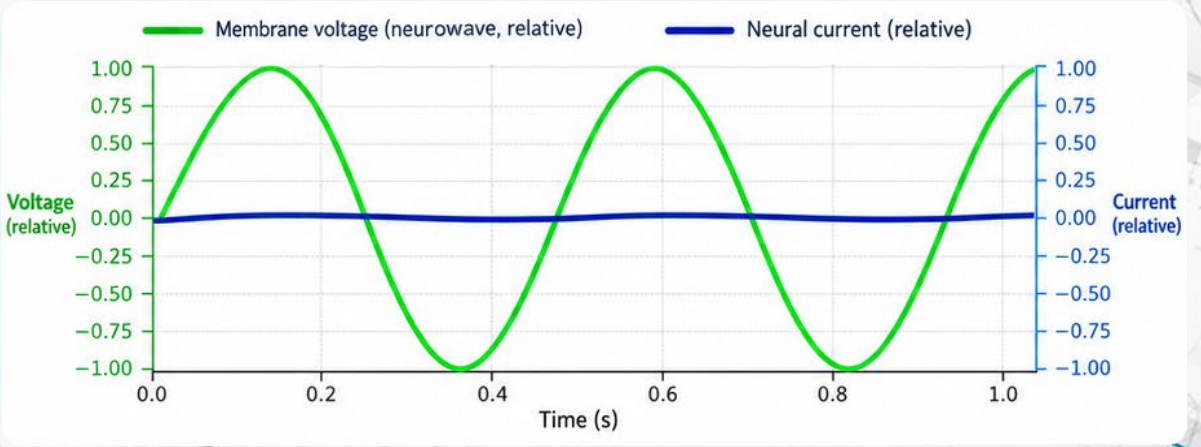
Neural resistance drives frequency and current.





Raising neuron resistance lowers neurowave frequency and neural current.

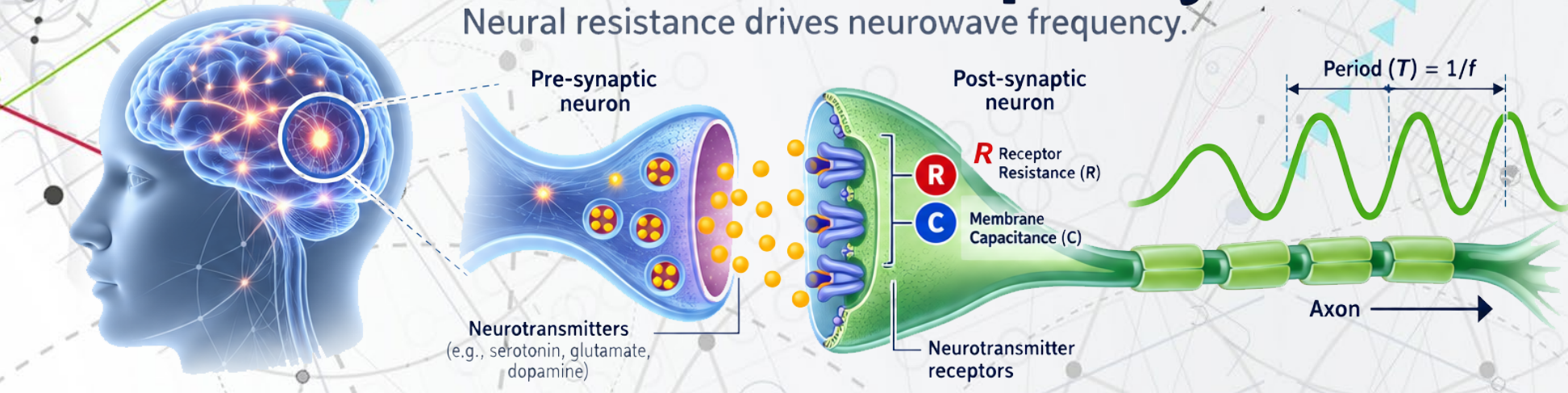




Note: This relationship applies to excitatory receptors, i.e. certain serotonin, glutamate and dopamine subtypes.

NeuroWave Frequency

Neural resistance drives neurowave frequency.



The relationship between neurowave frequency and neuron resistance can be expressed as:

$$f = \frac{1}{2\pi RC}$$

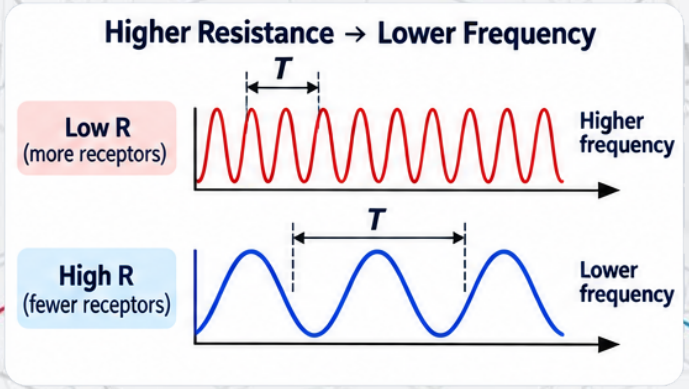
f = frequency (Hz)
R = resistance (ohms)
C = capacitance (farads)
π = 3.1416

Where:

- **Frequency (*f*)** is the number of neuron pulses per second or the wavelength between peaks.
- **Resistance (R)** varies with the number of neurotransmitter receptors receiving activation signals.
- **Capacitance (C)** is the neuron's ability for storing electrical charge. It is basically a constant.

Thus, resistance (R) determines frequency (*f*).

A neuron's pulse frequency (*f*) varies with its electrical resistance (*R*).



Note: This equation applies to excitatory receptors, i.e., certain serotonin, glutamate and dopamine subtypes.

Neural Current

2. Neurowave frequency drives neural current.

Neural current varies in proportion to neural voltage frequency.[1]
Higher frequencies allow more current to flow.
Lower frequencies reduce current flow.

Current-Frequency Relationship in Neural Resistor/Capacitor (RC) Circuits

$$X_C = 1 / (2 \pi f C)$$

Where:

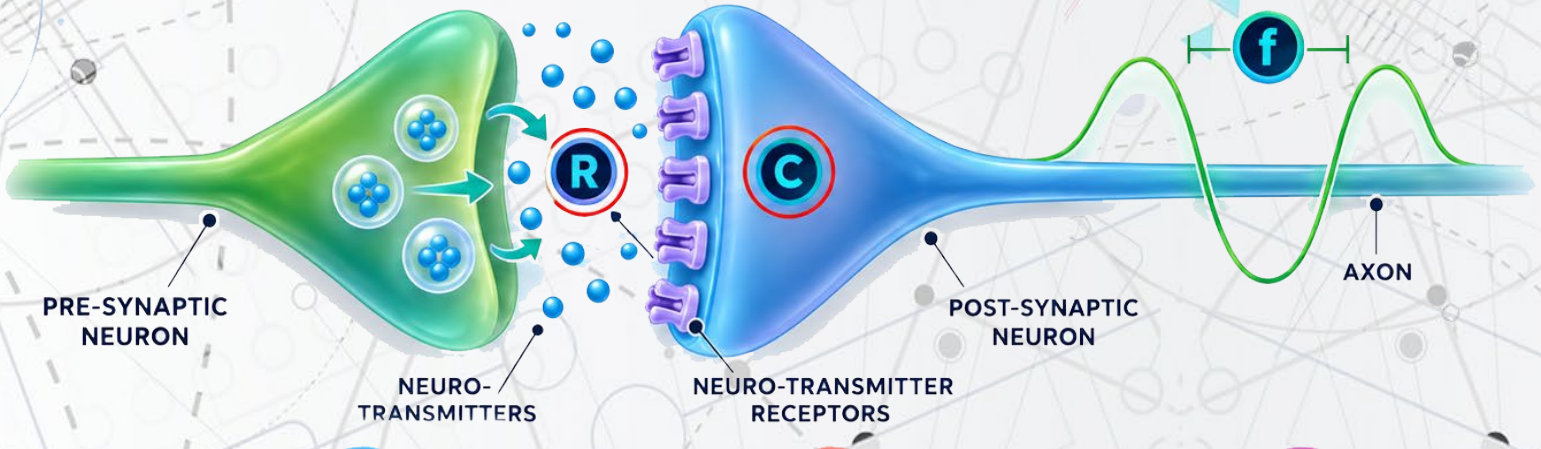
X_C = capacitive reactance (the opposition a capacitor offers to current)
f = frequency
C = capacitance (the amount of charge a capacitor can hold) (a constant)
Neurons function electrically like resistor/capacitors, accumulating and releasing charge.

As frequency decreases, capacitive reactance increases, reducing current flow. Theta frequencies (4-8 Hz) produce higher reactance and lower current than Beta frequencies (13-30 Hz).

[1] Assuming global neurowave coherence is within normal ranges.

Genetic Control

3. Neural resistance can be genetically modified.



STEP 1

Neurons receive excitatory signals through gateways called neurotransmitter receptors.

STEP 2

A neuron's electrical resistance R is largely determined by the number of these gateways open for signals to enter the neuron.

STEP 3

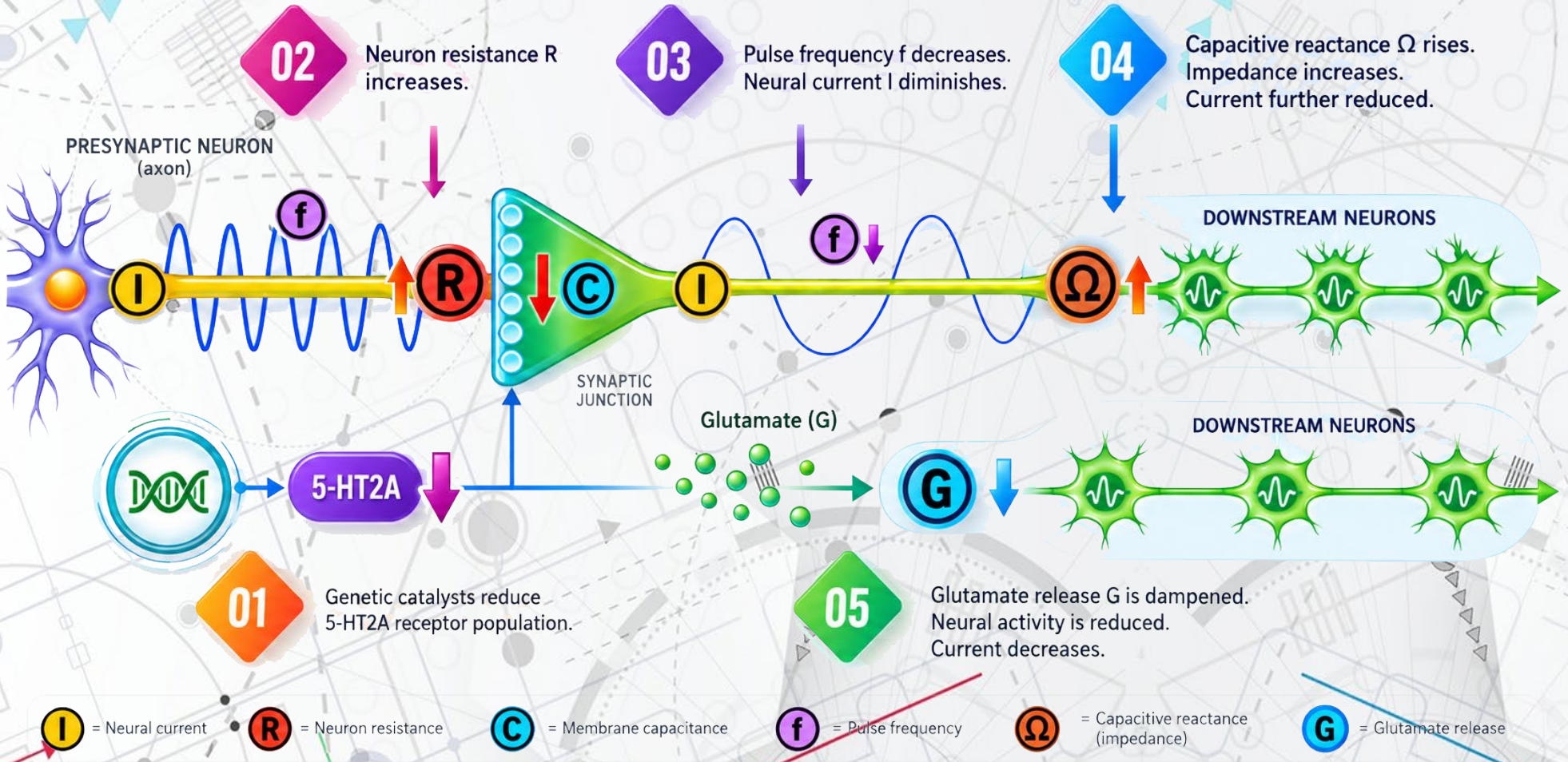
A neuron's resistance R can be increased by reducing its neuro-transmitter receptor population.

STEP 4

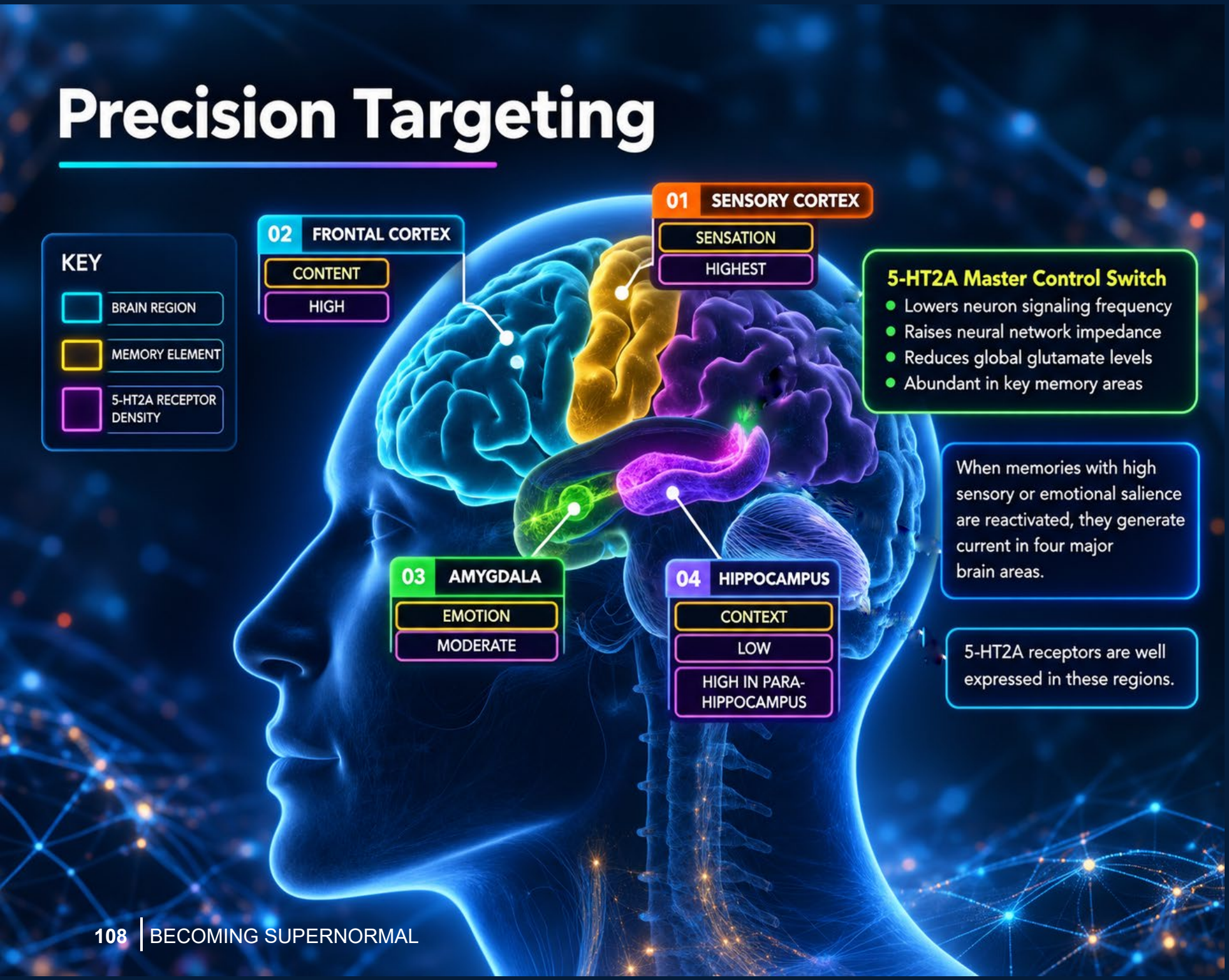
A neuron's receptor population can be controlled by modifying its DNA or RNA.

Methodology Schematic

Neural current attenuation strategies



Precision Targeting



Optimization

01

LIMBIC MEMORY CIRCUITS

Limbic memory circuits typically carry higher current than cortical circuits, especially for memories with emotional content.

02

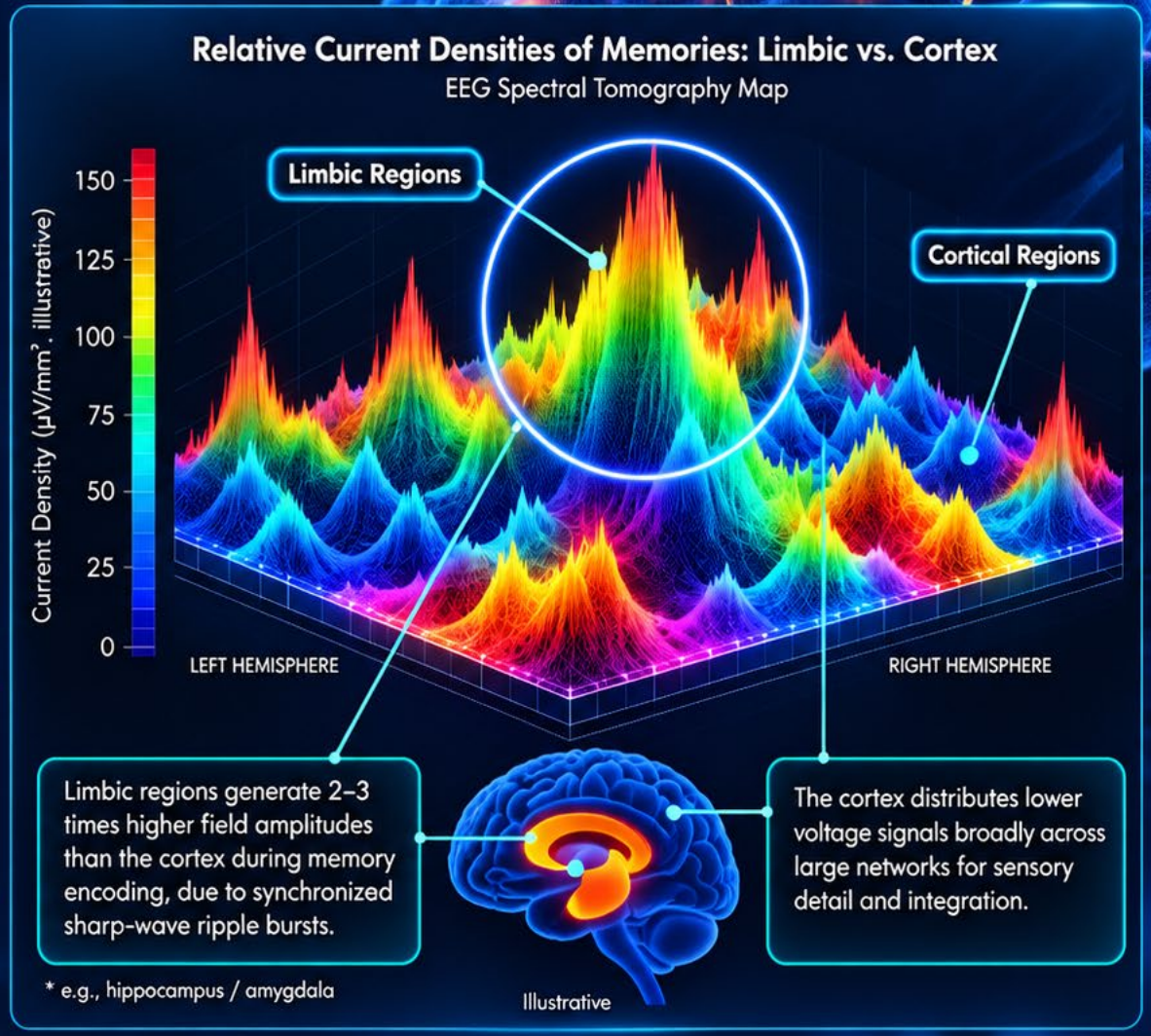
EDITING EFFICIENCY

Editing limbic neurons can impede more current than cortical neurons on a one-for-one basis.

03

TARGETED DELIVERY

Genetic catalysts can be preferentially targeted to the limbic region via intranasal delivery.



Safety

01 Experimental evidence confirms that down-regulating **5-HT2A** improves cognition in animal models without disrupting autonomic and metabolic functions.

02 **5-HT2A** is not expressed in the brainstem or hypothalamus. These regions maintain autonomic stability independent of 5-HT2A.

03 Autonomic functions rely on other serotonin receptors (5-HT1A, 5-HT2C, 5-HT3), **not 5-HT2A.**

04 Metabolism is regulated by multiple neurotransmitter systems, with **minimal 5-HT2A involvement.**

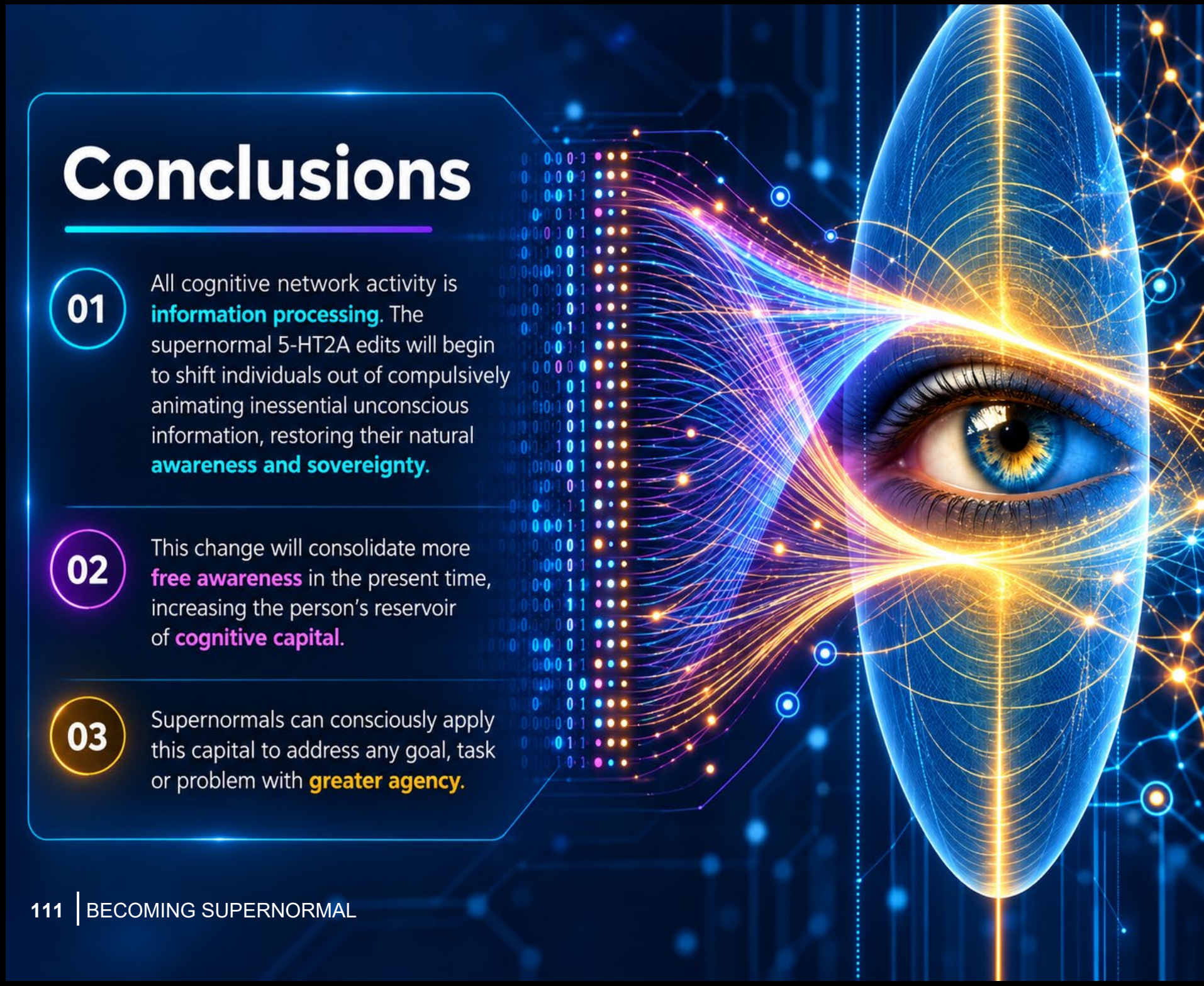


Conclusions

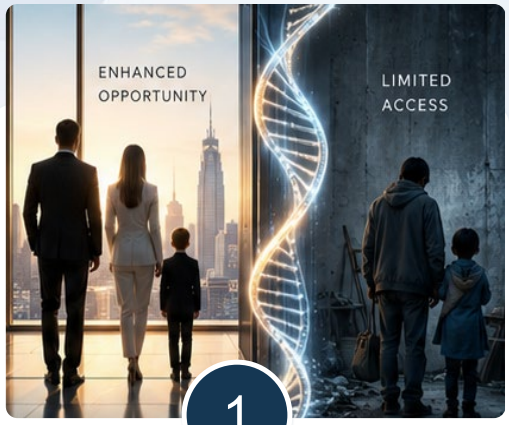
01 All cognitive network activity is **information processing**. The supernormal 5-HT2A edits will begin to shift individuals out of compulsively animating inessential unconscious information, restoring their natural **awareness and sovereignty**.

02 This change will consolidate more **free awareness** in the present time, increasing the person's reservoir of **cognitive capital**.

03 Supernormals can consciously apply this capital to address any goal, task or problem with **greater agency**.



Risks & Issues



1

1. The Cognitive Divide

Stratification between enhanced and unenhanced populations could create a permanent underclass. Access may be determined by wealth, geography, or political favor. Intergenerational compounding will occur as enhanced parents produce advantages for children, while unenhanced families fall further behind.



2

2. Capital Distribution

Enhanced individuals could accumulate disproportionate wealth and influence. Investment returns will favor the cognitively enhanced. New monopolistic dynamics may emerge as enhanced founders and executives dominate markets.



3

3. Cognitive Geopolitics

Nations will compete to enhance military, intelligence, and leadership personnel. First-mover advantages will create new power asymmetries. Cognitive enhancement risks becoming classified military technology, restricting civilian access while accelerating covert programs.



4

4. Labor Market Disruption

Enhanced workers may displace unenhanced workers in knowledge economies, compounding AI displacement. Wage compression will affect cognitive tasks. Credentialing crises will emerge as traditional qualifications become less meaningful against verified cognitive enhancement.

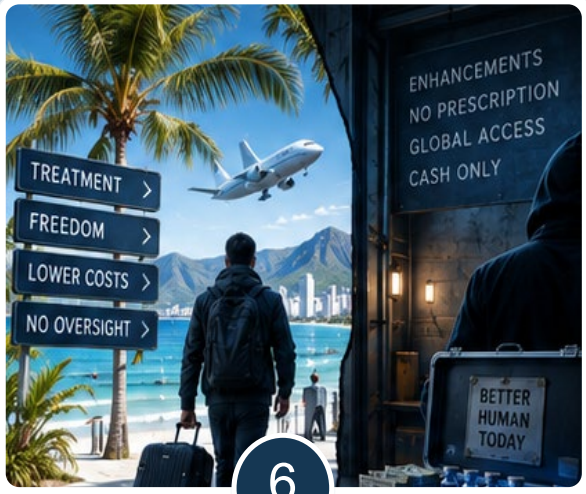


5

5. Identity and Psychological Destabilization

Individuals face risks of personality discontinuity, relationship issues, and existential disorientation. Depression or dissociation may follow enhancement. Enhanced individuals may lose connection with unenhanced family members and communities.

Does a cognitive enhancement alter something essential about the person who receives it? Human beings are changed by experience all the time, but deliberate cognitive modification still raises distinct questions about agency, authenticity, and mental autonomy. Choice, reversibility, and bounded scope diminish the issue, but do not erase it.



6

6. Regulatory Arbitrage and Black Markets

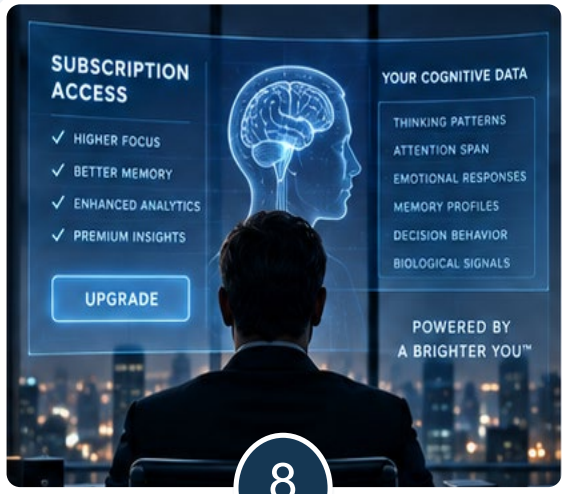
Enhancement tourism will emerge to unregulated jurisdictions. Underground providers will offer unverified treatments. Coerced enhancement may occur in employment or military contexts. Verification and enforcement will pose significant challenges.



7

7. Community Fragmentation

Social communities may divide along enhanced and unenhanced lines. Religious and philosophical conflicts will arise over human identity. Democratic legitimacy questions will surface when enhanced minorities hold disproportionate power.



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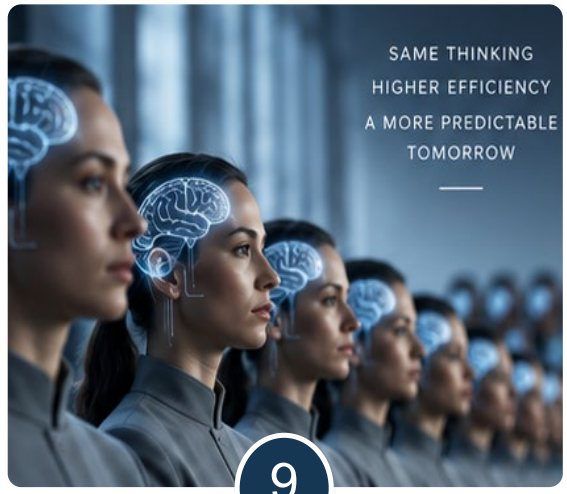
8. Corporate Cognitive Control

Proprietary cognitive technologies could create dependency relationships. Cognitive data harvesting will erode privacy. Enhancement may be tied to employment contracts or subscription models. Ongoing biological access creates manipulation risks.



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9. Homogenization Paradox

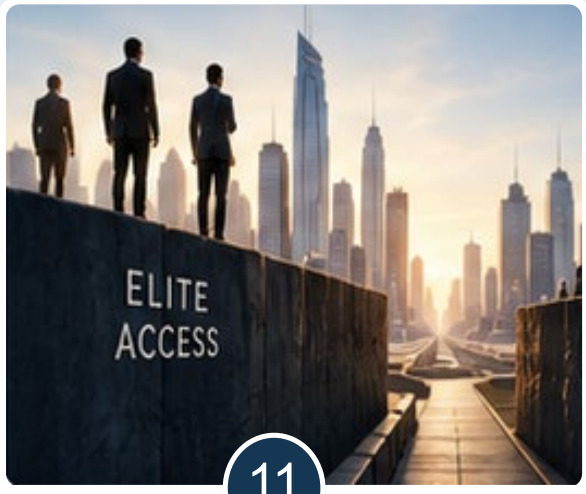
Enhancement toward uniform cognitive profiles may reduce the creative diversity that drives innovation. Groupthink could emerge at scale among similarly-enhanced leadership classes. Society may lose perspectives, intuitions, and cognitive styles that arise from unoptimized neurology.



10

10. Enhancement Definition

How does society define what represents improvement? Science can measure whether cognition changes, but it cannot decide which changes should be valued, rewarded, or broadly shared. The question is who decides what counts as improvement, who benefits, and what risks are acceptable when the design canvas is the human mind.



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11. Access

Cognitive enhancement distributed through markets alone will reach affluent buyers first. If pricing policy brings it within reach of the mainstream in a reasonable timeframe, the early gap closes. If it does not, the gap divides society by cognitive function as well as income.



12

12. Institutional Trust

Corporate practices have created widespread public distrust in the personal biology and personal data industries. If cognitive enhancement is introduced under the same umbrella, there may be reluctance to accept it.



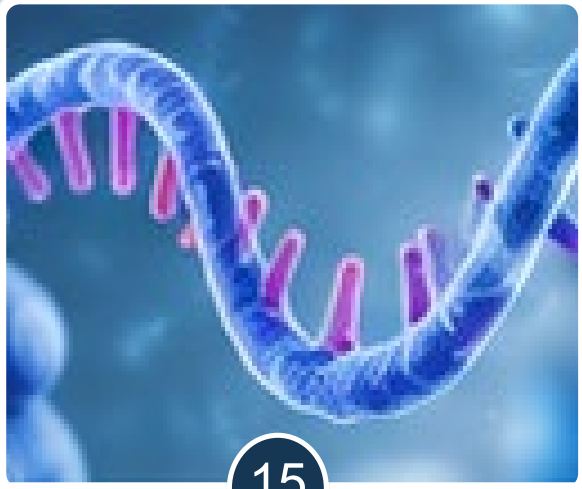
13. Scientific Overreach

The transhumanist literature has produced claims that go well beyond current evidence. Scientific skepticism toward those claims is justified. Progress in complex biological systems is neither linear nor guaranteed. Early effects may not replicate cleanly across populations or over time, and public association with inflated transhumanist narratives may persist regardless.



14. Unknowns

Biological systems behave nonlinearly. A single treatment can produce consequences that no trial can fully model in advance. Safeguards must be put in place for long-term follow-up, transparent reporting, and independent review.



15. Safety

RNA therapies use post-transcriptional silencing designed to produce temporary, non-inheritable effects. However, repeated dosing raises questions about cumulative exposure, interaction with aging, medication use, and genetic variation. Reversibility reduces risk but does not lessen the need for long-term evidence gathering and transparent reporting.

De-Risking Strategy

The Supernormal Initiative outlines key de-risking provisions but further measures are necessary.:

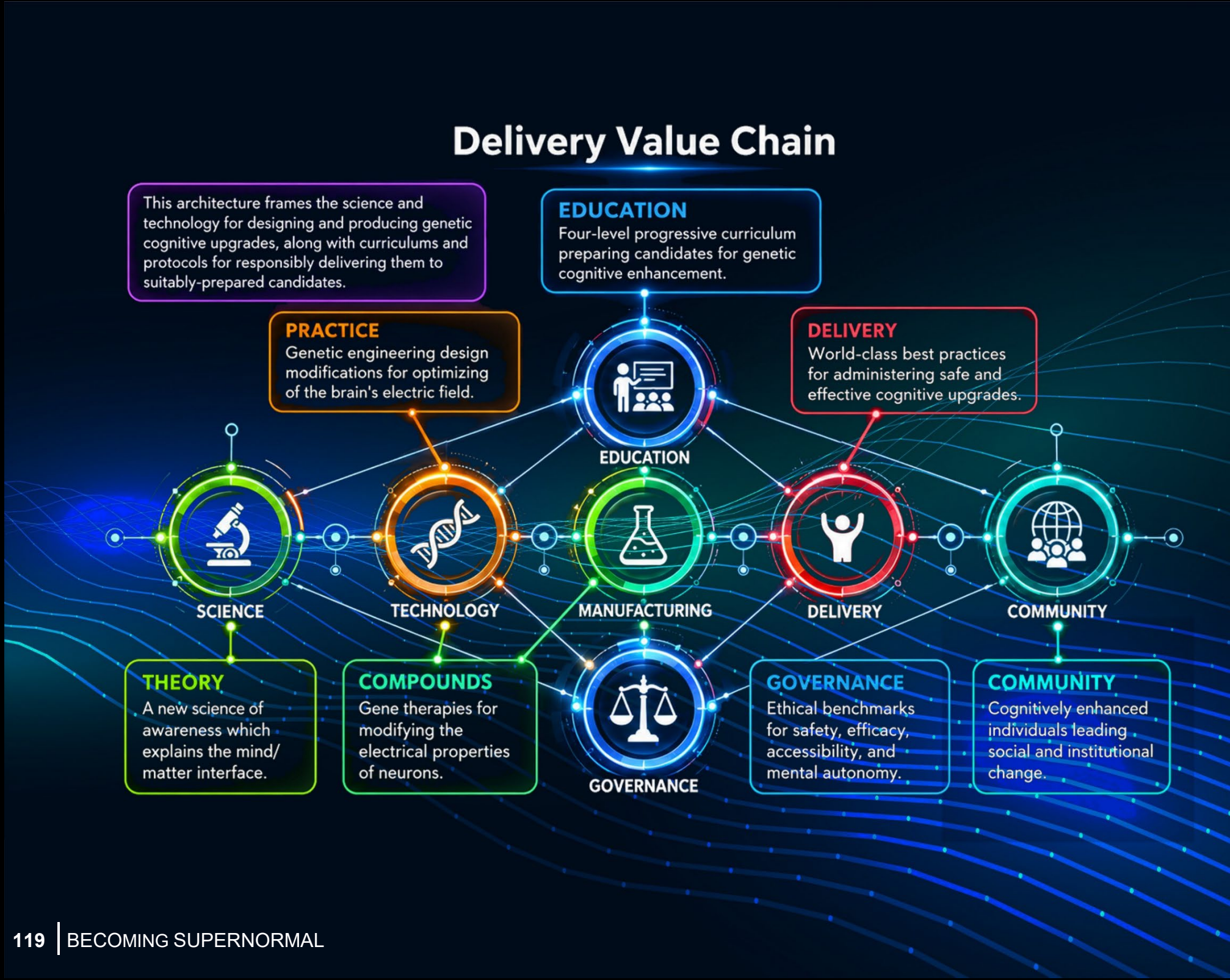
New Cognitive Divide	Cognitive Capital Distribution	Global Cognitive Geopolitics	Labor Market Disruption	Identity and Psychological Destabilization
Mitigated through tokenization and scholarship fund to democratize access.	Require additional policy frameworks beyond the initiative's current scope.			Addressed through development of therapeutic protocols and Level 100's curriculum designed to prime candidates psychologically for change.

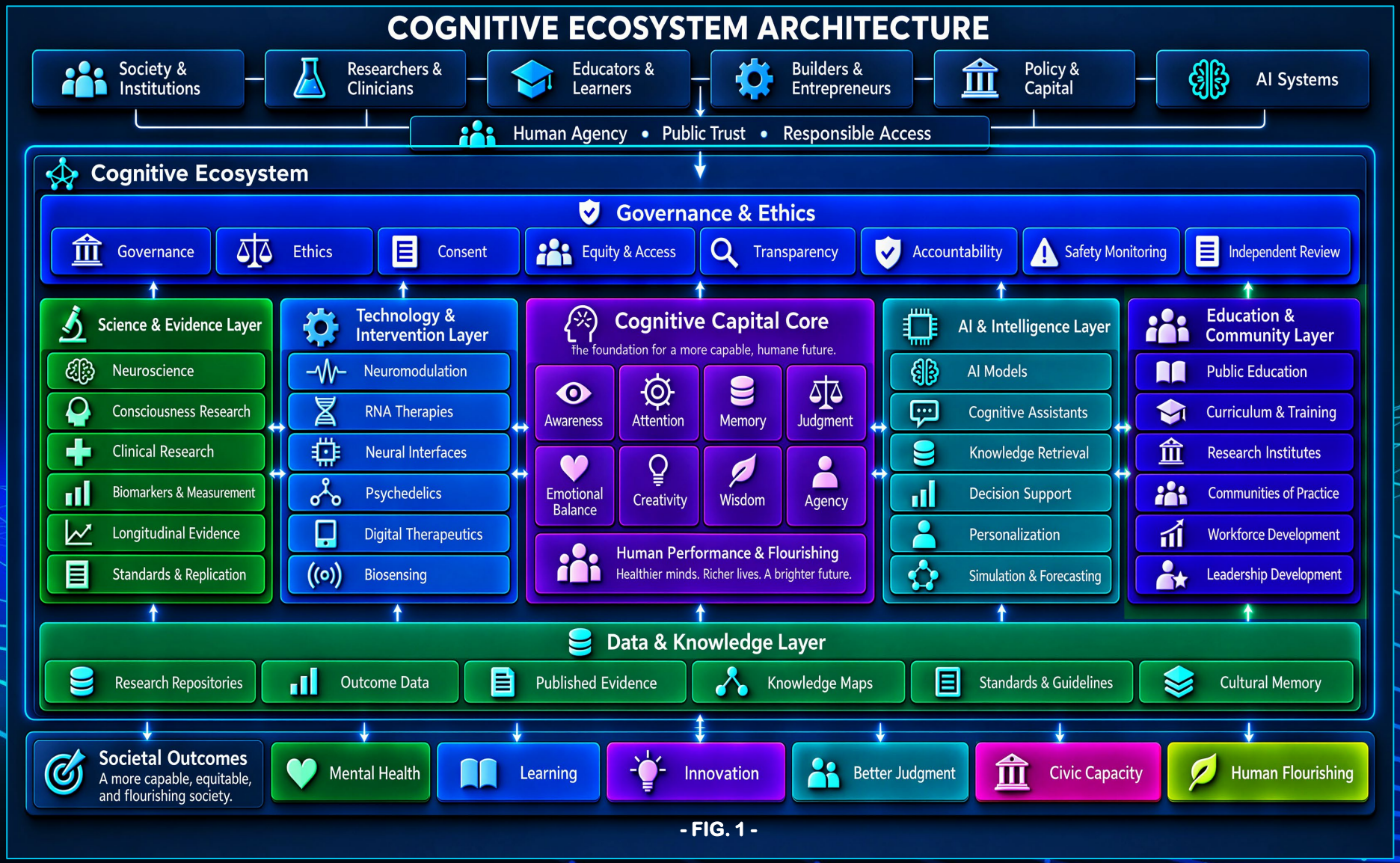
Regulatory Arbitrage and Black Markets	Community Fragmentation	Corporate Cognitive Control	Homogenization Paradox
Countered by robust policy development governing research ethics and clinical applications. The blockchain registry also provides auditability and quality control to distinguish legitimate providers from underground operators.	Requires additional policy frameworks	Partially addressed through the blockchain's transparency mechanisms and the token model's decentralized ownership structure.	Requires additional policy frameworks


Cognitive capital
Attention, memory, judgment, creativity, and resilience could become deliberately developed productive assets.
CORE ASSETS
ATTENTION
MEMORY
JUDGMENT
CREATIVITY
RESILIENCE
Economic transformation
Potential gains in learning, productivity , adaptability, and institutional judgment—alongside labor and inequality risks.
KEY DRIVERS
PRODUCTIVITY
ADAPTABILITY
LABOR & INEQUALITY RISKS
Human agency in the AI age
Strengthen the human ability to understand, direct, question, and govern increasingly powerful AI systems.
CORE FOCUS
GOVERNANCE
DIRECTION
AI ALIGNMENT
Governance and safeguards
Independent oversight, informed consent, safety, provider standards, and protection of mental autonomy.
FOCUS AREAS
OVERSIGHT
CONSENT
SAFETY
AUTONOMY
Education and readiness
Education and ongoing support prepare people to understand, manage, and apply enhanced capacities responsibly.
KEY ELEMENTS
EDUCATION
SUPPORT
READINESS
Access and power
Equitable access must counter coercion, cognitive inequality, corporate control, and geopolitical competition.
CORE IMPERATIVES
EQUITY
ANTI-COERCION
PUBLIC CONTROL

118

Delivery Value Chain



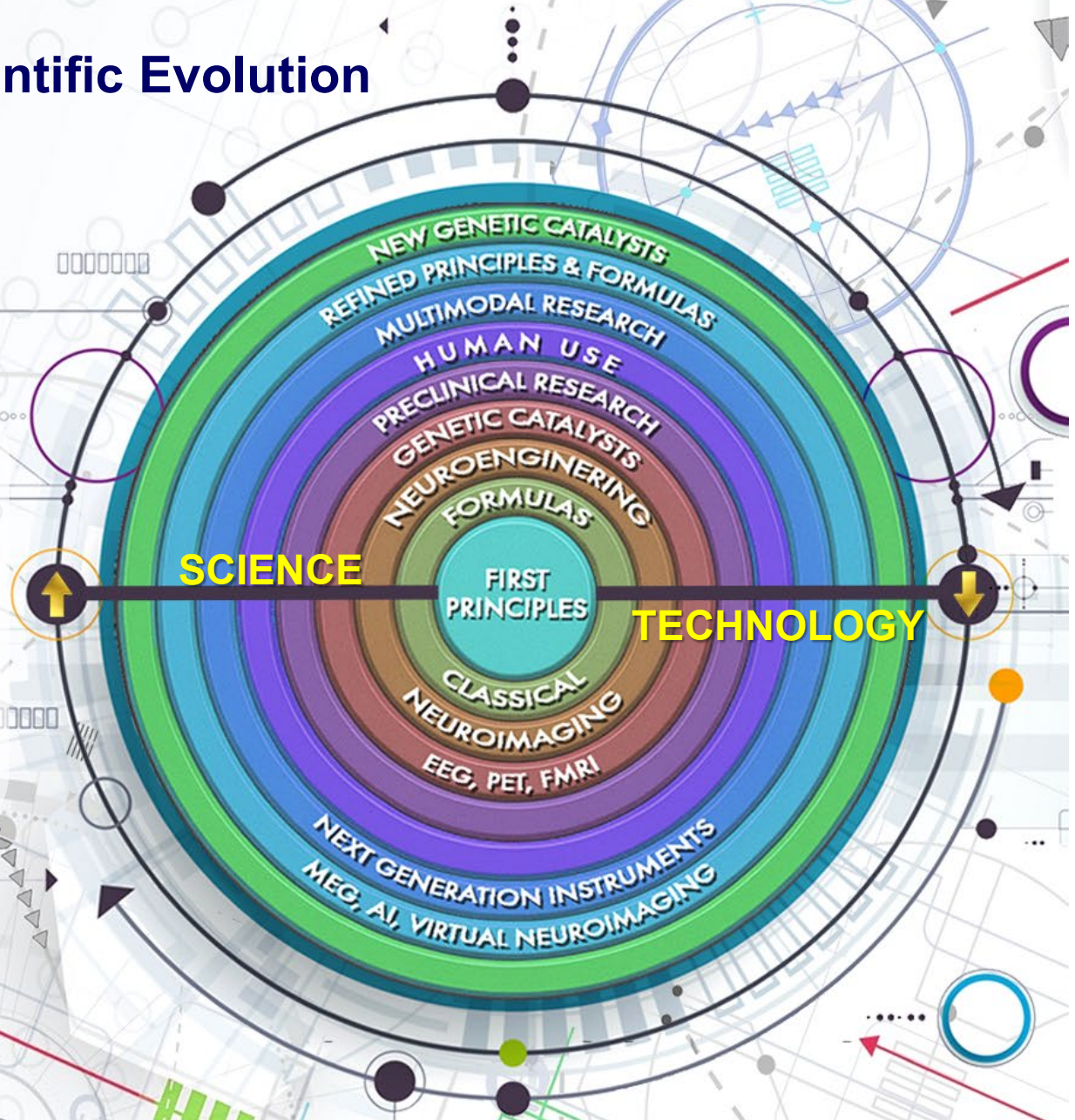

COGNITIVE ECOSYSTEM ARCHITECTURE
Society & Institutions
Researchers & Clinicians
Educators & Learners
Builders & Entrepreneurs
Policy & Capital
AI Systems
Human Agency • Public Trust • Responsible Access
Cognitive Ecosystem
Governance & Ethics
Governance
Ethics
Consent
Equity & Access
Transparency
Accountability
Safety Monitoring
Independent Review
Science & Evidence Layer
Neuroscience
Consciousness Research
Clinical Research
Biomarkers & Measurement
Longitudinal Evidence
Standards & Replication
Technology & Intervention Layer
Neuromodulation
RNA Therapies
Neural Interfaces
Psychedelics
Digital Therapeutics
Biosensing
Cognitive Capital Core
the foundation for a more capable, humane future.
Awareness
Attention
Memory
Judgment
Emotional Balance
Creativity
Wisdom
Agency
Human Performance & Flourishing
Healthier minds. Richer lives. A brighter future.
AI & Intelligence Layer
AI Models
Cognitive Assistants
Knowledge Retrieval
Decision Support
Personalization
Simulation & Forecasting
Education & Community Layer
Public Education
Curriculum & Training
Research Institutes
Communities of Practice
Workforce Development
Leadership Development
Data & Knowledge Layer
Research Repositories
Outcome Data
Published Evidence
Knowledge Maps
Standards & Guidelines
Cultural Memory
Societal Outcomes
A more capable, equitable, and flourishing society.
Mental Health
Learning
Innovation
Better Judgment
Civic Capacity
Human Flourishing

- FIG. 1 -

Scientific Evolution

The axioms and formulas in this book form the kernel of a new awareness science based on information from classical neuroimaging instruments such as EEG, PET and fMRI.

Next-generation systems, such as magnetic encephalography (MEG), virtual neuroimaging, and MEG-EEG hybrids, promise to deliver new levels of precision that will allow researchers to refine and expand the science.



Ethical Use

The emergence of cognitive enhancement technologies is inevitable. These inventions will profoundly shape the future of human potential, and consequently, they carry a substantial responsibility.

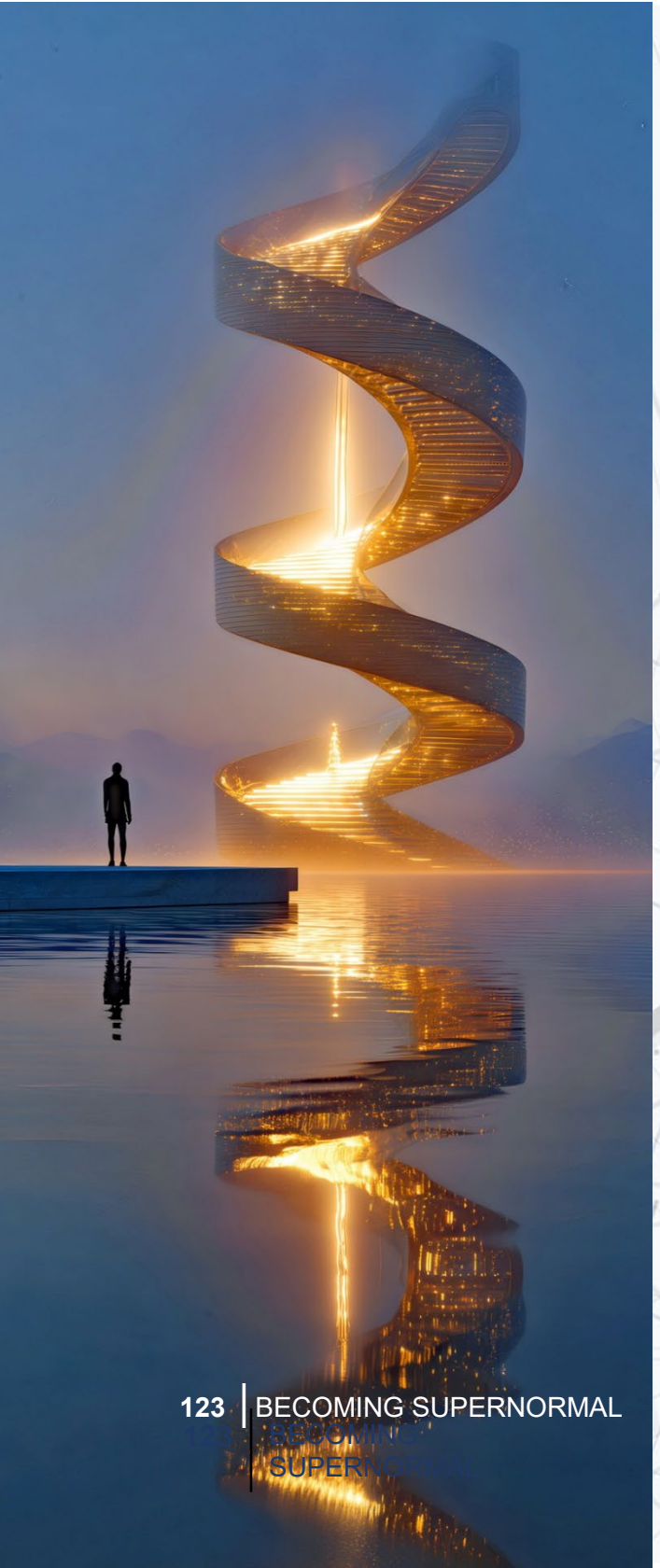
To ensure these advancements serve highest good, a conscious and principled leadership group is being formed to provide ethical stewardship. This group will include visionaries, ethicists, scientists, clinicians and engineers dedicated to safe-guarding human dignity, agency, and well-being.

Their mission will be to establish a framework of guiding principles that transcend regulatory compliance and prioritize integrity, compassion, and long-term societal benefit. They will define ethical benchmarks for research, development, and application which consider safety, efficacy, accessibility, fairness, and the preservation of mental autonomy. Through a transparent and inclusive process, this leadership body will offer moral clarity in an age of accelerating technological change.

While we cannot prevent every misuse or unintended consequence, we can establish uniform standards of excellence. Providers, institutions, and technologies that uphold these standards can be recognized through a formal system of ethical certification. This recognition will empower users to make informed, value-aligned decisions while incentivizing responsible innovation across this new industry.

The goal is to consciously guide the future to ensure cognitive enhancement becomes a force for healing, growth, and the flourishing of human consciousness.





Further Exploration

Any book proposing engineering human cognition will invite scrutiny. While the architecture rests on sound principles, several areas deserve open discussion and exploration.

1. Genetic Enhancement: Early studies suggest remarkable gains in memory and reductions in anxiety, but replication and long-term studies are needed. Translating preclinical outcomes into safe, reproducible human therapies is a major frontier. These techniques should be viewed as promising prototypes rather than finished solutions.

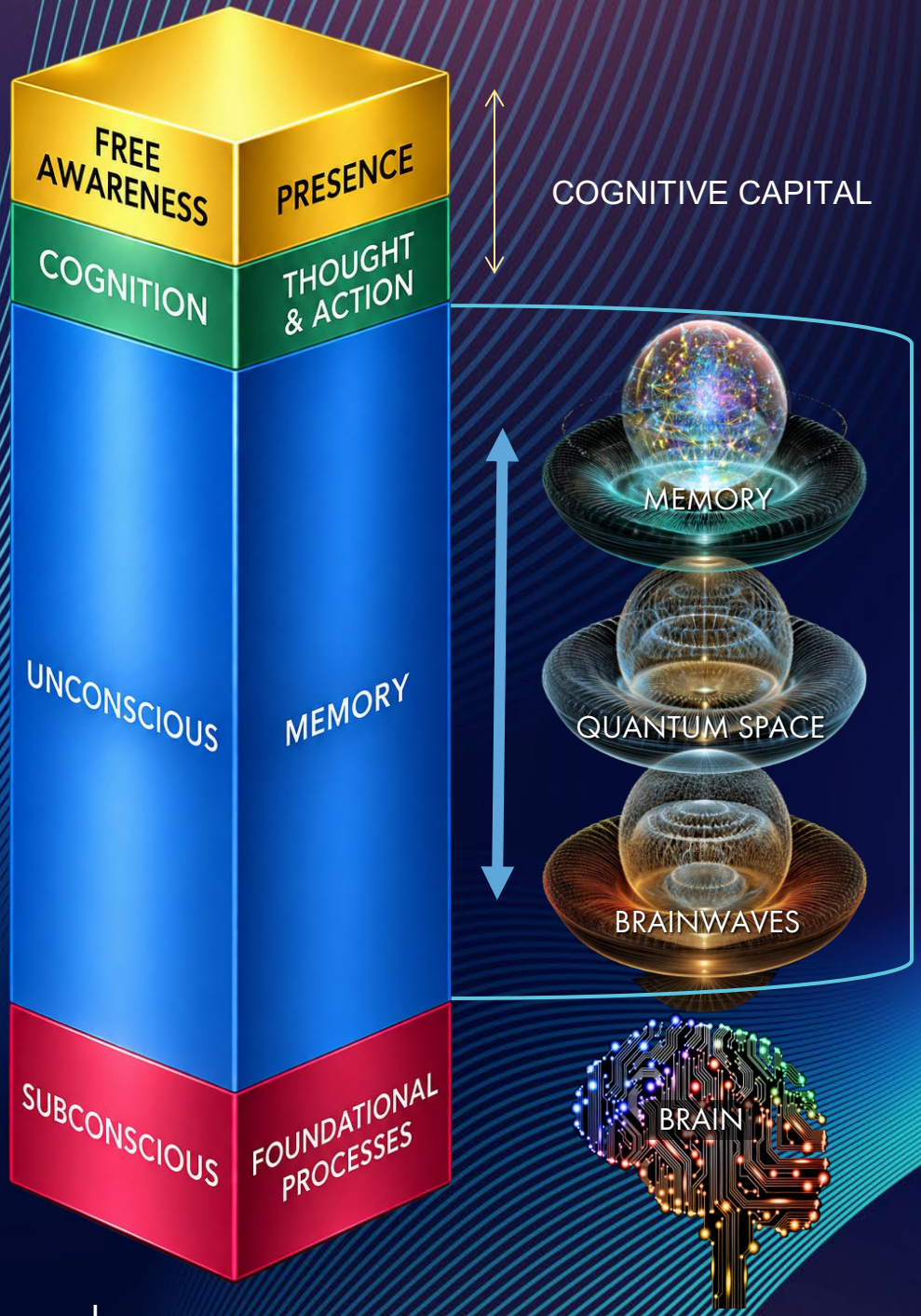
2. Inclusivity and Social Concerns: Introducing genetic upgrades raises legitimate concerns of misuse or inequality. The proposed ethos explicitly rejects any elitist or exclusionary application. Its principles are rooted in access, inclusivity, and the responsible use of biotechnology. It calls for robust institutional frameworks to govern distribution, safety, and fairness.

3. Scope of Impact: The book envisions cognitive enhancement as a catalyst for a new golden age. While aspirational, these outcomes cannot be guaranteed. They serve as guiding stars rather than fixed predictions. Real progress will depend on both scientific rigor and the ethical character of the individuals and communities who embrace these tools.

4. Conclusions: By acknowledging these critiques openly, we hope to invite dialogue, collaboration, and rigorous inquiry. *Becoming Supernormal* should not be seen as a finished doctrine, but as a living blueprint — one that evolves alongside the evidence, technologies, and values of humanity.

Awareness Characteristics and Content Density

	STATE	ATTRIBUTE	CONTENT	LOCATION	FREQUENCY	AMPLITUDE	DIMENSION	DESCRIPTION	DENSITY
1	BEING	CONSCIOUS	NONE	NON-LOCAL	✗	✗	SELF	FREE AWARENESS	
2	KNOWING	UNCONSCIOUS	INFORMATION	PHYSICAL UNIVERSE	✓	✓	TIME	MEMORY	
3					✓	✓	SPACE	Q-SPACE WAVES	
4					✓	✓	ENERGY	NEUROWAVES	
5					✓	✓	MATTER	IONS IN NEURONS	



Mind/Matter Interface

Mental information travels between consciousness and neurology through memory, quantum space and brainwave fields.

All brainwaves reflect unconscious activity.

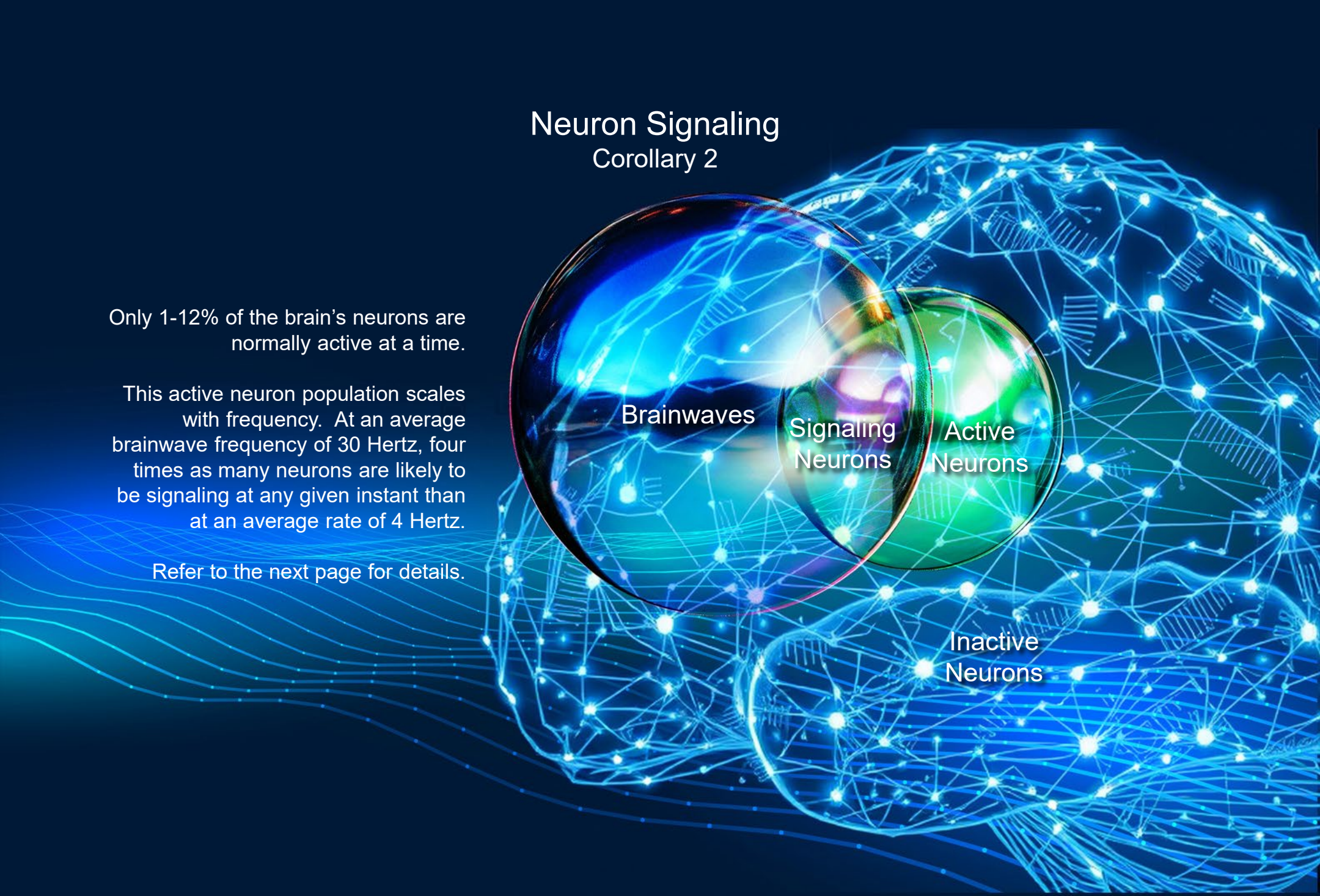
Neuron Signaling

Corollary 2

Only 1-12% of the brain's neurons are normally active at a time.

This active neuron population scales with frequency. At an average brainwave frequency of 30 Hertz, four times as many neurons are likely to be signaling at any given instant than at an average rate of 4 Hertz.

Refer to the next page for details.



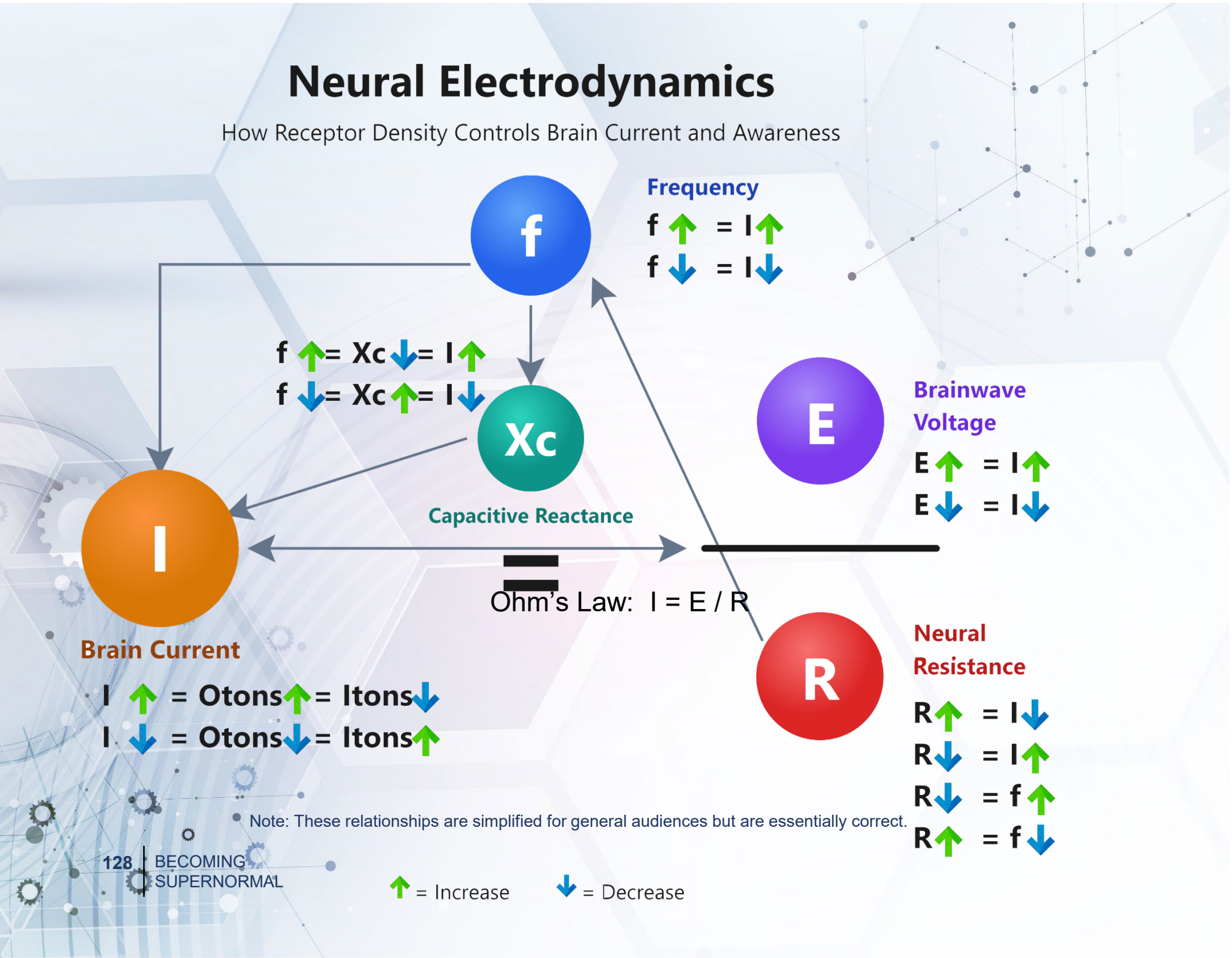
Neuron Signaling Analysis

EEG Band	Frequency Range (Hz)	Temporal Resolution (ms)	% of Neurons Active per second	% of Neurons Signaling (instantaneous)	% of Signaling Neurons that Synchronize	Net % of Total Neurons Driving the Wave
Delta	1–4	250–2000	1–3%	0.5–1%	40–50%	0.5–1%
Theta	4–8	125–250	3–6%	1–3%	40–60%	1–3%
Alpha	8–12	83–125	4–8%	2–4%	40–60%	2–4%
Beta	13–30	33–77	8–12%	4–7%	50–60%	4–7%

- Temporal resolution: How often excitability windows open each second (faster rhythms = finer timing).
- Active neurons: Percent that spike at least once per second (cycle-dependent).
- Signaling neurons: Percent spiking at the exact instant of measurement.
- Synchronization: The fraction of signaling neurons that align in phase.
- Net driving neurons: The effective percent of total neurons that contribute coherently to the oscillation.

Neural Electrodynamics

How Receptor Density Controls Brain Current and Awareness



Note: These relationships are simplified for general audiences but are essentially correct.

Current Density

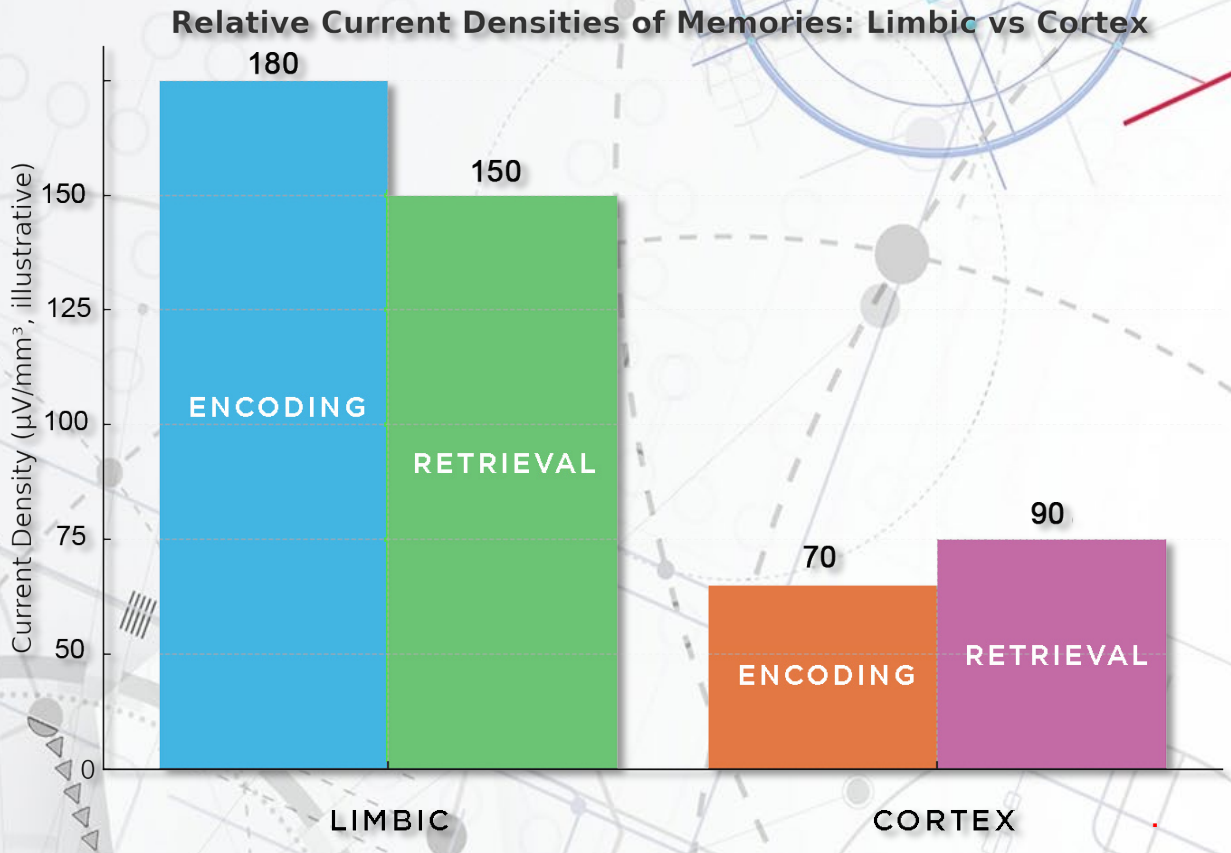
Limbic vs. Cortical Regions

01 The limbic system generates denser, more concentrated currents per unit volume during memory encoding, while cortical networks produce weaker but more widespread signals

02 The chart compares representative local field potential (LFP) amplitudes measured in limbic versus cortical regions during memory processes.

03 In hippocampus and amygdala (limbic structures), memory encoding produces high-amplitude sharp-wave ripple events (SWRs) in the range of ~150–200 μV, reflecting highly synchronized bursts of synaptic current.

04 In contrast, corresponding ripple-like activity in cortical networks typically falls in the ~50–80 μV range.



Encoding: Limbic amplitudes peak (~150–200 μV)
Retrieval: Limbic remains strong (~120–180 μV),

Encoding: Cortex lower (~50–80 μV).
Retrieval: Cortex rises slightly (~70–100 μV), reflecting its role in detailed recall.

Current Densities of Memories References

Buzsáki, G. (2015). Hippocampal sharp wave–ripple: A cognitive biomarker for episodic memory and planning. Hippocampus, 25(10), 1073–1188. https://doi.org/10.1002/hipo.22488

Dickey, C. W., Sargsyan, A., Madsen, J. R., Eskandar, E. N., Cash, S. S., Halgren, E., & Mehta, A. D. (2022). Cortical ripples during NREM sleep and waking in humans. Journal of Neuroscience, 42(42), 7931–7946. https://doi.org/10.1523/JNEUROSCI.0609-22.2022

Dickey, C. W., Sargsyan, A., Madsen, J. R., Eskandar, E. N., Cash, S. S., Halgren, E., & Mehta, A. D. (2022). Widespread ripples synchronize human cortical activity. Proceedings of the National Academy of Sciences, 119(27), e2202537119. https://doi.org/10.1073/pnas.2202537119

Dickey, C. W., Eskandar, E. N., Madsen, J. R., Halgren, E., Mehta, A. D., & Cash, S. S. (2024). Human ripples link hippocampus, cortex, and thalamus at rest and in memory. PLOS Biology, 22(2), e3002524. https://doi.org/10.1371/journal.pbio.3002524

Norman, Y., Yeagle, E. M., Khuvis, S., Harel, M., Mehta, A. D., & Malach, R. (2021). Hippocampal ripples and their coordination with neocortical activity during human memory retrieval. Neuron, 109(2), 402–413.e5. https://doi.org/10.1016/j.neuron.2020.10.032

Pedrosa, R. P., Clawson, B. C., Bakhurin, K. I., Latchoumane, C.-F. V., & Halgren, E. (2022). Coordination of hippocampal sharp wave ripples and neocortical activity during human memory consolidation. Proceedings of the National Academy of Sciences, 119(10), e2117565119. https://doi.org/10.1073/pnas.2117565119

Sakon, J. J., Munoz, C., Cash, S. S., Halgren, E., & Mehta, A. D. (2024). Hippocampal ripples track episodic memory encoding and retrieval in humans. Journal of Neuroscience, 44(6), 1031–1045. https://doi.org/10.1523/JNEUROSCI.1822-23.2023

Costa, K. M., Giocomo, L. M., Staresina, B. P., & Hauk, O. (2022). Aversive memory formation in humans involves an amygdala–hippocampus network. Nature, 610, 345–351. https://doi.org/10.1038/s41586-022-05228-0

Qasim, S. E., Fried, I., & Jacobs, J. (2021). Neuronal activity in the human amygdala and hippocampus enhances emotional memory encoding. bioRxiv. https://doi.org/10.1101/2021.02.17.431672

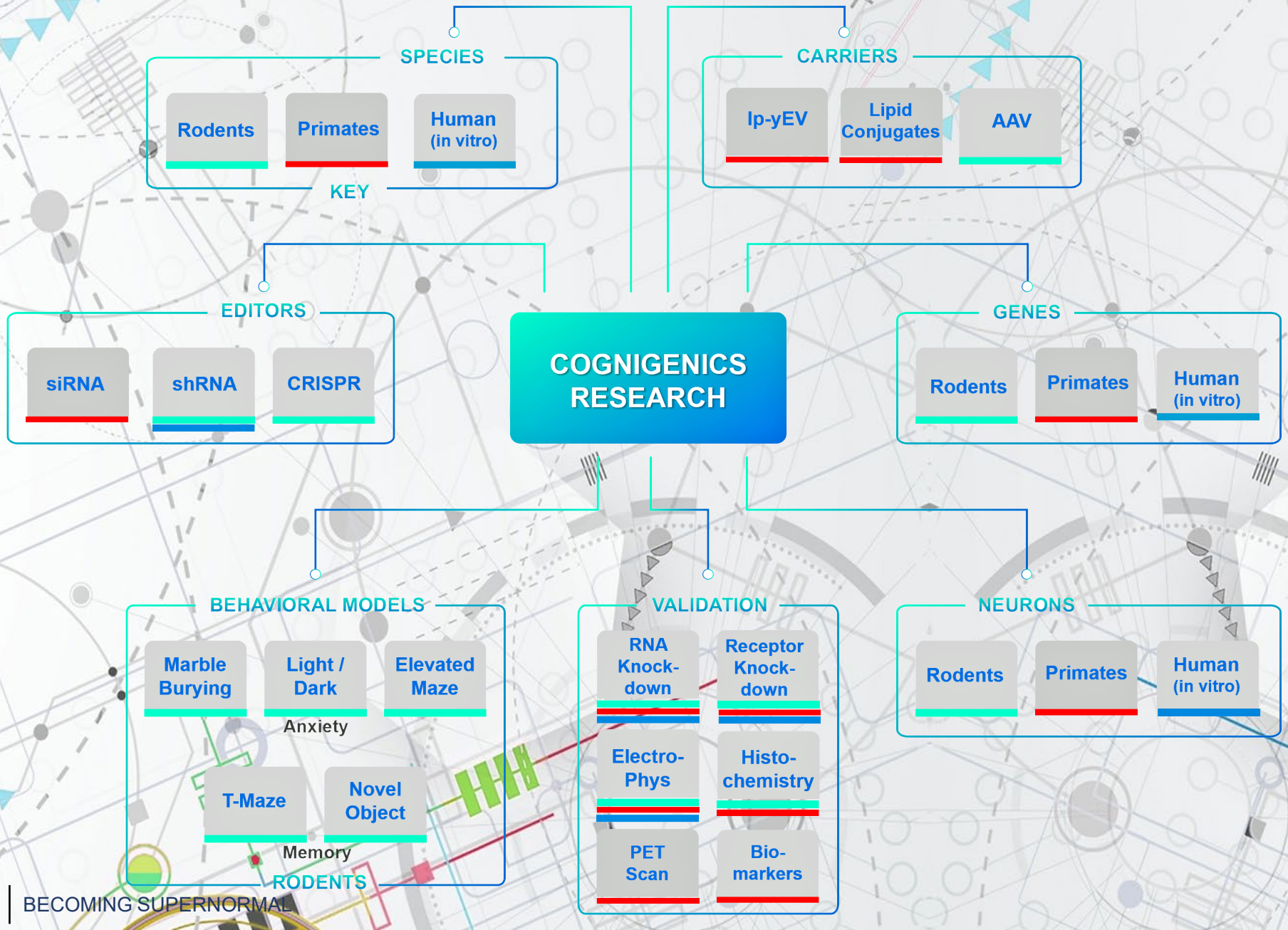
Butt, M., Almourad, M. B., & Hamid, Q. (2019). Brain signals of posttraumatic stress disorder filtered using EEG and MEG: A review. Frontiers in Human Neuroscience, 13, 133. https://doi.org/10.3389/fnhum.2019.00133

Radiske, A., Gonzalez, M. C., Rossato, J. I., Köhler, C. A., Bevilaqua, L. R., & Cammarota, M. (2020). Cross-frequency phase–amplitude coupling between theta and gamma rhythms in the amygdala–hippocampus is enhanced during avoidance memory reconsolidation. eNeuro, 7(1), ENEURO.0465-19.2020. https://doi.org/10.1523/ENEURO.0465-19.2020

Experimental Results

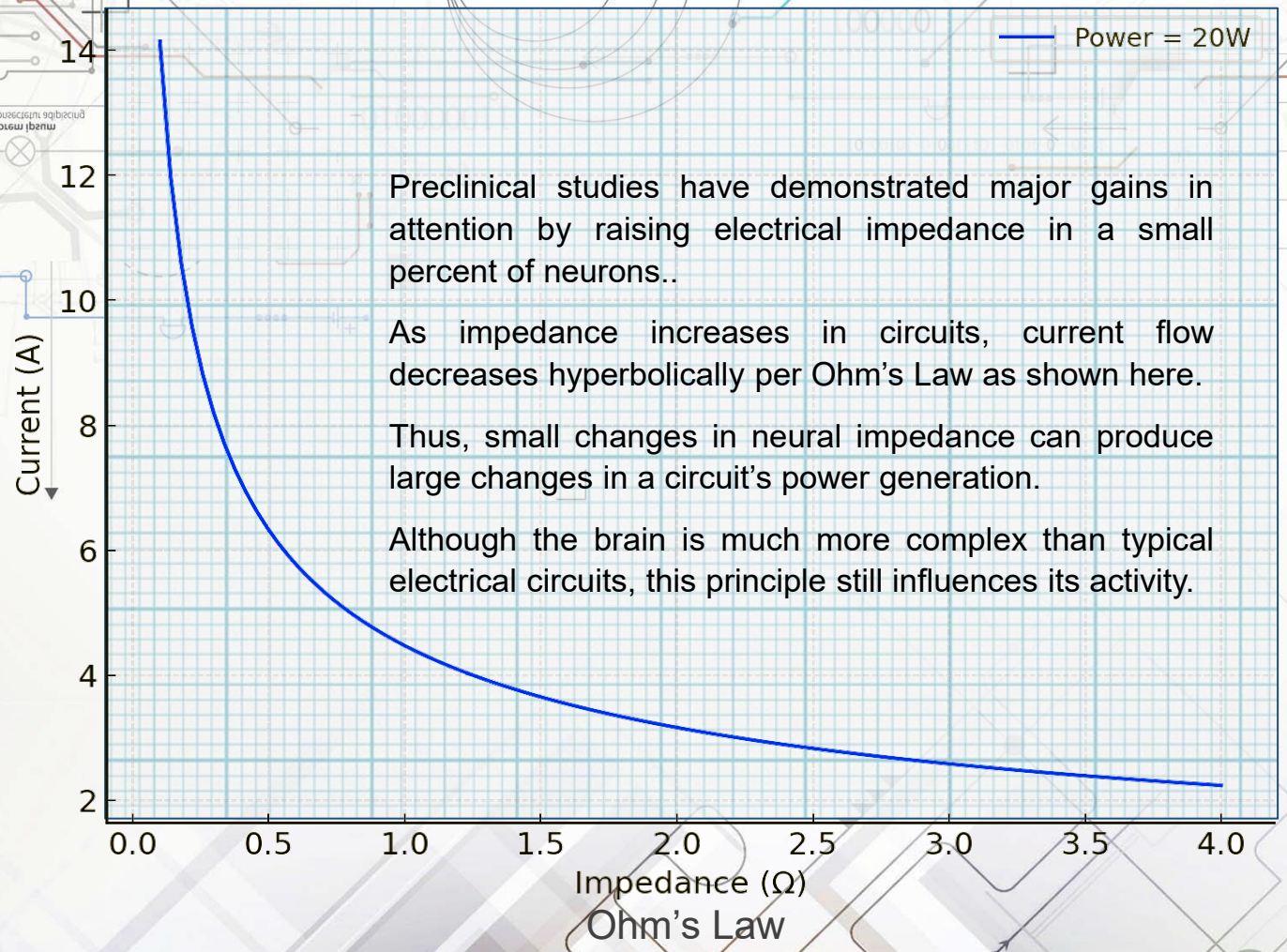
Cognitive neuroengineering has been validated in multiple species using multiple payload carriers with multiple gene editors for multiple genes.

Results have been replicated across multiple behavioral models and validated in multiple diagnostic assays on multiple neuron types.



Experimental Results Interpretation

Current vs. Impedance for 20W



Preclinical studies have demonstrated major gains in attention by raising electrical impedance in a small percent of neurons..

As impedance increases in circuits, current flow decreases hyperbolically per Ohm's Law as shown here.

Thus, small changes in neural impedance can produce large changes in a circuit's power generation.

Although the brain is much more complex than typical electrical circuits, this principle still influences its activity.

Brainwave Frequency

Low-Frequency Brainwaves and Mental Clarity

Low-frequency brainwaves—specifically delta, theta, and alpha—are correlated with states of deep relaxation, inner stillness, and enhanced creativity. These patterns commonly emerge during meditation, deep sleep, and other altered states of consciousness. Their presence is associated with reduced anxiety, heightened clarity, and improved memory performance.

DMN Activity and Meditation

Functional MRI studies reveal that experienced meditators show reduced activity in the brain's default mode network (DMN), a network involved in mind-wandering and self-referential thought (Brewer et al., 2011). Suppressed DMN activity is closely linked to enhanced mindfulness and metacognitive awareness, contributing to improved emotional regulation and lower stress levels (Garrison et al., 2015; Pagnoni, 2012).

Altered States and Neural Activity

Altered states of consciousness—whether induced by meditation, psychedelics, or breathwork—often lead to a reduction in DMN activity and greater synchrony among neural oscillations. These shifts are linked to experiences of ego-dissolution, expanded self-awareness, and transcendental or mystical insights (Brewer et al., 2013; Carhart-Harris et al., 2012).

Theta Waves, Memory, and Intuition

Theta brainwaves are integral to memory encoding and retrieval. They facilitate the consolidation of newly acquired information and are often elevated during learning and problem-solving tasks (Klimesch, 1999). In addition to their cognitive roles, theta waves are associated with intuitive insight and self-awareness. During meditation, heightened theta activity has been linked to improved decision-making and a deeper connection with inner experience (Basar et al., 2001).

Brainwave Changes from Meditation

Meditation is known to increase both alpha (8–12 Hz) and theta (4–8 Hz) wave activity. Alpha waves are characteristic of a calm, alert mental state, while theta waves reflect deeper meditative and intuitive states. The increase in these rhythms contributes to greater emotional balance, relaxation, and attentional control—facilitating a more present-focused awareness (Cahn & Polich, 2006; Tomasino et al., 2012).

Brainwave Frequency

Brain Structure, Intelligence, and Alpha Waves

Cognitive ability is strongly influenced by brain structure. Studies indicate that individuals with greater dendritic density and more complex gray matter arborization tend to perform better on intelligence measures (Genc et al., 2018). Higher levels of alpha wave activity are also associated with mental clarity, working memory performance, and effective problem-solving (Bazanova & Vernon, 2014).

Psychedelics, Entropy, and Mystical States

Psychedelics such as psilocybin and LSD provide insight into how brain activity changes during spiritual or mystical experiences. These compounds reduce activity in the DMN and shift brain oscillations toward more flexible, less predictable patterns—a phenomenon referred to as increased neural entropy (Carhart-Harris et al., 2014). This may explain the heightened imagination, emotional depth, and cognitive flexibility often reported during psychedelic sessions (MacLean et al., 2011; Kometer et al., 2015; Carhart-Harris et al., 2012; Muthukumaraswamy et al., 2013).

Alpha-Theta Neurofeedback and Creativity

Neurofeedback techniques that train individuals to elevate both alpha and theta wave activity have been shown to support creativity and reduce anxiety. By receiving real-time feedback on their brain activity, individuals can learn to shift into more optimal cognitive states that support creative thought and emotional calm (Gruzelier, 2009).

Alpha Waves and Emotional Regulation

Increased alpha brainwave activity has been consistently associated with improved emotional resilience and stability. Individuals with naturally higher alpha activity tend to experience lower levels of stress and enhanced emotional regulation (Davidson, 2004). Mindfulness meditation also plays a key role, helping individuals manage emotional responses and reduce negative affect (Taylor et al., 2011).

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Evidence Base

01 Supernormal Benefits

Neuroscience experiments providing evidence for benefits of downregulating HTR2A expression.

Technical Appendix 1: Supporting evidence categorized by **experimental domain**

02 Corollary 2

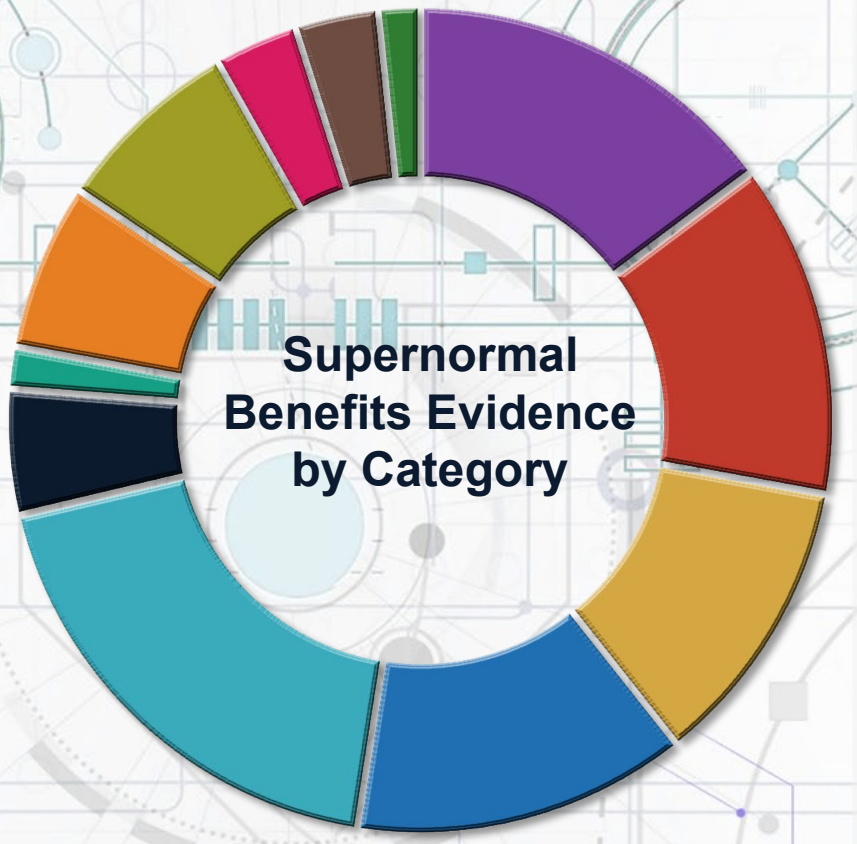
Scientific literature associating attenuated neural activity and brainwave power with expanded conscious awareness and cognitive ability

Technical Appendix 2: Experimental studies supporting Corollary 2 indexed by **evidence strength**

Technical Appendix 3: Supporting experiments organized by participants' **cognitive state density**

Note: Neuroscience is an evolving field and scientists still frequently disagree on many subjects. Contrary experimental evidence is common across many domains and this one is no exception. However, the supporting experiments outweigh the confounding ones.

Supernormal Benefits Evidence by Category



5-HT2A Downregulation
Cognitive Advantages

122 experiments in 12 categories
See the Reference section for details.

Supporting Experiment Counts by Domain

Psychedelic neuroimaging MEG, fMRI and EEG under psilocybin, LSD, DMT and ayahuasca	18
Psychedelic clinical trials RCTs: depression, anxiety, personality and mindfulness outcomes	16
Neural efficiency Higher ability and expertise use less cortical activation per task	14
Meditation: DMN and awareness Midline prefrontal and cingulate suppression during and after practice	16
Meditation: attention and emotion Attentional capacity, amygdala reactivity, emotional regulation	23
Meditation: structural anatomy MRI and DTI: grey and white matter change with practice hours	6
Advanced and non-dual states Practitioners imaged in states without ordinary self-boundaries	2
Flow and optimal performance Prefrontal and amygdala deactivation predicts flow intensity	8
EEG alpha, creativity, insight Alpha as inhibitory gating; cortical quieting precedes insight	9
Neurofeedback Closed-loop training into lower-excitation states; causal by design	4
DMN and mind-wandering Elevated midline activity tracks distraction moment to moment	4
Longevity and healthspan REST suppresses excitation and extends lifespan across species	2
Total	**122**

01

DETAIL

Technical Appendix 1: Evidence Base for Supernormal Benefits

This section lists the scientific evidence supporting the claims presented for Supernormal benefits. It gives methodological details, effect sizes and complete citations, organised by research domain. Evidence strength ratings reflect the quality, consistency and replicability of findings across the literature

.Contents

Section	Contents
Appendix A	Anxiety reduction — primary studies, human clinical evidence, sleep and memory mechanisms
Appendix B	Depression and mood — current receptor evidence, SSRI mechanism, circuit framing
Appendix C	Hippocampal hyperactivity — anatomical distribution, electrophysiology, Bakker trial
Appendix D	Limbic hyperactivity and neuroprotection — meta-analyses, stress mechanisms
Appendix E	Neural excitation and cognitive longevity — REST, excitotoxicity, causal chain
Appendix F	Memory enhancement — direct evidence and mechanism
Appendix G	Attention — blocking studies and antagonist effects
Appendix H	Cognitive function and neural efficiency
Appendix I	The psychedelic paradox — receptor dynamics and the three-phase model
Appendix J	Long-term safety — what is documented and what is not
Appendix K	Individual differences — illustrative response model
Appendix L	Complete reference list, classified by evidentiary role
Appendix M	Summary evidence table
Appendix N	Open documentation items

Appendix A: Anxiety reduction

A.1 Primary animal studies

Rohn, T.T., Radin, D., Brandmeyer, T., Seidler, P.G., Linder, B.J., Lytle, T., Mee, J.L., & Macciardi, F. (2024). *Intranasal delivery of shRNA to knockdown the 5HT-2A receptor enhances memory and alleviates anxiety. Translational Psychiatry*, 14, 154.

- AAV9 vector carrying shRNA against HTR2A, delivered intranasally in mice and rats.
- Knockdown confirmed at mRNA and protein level in treated animals.
- Multi-electrode array recording in human iPSC-derived neurons showed decreased spontaneous electrical activity following knockdown.
- Reduced anxiety-like behaviour in mice on standard conflict paradigms.
- No effects observed on locomotion or feeding.

Parameter	Value
Model	Mice and rats; human iPSC-derived neurons in vitro
Intervention	Intranasal AAV9-shRNA targeting HTR2A (COG-201)
Anxiety measures	Elevated plus maze, open field
Reported anxiety effect	34% reduction in anxiety-related behaviour (see note below)
Electrophysiology	Decreased spontaneous activity, multi-electrode array
Motor effects	None observed

Rohn, T.T., et al. (2023). Genetic modulation of the HTR2A gene reduces anxiety-related behavior in mice. *PNAS Nexus*, 2(6), pgad170.

- CRISPR-based genetic disruption of HTR2A in mice.

- Approximately 68% reduction in 5-HT2A immunostaining.
- Significantly reduced anxiety-like behaviour.

Weisstaub, N.V., Zhou, M., Lira, A., et al. (2006). Cortical 5-HT2A receptor signaling modulates anxiety-like behaviors in mice. *Science*, 313(5786), 536-540.

- Global 5-HT2A knockout reduced conflict anxiety.
- Cortex-restricted restoration of 5-HT2A signalling reinstated the anxiety phenotype.
- Fear-conditioned and depression-related behaviours were unaffected, indicating specificity to conflict anxiety.
- Independent of the Rohn programme. This is the strongest causal evidence in the corpus and establishes cortical rather than subcortical mediation.

Millan, M.J. (2003). The neurobiology and control of anxious states. *Progress in Neurobiology*, 70(2), 83-244. Review establishing 5-HT2A as an anxiogenic receptor subtype, differentiated from 5-HT1A.

A.2 Human clinical evidence

No human trial of HTR2A knockdown has been conducted. The human evidence below concerns pharmacological 5-HT2A antagonism and inverse agonism, which is a related but not identical intervention.

Pimavanserin (5-HT2A inverse agonist)

Study	N	Design	Finding
Cummings et al. (2014) Lancet	199	Phase 3 RCT	Improved psychosis in Parkinson disease without cognitive impairment
Meltzer et al. (2010) Neuropsychopharmacology	60	Phase 2 RCT	No sedation, no motor effects
Kitten et al. (2018) Innov Clin Neurosci	—	Review	Safety profile summarised

Required qualification. Pimavanserin carries a boxed warning for increased mortality in elderly patients with dementia-related psychosis. Any use of the pimavanserin literature to support a safety claim must state this.

Ritanserin

Study	N	Design	Finding
Reyntjens et al. (1986) Drug Dev Res	40	Controlled trial	Anxiolytic without sedation
Louwerens et al. (1986) Psychopharmacology	24	Crossover (abstract)	No driving impairment

Qualification. Both entries predate CONSORT reporting standards and trial registration, and the second is a supplement abstract rather than a full paper. Randomisation, blinding and outcome selection cannot be evaluated.

A.3 Sleep

Study	Finding
Landolt et al. (1999) Neuropsychopharmacology	5-HT2A antagonism increases slow-wave sleep
Landolt et al. (2009) Eur Neuropsychopharmacol	Confirmatory sleep architecture effects
Sharpley et al. (1990) Psychopharmacology	Dose-dependent slow-wave sleep enhancement (short report)
Monti (2011) Sleep Med Rev	5-HT2A blockade reduces awakenings
Rosenberg et al. (2008) Sleep Medicine	Eplivanserin Phase 2: improved sleep maintenance without next-day cognitive impairment
Staner (2003) Dialogues Clin Neurosci	Bidirectional anxiety-sleep relationship

A.4 Memory improvement via anxiety reduction

Shields, G.S., et al. (2017). The effects of acute stress on episodic memory: a meta-analysis. *Psychological Bulletin*, 143(6), 636-675. Meta-analysis of 113 studies. Acute stress impairs encoding and retrieval; d = -0.22 to -0.34 depending on memory phase.

Eysenck, M.W., et al. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion*, 7(2), 336-353. Theoretical framework: anxiety consumes working memory resources; processing efficiency degrades before accuracy.

Schwabe et al. (2012) and Robinson et al. (2013) provide converging evidence on stress and anxiety effects on cognitive performance.

A.6 Well-being

Study	Finding
Olatunji et al. (2007) Clin Psychol Rev	Anxiety reduces quality of life comparably to depression
Mendlowicz & Stein (2000) Am J Psychiatry	All anxiety disorders impair well-being
Hofmann et al. (2010) J Consult Clin Psychol	Treatment restores well-being metrics

A.6 Evidence strength: anxiety

Claim	Rating	Basis
5-HT2A downregulation reduces anxiety-like behaviour in rodents	Strong (preclinical)	Three genetic studies, two approaches; Weisstaub independent and causal. Two of three are sponsor-affiliated.
Decreased anxiety improves sleep	Strong	Dose-response, multiple antagonists, mechanism known
Reduced anxiety improves memory	Strong	Meta-analysis of 113 studies, clear mechanism
Lower anxiety improves well being	Strong	Consistent across treatment modalities

Appendix B: Depression and mood

B.1 What the receptor evidence shows

Chapman, G.E., Turner, G., Noar, A.P., Barba, T., Zafar, R., McCutcheon, R.A., & Erritzoe, D. (2025). Cortical 5-HT2A receptors in depression and suicide: a systematic review and meta-analysis of in vivo and post-mortem imaging studies. *Molecular Psychiatry*, 30(12), 6045-6062.

- Ten PET and SPECT case-control studies, 188 patients and 170 controls; 19 post-mortem radioligand binding studies, 349 patients or suicide victims and 356 controls.
- Cortical 5-HT2A binding was significantly lower in unmedicated patients with major depressive disorder than in controls, in frontal, prefrontal, cingulate and anterior cingulate cortex. Hedges g = -0.40 to -0.57.
- In frontal and cingulate regions, binding effect size correlated with depression severity at baseline.
- The results of most post-mortem analyses were negative, and included studies were of variable quality.

Study	Population	Direction of finding
Yatham et al. (2000) Arch Gen Psychiatry	Depressed patients	Approximately 22% lower cortical 5-HT2 binding; authors concluded receptors were decreased
Meyer et al. (2001) Am J Psychiatry	Depressed, medication-free	No baseline difference from controls
Bhagwagar et al. (2006) Am J Psychiatry	Euthymic, recovered, medication-free	19-25% higher cortical binding. [11C]MDL 100,907 PET. A trait marker in remission, not a finding in active depression
Pandey et al. (2002) Am J Psychiatry	Teenage suicide victims	Increased 5-HT2A mRNA and protein in prefrontal cortex

Study	Population	Direction of finding
Massou et al. (1997) Psychopharmacology	SSRI-treated vs untreated depressed	Higher frontal binding with treatment, suggesting SSRI-associated upregulation
Meyer et al. (2003) Am J Psychiatry	Depressed patients	Binding related to dysfunctional attitudes; not a case-control density study

B.2 SSRI mechanism

Chronic SSRI treatment alters 5-HT2A receptor availability. Meyer et al. (2001) reported age-dependent downregulation with paroxetine; Massou et al. (1997) reported higher binding in treated patients. The time course of receptor change broadly matches the two to four week therapeutic delay, which is the basis of the mechanistic evidence.

Celada, P., Puig, M.V., & Artigas, F. (2013). Serotonin modulation of cortical neurons and networks. *Frontiers in Integrative Neuroscience*, 7, 25. 5-HT2A antagonism disinhibits prefrontal pyramidal neurons.

Marek, G.J., et al. (2003). Synergistic action of 5-HT2A antagonists and selective serotonin reuptake inhibitors in neuropsychiatric disorders. *Neuropsychopharmacology*, 28(2), 402-412. Combined 5-HT2A antagonism and SSRI superior to SSRI alone, The proposed mechanism is increased prefrontal serotonin release.

Carhart-Harris, R.L., et al. (2016). Psilocybin with psychological support for treatment-resistant depression. *The Lancet Psychiatry*, 3(7), 619-627. Open-label, n = 12, no control arm.

B.3 Depression claim

Reducing 5-HT2A signalling does not require elevated receptor density to be therapeutic. A receptor population at normal density can contribute excess functional drive within a circuit, and reducing that drive can alter circuit behaviour whether or not density was ever abnormal. The augmentation literature in B.3 indicates that 5-HT2A antagonism improves antidepressant response in patients with normal receptor density.

B.4 Evidence strength: depression

Claim	Rating	Basis
5-HT2A findings in MDD are heterogeneous and depend on medication status, region, suicidality and episode state	Strong	Chapman 2025 meta-analysis plus the individual studies in B.1
Cortical 5-HT2A binding is lower in unmedicated MDD than in controls	Moderate-Strong	Chapman 2025, ten in vivo studies, g = -0.40 to -0.57
Elevated cortical 5-HT2A binding is found post-mortem in suicide	Moderate	Pandey 2002 and converging post-mortem work; distinct from MDD
5-HT2A antagonism augments antidepressant response	Strong	Marek 2003, Celada 2013
↑5-HT2A density in depression	Withdrawn	Not supported by the aggregate evidence; previously rated Strong in error

Appendix C: Hippocampal hyperactivity

C.1 Receptor distribution

Pompeiano, M., et al. (1994). *Molecular Brain Research*, 23(1-2), 163-178. Distribution of 5-HT2A mRNA in rat brain.

Cornea-Hébert, V., et al. (1999). *Journal of Comparative Neurology*, 409(2), 187-209. 5-HT2A immunoreactivity in rat CNS. Hippocampal 5-HT2A receptors are expressed predominantly at dendritic sites on pyramidal neurons.

Luttgen, M., et al. (2004). *Brain Research*, 1010(1-2), 156-165.

C.2 Electrophysiology

Beck, S.G. (1992). 5-Hydroxytryptamine increases excitability of CA1 hippocampal pyramidal cells. *Synapse*, 10(4), 334-340.

- Intracellular recording in rat hippocampal slices, CA1.
- Serotonin increased subthreshold rectification, increased input resistance, and increased the amplitude of subthreshold excitatory postsynaptic potentials sufficient to initiate spike firing.
- The 5-HT2-selective agonist DOI reproduced the effect; the antagonist ketanserin blocked it.
- Qualification: the pharmacology available at the time does not separate 5-HT2A from 5-HT2C.

Wang, R.Y., & Arvanov, V.L. (1998). M100907, a highly selective 5-HT2A receptor antagonist and a potential atypical antipsychotic drug, facilitates induction of long-term potentiation in area CA1 of the rat hippocampal slice. *Brain Research*. Volume and page numbers to be confirmed before citation.

- Selective 5-HT2A antagonism facilitated LTP induction in CA1, indicating that 5-HT2A tone constrains hippocampal plasticity.

C/3 In vivo glutamate and firing rate

Zhang, G., & Stackman, R.W., et al. (2015). *Learning & Memory*, 22(9), 498-506.

- 5-HT2A receptor activation increased extracellular glutamate efflux in dorsal hippocampus.
- 5-HT2A activation increased basal firing rates of CA1 pyramidal neurons in awake behaving mice.
- Immuno-electron microscopy localised 5-HT2A to dendritic spines, shafts and presynaptic terminals of CA1 neurons.

In the same study, 5-HT2A activation facilitated object memory consolidation through this glutamate mechanism. The excitability mechanism supports the present framework although the behavioural direction in that paper does not. The resolution is dose and timing: acute receptor activation during a consolidation window is a different manipulation from sustained reduction of baseline receptor tone.

Aghajanian, G.K., & Marek, G.J. (1997). Serotonin induces excitatory postsynaptic potentials in apical dendrites of neocortical pyramidal cells. *Neuropharmacology*, 36(4-5), 589-599. 5-HT2A activation drives glutamate release onto pyramidal cells. Cortical rather than hippocampal, and the primary mechanistic anchor for the framework.

C.4 Hippocampal hyperactivity and memory in humans

Bakker, A., et al. (2012). Reduction of hippocampal hyperactivity improves cognition in amnestic mild cognitive impairment. *Neuron*, 74(3), 467-474.

- Double-blind, placebo-controlled crossover in amnestic MCI patients.
- Low-dose levetiracetam normalised hippocampal hyperactivity on fMRI and improved memory performance.
- Sample size should be checked against the published trial before any N is quoted.

Study	Finding
Yassa et al. (2010) NeuroImage	Hippocampal hyperactivity in ageing and memory impairment
Putcha et al. (2011) J Neurosci	Hyperactivation in prodromal Alzheimer disease
Miller et al. (2008) JNNP	Hippocampal activation and memory in MCI
Wilson et al. (2006) Trends Neurosci	Review: ageing hippocampal circuit dysfunction
Bakker et al. (2015) NeuroImage Clin	Dose finding for hippocampal normalisation

Study	Finding
Leal et al. (2017) Behav Neurosci	Hyperactivity and memory specificity

C.5 Evidence strength: hippocampal hyperactivity

Claim	Rating	Basis
Hippocampal hyperactivity impairs memory and predicts decline	Very Strong	Bakker 2012, replicated, longitudinal human data
Reducing hippocampal hyperactivity improves memory	Strong	Bakker 2012, placebo-controlled
5-HT2 activation increases CA1 pyramidal excitability	Strong	Beck 1992, intracellular recording
5-HT2A activation increases hippocampal glutamate and CA1 firing	Strong	Zhang 2015, in vivo, awake behaving
5-HT2A antagonism alters hippocampal plasticity	Moderate	Wang & Arvanov 1998, single slice study, citation to be confirmed
5-HT2A knockdown reduces hippocampal hyperactivity in vivo	Not established	Mechanistically plausible; not directly tested

Appendix D: Limbic hyperactivity and neuroprotection

This section establishes that sustained limbic hyperactivation is harmful., The inference from this literature is that a 5-HT2A reduction may have a cognitive health benefitl.

Study	Finding
Etkin & Wager (2007) Am J Psychiatry	Meta-analysis: amygdala hyperactivation across anxiety disorders
Sheline et al. (2001) Biol Psychiatry	Amygdala response normalises with treatment
Harmer et al. (2006) Biol Psychiatry	Antidepressant effects on emotional processing
Peluso et al. (2009) Psychiatry Res Neuroimaging	Amygdala reactivity in mood disorder
Sapolsky (2000) Arch Gen Psychiatry	Glucocorticoid neurotoxicity and hippocampal atrophy
McEwen et al. (2016) Neuropsychopharmacology	Allostatic load and structural remodelling
Radley et al. (2006) Cereb Cortex	Stress-induced dendritic remodelling in prefrontal cortex
Lupien et al. (2009) Nat Rev Neurosci	Stress effects across the lifespan
Mattson & Magnus (2006) Nat Rev Neurosci	Ageing and neuronal vulnerability

Claim	Rating	Basis
Limbic hyperactivation characterises anxiety and depression	Very Strong	Meta-analyses

Study	Finding	
Treatment normalises limbic activity	Strong	Multiple fMRI studies
Chronic hyperactivation causes structural damage	Strong	Sapolsky, McEwen, Radley
5-HT2A↓ reduces limbic hyperactivity	Moderate (inferred)	No direct test; mechanism plausible via cortical control of limbic output

Appendix E: Neural excitation and cognitive longevity

E.1 Excitation and lifespan

Zullo, J.M., et al. (2019). Regulation of lifespan by neural excitation and REST. *Nature*, 574(7778), 359-364.

Finding	Detail
Human observation	Extended-longevity individuals showed higher REST expression and lower excitation markers in cortical tissue
Causal test	Increasing REST or decreasing excitation extended lifespan in C. elegans
Reverse test	Decreasing REST or increasing excitation shortened lifespan
Conservation	Pattern held across worms, mice and human tissue
Mechanism	REST represses synaptic and excitation-related genes

Lu, T., et al. (2014). REST and stress resistance in ageing and Alzheimer disease. *Nature*, 507(7493), 448-454. REST is induced in normal ageing neurons and lost in mild cognitive impairment and Alzheimer disease; it represses pro-apoptotic genes and protects against oxidative stress and amyloid toxicity.

E.2 Hyperexcitability and cognitive decline

Study	Finding
Bakker et al. (2012) Neuron	Hippocampal hyperactivity predicts progression in amnestic MCI
Vossel et al. (2013) JAMA Neurology	Subclinical epileptiform activity accelerates cognitive decline in early Alzheimer disease
Sanchez et al. (2012) PNAS	Levetiracetam reverses network dysfunction and cognitive deficits in hAPP mice
Haberman et al. (2017) Neurobiol Aging	Cortical excitability correlates with memory impairment in aged rodents

E.3 The causal chain

The framework proposes: 5-HT2A activation drives glutamate release (Aghajanian & Marek 1997; Zhang 2015) → increased neuronal excitation → accelerated cellular ageing and network dysfunction (Zullo 2019; Lu 2014) → cognitive decline (Bakker 2012; Vossel 2013). Each link is supported although the chain as a whole has not been tested end to end with a 5-HT2A manipulation,

Claim	Rating	Basis
Neural excitation accelerates ageing	Very Strong	Zullo 2019, cross-species causal manipulation
REST suppression of excitation extends lifespan	Very Strong	Zullo 2019, conserved
Hippocampal hyperactivity predicts Alzheimer progression	Very Strong	Bakker, Vossel, longitudinal
5-HT2A↑ → glutamate → hyperexcitability	Strong	Aghajanian & Marek mechanism, Zhang in vivo
5-HT2A↓ extends cognitive longevity	Hypothesis	Logical chain from established components; awaits direct test

Appendix F: Memory enhancement

F.1 Direct evidence

Rohn et al. (2024), Translational Psychiatry, 14, 154, reported memory improvement on novel object recognition following intranasal HTR2A knockdown, relative to vehicle-treated animals.

Parameter	Value
Memory test	Novel object recognition
Effect, rats	92% improvement versus vehicle
Effect, mice	104% improvement versus vehicle
Headline figure used in this document	92% (rats), the more conservative of the two published values
Supporting in vitro finding	Reduced spontaneous electrical activity, human iPSC-derived neurons, multi-electrode array
Analysis	Bayesian analysis of memory outcome reported in the paper

F.2 Mechanism

Study	Finding
Harvey (2003) Learn Mem	5-HT2A modulates learning; optimal function requires moderate rather than maximal activity
Zhang & Stackman (2015) Learn Mem	5-HT2A signalling affects hippocampal glutamate, CA1 firing and object memory consolidation
Meneses (2013) Rev Neurosci	Review: 5-HT2A antagonists enhance memory under stress conditions
Klimesch (1999) Brain Res Rev	Theta rhythms are critical for encoding. Does not concern 5-HT2A

F.3 Evidence strength: memory

Claim	Rating	Basis
5-HT2A↓ improves recognition memory in rodents	Strong (preclinical)	Rohn 2024, two species, single study, single laboratory
Mechanism via reduced neuronal excitability	Moderate-Strong	MEA confirmation in vitro; Beck 1992 and Zhang 2015 for the excitability link

Appendix G: Attention

G.1 Agonists impair attention

Study	Agent	Finding
Carter et al. (2005) J Cogn Neurosci	Psilocybin	Impaired sustained attention and working memory
Umbricht et al. (2003) Neuropsychopharmacology	Psilocybin	Impaired AX-CPT performance
Gouzoulis-Mayfrank et al. (1999) Psychopharmacology	Psilocybin	Concentration and vigilance deficits

G.2 The blocking study

Quednow, B.B., et al. (2012). *Neuropsychopharmacology*, 37(3), 630-640.

Parameter	Value
Design	Placebo-controlled, ketanserin pretreatment before psilocybin
Finding	Ketanserin blocked psilocybin-induced attentional deficits
Implication	5-HT2A directly mediates the attentional impairment

This is among the strongest human causal evidence in the corpus.

G.3 Antagonist effects on attention

Study	Model	Agent	Finding
Carli & Invernizzi, 5-CSRTT programme	Rat	M100907	Prefrontal 5-HT2A modulates attentional performance. Specific citation to be confirmed.
Talpos et al. (2006) Psychopharmacology	Rat	MDL 100,907	Effects on attentional performance
Akhondzadeh et al. (2008) J Clin Pharm Ther	Alzheimer patients	Ritanserin	Reported attention outcome; agent and endpoint to be confirmed against the paper

G.4 Imaging and genetics

Frokjaer, V.G., et al. (2014). *Psychopharmacology*, 231(6), 1031-1040. Relationship between 5-HT2A binding and cognitive performance.

Preller, K.H., et al. (2019). *PNAS*, 116(7), 2743-2748. Role of 5-HT2A in the cortical effects of psilocybin.

G.5 Evidence strength: attention

Claim	Rating	Basis
5-HT2A agonists impair attention in humans	Very Strong	Three independent studies, consistent direction
5-HT2A blockade prevents that impairment	Very Strong	Quednow 2012, controlled, mechanistically decisive
5-HT2A antagonists improve attention in rodents	Moderate	Carli programme and Talpos 2006; citations to be confirmed
Genetic and imaging markers predict attention	Not established	Three of four supporting citations unlocatable and removed

Appendix H: Cognitive function and neural efficiency

H.1 Neural efficiency

PET and fMRI studies consistently demonstrate that individuals with higher cognitive ability show less neural activation when performing the same tasks as those with lower ability.

Study	Finding
Haier et al. (1988) Intelligence	Original neural efficiency observation, PET glucose metabolism
Neubauer & Fink (2009) Neurosci Biobehav Rev	Review of the neural efficiency literature
Basten et al. (2015) Intelligence	Meta-analysis of intelligence and brain activation
Genç et al. (2018) Nat Commun	Higher IQ associated with lower cortical dendritic density, diffusion MRI

H.2 Antipsychotic cognitive outcomes

Study	Finding
Keefe et al. (2007) Arch Gen Psychiatry	CATIE neurocognitive outcomes; no meaningful advantage for atypicals over perphenazine
Lieberman et al. (2005) NEJM	CATIE primary outcome; high discontinuation across all arms
Woodward et al. (2005) Int J Neuropsychopharmacol	Meta-analysis of cognitive effects of antipsychotics; study count to be confirmed before it is quoted
Meltzer & McGurk (1999) Schizophr Bull	Effects of atypical antipsychotics on cognition

H.3 Dendritic structure

Ssparse, efficient neural networks outperform dense ones. The inference is that reducing 5-HT2A signalling moves the network in that direction.

Study	Finding	Direction relative to the argument
Genç et al. (2018) Nat Commun	Lower dendritic density associated with higher IQ	Supports
Tang et al. (2014) Neuron	Impaired spine pruning in autism	Supports
Glantz & Lewis (2000) Arch Gen Psychiatry	Reduced spine density in schizophrenia	Complicates: lower density is not uniformly favourable
Ly et al. (2018) Cell Reports	5-HT2A agonists increase dendritic complexity	Counter-argument

Claim	Rating	Basis
Lower dendritic density associates with higher IQ	Strong	Genç 2018
Neural efficiency is a robust phenomenon	Strong	Haier, Neubauer, Basten meta-analysis
5-HT2A antagonism improves cognition in patients	Moderate	Woodward 2005; CATIE does not support the stronger version
5-HT2A↓ reduces dendritic density	Not established	Supporting citations unlocatable; Ly 2018 points the other way
Optimisation model	Hypothesis	Internally coherent, not yet bridged empirically

Appendix I: The psychedelic paradox

5-HT2A agonists produce durable clinical benefit while this framework proposes benefit from reduced 5-HT2A signalling. The proposed resolution is that acute agonism is followed by receptor downregulation, so that both routes converge on reduced signalling.

Phase	Timing	Mechanism
Acute	0-6 hours	5-HT2A activation, glutamate release, acute plasticity
Subacute	1-7 days	Receptor internalisation and downregulation
Long-term	Weeks to months	Circuits stabilised at reduced 5-HT2A signalling

Study	Finding
Roth et al. (1995) JPET	5-HT2A receptor regulation following agonist exposure
Gray & Roth (2001) Brain Res Bull	Mechanisms of 5-HT2A regulation
Madsen et al. (2020) Eur Neuropsychopharmacol	n = 10. Decreased 5-HT2A binding one week after psilocybin; reduction correlated with increased mindfulness at three months
Raval et al. (2021) Int J Mol Sci	Psilocybin effects on receptor availability, preclinical
Vollenweider & Preller (2020) Nat Rev Neurosci	Review of psychedelic mechanisms
Griffiths et al. (2016) J Psychopharmacol	Sustained decreases in depression and anxiety at six months
Gukasyan et al. (2022) J Psychopharmacol	Effects maintained at twelve months, open-label extension

Disclaimer. The convergence argument is a plausible hypothesis. Madsen 2020 carries most of the weight of the model and has n = 10 with a correlational endpoint. Griffiths and Gukasyan show durable clinical benefit but do not measure receptor binding.

Claim	Rating	Basis
Psychedelics induce 5-HT2A downregulation	Moderate-Strong	Roth 1995, Madsen 2020, preclinical receptor work
Downregulation correlates with clinical benefit	Moderate	Madsen 2020 only; n = 10, correlational
Both routes converge on the same endpoint	Hypothesis	Mechanistically coherent; not demonstrated

Appendix J: Long-term safety

J.1 What is documented

Study	Finding
Hacksell et al. (2014) Neurochem Res	Pimavanserin pharmacology; selective 5-HT2A inverse agonism
Cummings et al. (2014) Lancet	Phase 3, n = 199. No cognitive impairment, no motor effects, no sedation at therapeutic dose
Meltzer et al. (2010) Neuropsychopharmacology	Phase 2, n = 60. No sedation or motor effects
Tariot et al. (2021) NEJM	Pimavanserin in dementia-related psychosis
Lieberman et al. (2005) NEJM; Keefe et al. (2007) Am J Psychiatry	CATIE 18-month outcomes in a population receiving 5-HT2A-active agents
Parameter	**Finding in the pimavanserin trials**
Sedation	None reported
Cognitive impairment	None reported
Motor effects	None reported
Metabolic effects	None reported

Study	Finding
QTc prolongation	Minimal

J.2 Required safety statement

Pimavanserin carries a boxed warning for increased mortality in elderly patients with dementia-related psychosis. Any section citing the pimavanserin literature in support of a safety claim must state this..

Claim	Rating	Basis
Short-term 5-HT2A inverse agonism is well tolerated in the studied populations	Strong	Two controlled trials with consistent tolerability findings
No cognitive impairment at therapeutic doses	Moderate-Strong	Pimavanserin trials; specific to that agent and population
Long-term safety of sustained 5-HT2A reduction	Not established	No source; previously rated Strong in error

Appendix K: Individual differences

The table below is an illustrative response-prediction framework. Predictor weights are hypothesized. The combined accuracy figure is a modelling estimate.

K.1 Illustrative response-prediction model

Predictor	Hypothesised weight	Rationale
Baseline PET 5-HT2A binding	35%	Receptor availability determines the magnitude of change achievable
HTR2A genotype	20%	Common variants associate with expression level
Baseline anxiety	20%	Room-for-improvement effect observed across anxiolytic interventions
Age and sex	15%	Receptor density varies with both
Trait neuroticism	10%	5-HT2A binding associates with inward facets of neuroticism

K.2 What is documented

McMahon, F.J., et al. (2006). Variation in the gene encoding the serotonin 2A receptor is associated with outcome of antidepressant treatment. *American Journal of Human Genetics*, 78(5), 804-814. Large pharmacogenetic analysis within STAR*D. HTR2A variation associated with citalopram response.

Biver, F., et al. (1996). *Neuroscience Letters*, 204(1-2), 25-28. Sex and age differences in 5-HT2A binding.

Published PET work also reports a positive association between neocortical 5-HT2A binding and the inward facets of neuroticism in healthy individuals, which supports the inclusion of neuroticism as a candidate predictor.

Claim	Rating	Basis
HTR2A variation modulates treatment response	Strong	McMahon 2006, STAR*D
5-HT2A binding varies with age and sex	Strong	Biver 1996
Baseline binding predicts magnitude of response	Not established	Supporting citation unlocatable
Multivariate prediction at 82% accuracy	Model, untested	Illustrative; no prospective validation

Appendix L: Reference list, classified by evidentiary role

References are classified by the role they play in testing Corollary 2.

Class 1 — Direct experimental evidence for HTR2A reduction

Studies that manipulate 5-HT2A expression or signalling and measure an outcome of interest.

Rohn, T.T., Radin, D., Brandmeyer, T., Seidler, P.G., Linder, B.J., Lytle, T., Mee, J.L., & Macciardi, F. (2024). Translational Psychiatry, 14, 154.

Rohn, T.T., et al. (2023). PNAS Nexus, 2(6), pgad170.

Weisstaub, N.V., et al. (2006). Science, 313(5786), 536-540.

Quednow, B.B., et al. (2012). Neuropsychopharmacology, 37(3), 630-640.

Beck, S.G. (1992). Synapse, 10(4), 334-340.

Zhang, G., & Stackman, R.W., et al. (2015). Learning & Memory, 22(9), 498-506.

Wang, R.Y., & Arvanov, V.L. (1998). Brain Research. (Volume and pages to be confirmed.)

Aghajanian, G.K., & Marek, G.J. (1997). Neuropharmacology, 36(4-5), 589-599.

Talpos, J.C., et al. (2006). Psychopharmacology, 187(3), 241-252.

Ly, C., et al. (2018). Cell Reports, 23(11), 3170-3182.

Class 2 — Human clinical evidence, 5-HT2A-active agents

Cummings, J., et al. (2014). The Lancet, 383(9916), 533-540.

Meltzer, H.Y., et al. (2010). Neuropsychopharmacology, 35(4), 881-892.

Tariot, P.N., et al. (2021). NEJM, 385(4), 309-319.

Hacksell, U., et al. (2014). Neurochemical Research, 39(10), 2008-2017. Kitten, A.K., et al. (2018). Innovations in Clinical Neuroscience, 15(1-2), 16-22.

Lieberman, J.A., et al. (2005). NEJM, 353(12), 1209-1223.

Keefe, R.S., et al. (2007). Archives of General Psychiatry, 64(6), 633-647. Keefe, R.S., et al. (2007). American Journal of Psychiatry, 164(7), 1061-1071. Woodward, N.D., et al. (2005). Int J Neuropsychopharmacology, 8(3), 457-472. Meltzer, H.Y., et al. (1999). Schizophrenia Bulletin, 25(2), 233-255.

Akhondzadeh, S., et al. (2008). J Clin Pharmacy Therapeutics, 33(5), 495-499.

Reyntjens, A., et al. (1986). Drug Development Research, 8(1-4), 205-211.

Louwerens, J.W., et al. (1986). Psychopharmacology, 89, S18-S19. (Abstract.)

Rosenberg, R., et al. (2008). Sleep Medicine, 9(3), 274-278.

McMahon, F.J., et al. (2006). American Journal of Human Genetics, 78(5), 804-814.

Class 3 — Receptor imaging and distribution

Chapman, G.E., Turner, G., Noar, A.P., Barba, T., Zafar, R., McCutcheon, R.A., & Erritzoe, D. (2025). Molecular Psychiatry, 30(12), 6045-6062.

Yatham, L.N., et al. (2000). Archives of General Psychiatry, 57(9), 850-858.

Meyer, J.H., et al. (2001). American Journal of Psychiatry, 158(1), 78-85.

Meyer, J.H., et al. (2003). American Journal of Psychiatry, 160(1), 90-99.

Bhagwagar, Z., et al. (2006). American Journal of Psychiatry, 163(9), 1580-1587.

Pandey, G.N., et al. (2002). American Journal of Psychiatry, 159(3), 419-429.

Massou, J.M., et al. (1997). Psychopharmacology, 133(1), 99-101.

Biver, F., et al. (1996). Neuroscience Letters, 204(1-2), 25-28.

Frokjaer, V.G., et al. (2014). Psychopharmacology, 231(6), 1031-1040.

Madsen, M.K., et al. (2020). European Neuropsychopharmacology, 33, 71-80.

Raval, N.R., et al. (2021). Int J Molecular Sciences, 22(2), 835.

Roth, B.L., et al. (1995). JPET, 275(3), 1638-1646.

Gray, J.A., & Roth, B.L. (2001). Brain Research Bulletin, 56(5), 441-451.

Pompeiano, M., et al. (1994). Molecular Brain Research, 23(1-2), 163-178.
Cornea-Hébert, V., et al. (1999). Journal of Comparative Neurology, 409(2), 187-209.
Luttgen, M., et al. (2004). Brain Research, 1010(1-2), 156-165.

Class 4 — Mechanistic and background neuroscience

Zullo, J.M., et al. (2019). Nature, 574(7778), 359-364.
Lu, T., et al. (2014). Nature, 507(7493), 448-454.
Bakker, A., et al. (2012). Neuron, 74(3), 467-474.
Bakker, A., et al. (2015). NeuroImage: Clinical, 7, 688-698.
Vossel, K.A., et al. (2013). JAMA Neurology, 70(9), 1158-1166.
Sanchez, P.E., et al. (2012). PNAS, 109(42), E2895-E2903.
Haberman, R.P., et al. (2017). Neurobiology of Aging, 54, 144-151.
Yassa, M.A., et al. (2010). NeuroImage, 51(3), 1242-1252.
Putcha, D., et al. (2011). Journal of Neuroscience, 31(48), 17680-17688.
Miller, S.L., et al. (2008). J Neurol Neurosurg Psychiatry, 79(6), 630-635.
Leal, S.L., et al. (2017). Behavioral Neuroscience, 131(6), 434-448.
Celada, P., Puig, M.V., & Artigas, F. (2013). Frontiers in Integrative Neuroscience, 7, 25.
Marek, G.J., et al. (2003). Neuropsychopharmacology, 28(2), 402-412.
Jørgensen, H., et al. (2002). Brain Research, 952(2), 295-305.
Yamauchi, M., et al. (2006). Brain Research, 1067(1), 164-169.
Genç, E., et al. (2018). Nature Communications, 9, 1905.
Haier, R.J., et al. (1988). Intelligence, 12(2), 199-217.
Basten, U., et al. (2015). Intelligence, 51, 10-27.
Tang, G., et al. (2014). Neuron, 83(5), 1131-1143.
Glantz, L.A., & Lewis, D.A. (2000). Archives of General Psychiatry, 57(1), 65-73.

Sheline, Y.I., et al. (2001). Biological Psychiatry, 50(9), 651-658.
Harmer, C.J., et al. (2006). Biological Psychiatry, 59(9), 816-820.
Peluso, M.A., et al. (2009). Psychiatry Research: Neuroimaging, 173(2), 158-161.
Radley, J.J., et al. (2006). Cerebral Cortex, 16(3), 313-320.
Sapolsky, R.M. (2000). Archives of General Psychiatry, 57(10), 925-935.
Landolt, H.P., et al. (1999). Neuropsychopharmacology, 21(3), 455-466.
Landolt, H.P., et al. (2009). European Neuropsychopharmacology, 19(2), 121-131.
Sharpley, A.L., et al. (1990). Psychopharmacology, 101(4), 568-569.
Preller, K.H., et al. (2019). PNAS, 116(7), 2743-2748.
Carter, O.L., et al. (2005). Journal of Cognitive Neuroscience, 17(10), 1497-1508.
Umbricht, D., et al. (2003). Neuropsychopharmacology, 28(1), 170-181.
Gouzoulis-Mayfrank, E., et al. (1999). Psychopharmacology, 142(1), 41-50.
Griffiths, R.R., et al. (2016). Journal of Psychopharmacology, 30(12), 1181-1197.
Gukasyan, N., et al. (2022). Journal of Psychopharmacology, 36(2), 151-158.
Carhart-Harris, R.L., et al. (2016). The Lancet Psychiatry, 3(7), 619-627.

Class 5 — Reviews and theoretical frameworks

Millan, M.J. (2003). Progress in Neurobiology, 70(2), 83-244.
Nichols, D.E. (2016). Pharmacological Reviews, 68(2), 264-355.
Carhart-Harris, R.L., & Friston, K.J. (2017). Journal of Psychopharmacology, 31(9), 1091-1120.
Vollenweider, F.X., & Preller, K.H. (2020). Nature Reviews Neuroscience, 21(11), 611-624.
Vollenweider, F.X., & Kometer, M. (2010). Nature Reviews Neuroscience, 11(9), 642-651.
Meneses, A. (2013). Reviews in the Neurosciences, 24(6), 629-664.
Harvey, J.A. (2003). Learning & Memory, 10(5), 355-362.
Klimesch, W. (1999). Brain Research Reviews, 29(2-3), 169-195.

Monti, J.M. (2011). Sleep Medicine Reviews, 15(4), 269-281.
Staner, L. (2003). Dialogues in Clinical Neuroscience, 5(3), 249-258.
Lima, L., et al. (2007). Current Psychiatry Reviews, 3(4), 241-250.
Wilson, I.A., et al. (2006). Trends in Neurosciences, 29(12), 662-670.
McEwen, B.S., et al. (2016). Neuropsychopharmacology, 41(1), 3-23.
Lupien, S.J., et al. (2009). Nature Reviews Neuroscience, 10(6), 434-445.
Mattson, M.P., & Magnus, T. (2006). Nature Reviews Neuroscience, 7(4), 278-294. Neubauer, A.C., & Fink, A. (2009). Neuroscience & Biobehavioral Reviews, 33(7), 1004-1023. Zuo, Y., et al. (2021). Neuroscience & Biobehavioral Reviews, 128, 289-301.
Etkin, A., & Wager, T.D. (2007). American Journal of Psychiatry, 164(10), 1476-1488.
Shields, G.S., et al. (2017). Psychological Bulletin, 143(6), 636-675.
Schwabe, L., et al. (2012). Neuroscience & Biobehavioral Reviews, 36(7), 1740-1749.
Eysenck, M.W., et al. (2007). Emotion, 7(2), 336-353.
Robinson, O.J., et al. (2013). Frontiers in Human Neuroscience, 7, 203.
Hofmann, S.G., et al. (2010). Journal of Consulting and Clinical Psychology, 78(2), 169-183.
Olatunji, B.O., et al. (2007). Clinical Psychology Review, 27(5), 572-581.
Mendlowicz, M.V., & Stein, M.B. (2000). American Journal of Psychiatry, 157(5), 669-682.

Class 6 — Contextual (meditation and default mode network)

These references concern attentional and self-referential processing. They do not bear on 5-HT2A and are not counted toward the evidence base for any receptor claim.

Brewer, J.A., et al. (2011). PNAS, 108(50), 20254-20259.
Garrison, K.A., et al. (2015). Cognitive, Affective, & Behavioral Neuroscience, 15(3), 712-720.
Garrison, K.A., et al. (2013). Frontiers in Human Neuroscience, 7, 468.
Cahn, B.R., & Polich, J. (2006). Psychological Bulletin, 132(2), 180-211.

Taylor, V.A., et al. (2011). NeuroImage, 57(4), 1524-1533.

Davidson, R.J. (2004). Philosophical Transactions of the Royal Society B, 359(1449), 1395-1411.

Reference count by class

Class	Count	Role
1. Direct experimental evidence	10	Tests a 5-HT2A manipulation against an outcome
2. Human clinical	15	5-HT2A-active agents in patients
3. Receptor imaging & distribution	16	Receptor location and population
4. Mechanistic and background	35	Establishes the surrounding neuroscience
5. Reviews and frameworks	25	Synthesis (secondary evidence)
6. Contextual	6	Adjacent evidence
Total	107	

Appendix M: Summary evidence table

30 claims · 11 domains · ratings from Very Strong to Not established

DOMAIN	CLAIM	RATING	KEY SOURCES
Anxiety 4 CLAIMS	5-HT2A↓ reduces anxiety-like behaviour in rodents	Strong (preclinical)	Rohn 2024, Rohn 2023, Weisstaub 2006
	5-HT2A↓ treats human anxiety disorder	Not established	No human trial
	Sleep improvement with 5-HT2A antagonism	Strong	Landolt, Monti, Rosenberg
	Anxiety reduction improves well-being	Strong	Olatunji, Hofmann
Depression 4 CLAIMS	5-HT2A findings in MDD are heterogeneous	Strong	Chapman 2025
	Cortical binding lower in unmedicated MDD	Moderate-Strong	Chapman 2025
	Elevated binding post-mortem in suicide	Moderate	Pandey 2002
	5-HT2A antagonism augments antidepressant response	Strong	Marek 2003, Celada 2013
Hippocampus 3 CLAIMS	Hyperactivity impairs memory and predicts decline	Very Strong	Bakker 2012, Vossel 2013
	5-HT2 activation increases CA1 excitability	Strong	Beck 1992
	5-HT2A activation increases hippocampal glutamate	Strong	Zhang 2015
Limbic 2 CLAIMS	Chronic hyperactivation causes damage	Strong	Sapolsky, McEwen
	5-HT2A↓ reduces limbic hyperactivity	Moderate (inferred)	No direct test
Longevity 3 CLAIMS	Neural excitation accelerates ageing	Very Strong	Zullo 2019
	REST suppression of excitation extends lifespan	Very Strong	Zullo 2019, Lu 2014
	5-HT2A↓ extends cognitive longevity	Hypothesis	Chain of established components

Appendix M: Summary evidence table (continued)

DOMAIN	CLAIM	RATING	KEY SOURCES
Memory 2 CLAIMS	5-HT2A↓ improves recognition memory in rodents	Strong (preclinical)	Rohn 2024; 92% rats / 104% mice
	Mechanism via reduced excitability	Moderate-Strong	MEA data, Beck 1992, Zhang 2015
Attention 4 CLAIMS	Agonists impair attention in humans	Very Strong	Carter, Umbricht, Gouzoulis-Mayfrank
	Ketanserin blocks that impairment	Very Strong	Quednow 2012
	Antagonists improve attention in rodents	Moderate	Carli programme, Talpos 2006
	Genetic markers predict attention	Not established	Sources removed
Cognition 2 CLAIMS	Neural efficiency is robust	Strong	Haier, Basten, Genç
	5-HT2A↓ reduces dendritic density	Not established	Ly 2018 points the other way
Psychedelics 2 CLAIMS	Agonists induce downregulation	Moderate-Strong	Roth 1995, Madsen 2020
	Downregulation correlates with benefit	Moderate	Madsen 2020, n = 10
Safety 2 CLAIMS	Short-term tolerability of 5-HT2A inverse agonism	Strong	Cummings 2014, Meltzer 2010
	Long-term safety of sustained reduction	Not established	Sources removed
Individual differences 2 CLAIMS	HTR2A variation modulates treatment response	Strong	McMahon 2006
	82% multivariate prediction	Model, untested	Illustrative only

Appendix N: Open documentation items

Item	Action required
Wang & Arvanov (1998) Brain Research	Confirm volume and page numbers before citing
Carli & Invernizzi 5-CSRTT work	Identify the specific paper
Akhondzadeh et al. (2008)	Confirm that agent and endpoint match the description given
Frokjaer et al. (2014)	Confirm the direction of the binding-performance relationship before restating the claim
Woodward et al. (2005)	Confirm the study count before quoting "meta-analysis of 41 studies"
Bakker et al. (2012)	Confirm sample size before quoting any N
34% anxiety reduction	Cite to a specific figure panel, or label as data on file
Homeostatic compensation (15-30%, plateauing)	Locate a receptor regulation source or leave withdrawn
Ten-year cognitive outcome claim	Locate a source or leave withdrawn
Creativity preservation claim	Locate a source or leave withdrawn
5-HT2A modulation of theta rhythm	Locate a source or leave withdrawn
5-HT2A↓ and dendritic density	Locate a source; address Ly 2018 directly in the text
Zhang 2015 behavioural direction	Address the consolidation finding explicitly rather than citing only the mechanism

Downstream Transcriptional Effects of Reduced HTR2A Expression

Downstream effect	Gene names and mechanism
Lower cortical excitability Neural networks may fire less intensely and become less prone to runaway excitation.	HTR2A ↓ → weaker 5-HT2A drive and lower activity-dependent transcription. FOS/FOSB, EGR1–4, ARC and NPAS4 shift with reduced firing, helping stabilize a less excitable cortical state.
Changed sensory gain The brain may assign less weight to incoming sensory signals, potentially reducing overstimulation and mistaken significance.	HTR2A ↓ → less activity-driven induction of EGR1, EGR2, ARC, FOS and NPAS4. These genes tune how strongly cortical circuits amplify and adapt to sensory input.
Stronger attentional control Reduced cortical noise may improve the ability to sustain attention and suppress irrelevant signals.	HTR2A ↓ → lower spontaneous cortical activity → altered ARC, EGR1–4, FOS/FOSB and NPAS4 signaling. A quieter activity pattern can improve circuit signal-to-noise.
Changed learning and memory Plasticity-related transcription can alter how strongly experiences are encoded and retained.	HTR2A ↓ → altered activity-dependent control of ARC, BDNF, EGR1/EGR2 and CREB1. These genes govern synaptic remodeling, consolidation and persistence of memory traces.
Reduced anxiety and stress reactivity Changes in cortical-limbic regulation may dampen exaggerated threat responses.	HTR2A ↓ → altered CRH/CRHR1 and glucocorticoid-receptor signaling (NR3C1, NR3C2), with changes in BDNF, FOS and EGR genes. This can reshape the intensity and duration of stress responses.

Downstream Transcriptional Effects of Reduced HTR2A Expression 2

Downstream effect	Gene names and mechanism
Altered network oscillations Changes in neuronal excitability can shift the timing and synchronization of large neural populations, affecting brainwave patterns and information processing.	HTR2A ↓ → lower firing and altered NPAS4, ARC, CAMK2, ion-channel and glutamate-related gene programs. Those changes can shift excitation/inhibition balance and network synchrony.
Changed synaptic plasticity Neural circuits may become more or less able to strengthen, weaken, and reorganize in response to experience.	HTR2A ↓ → altered BDNF, ARC, EGR1–4, FOS/FOSB, CREB1 and NPAS4 activity. These genes convert changes in firing into lasting synaptic and structural remodeling.
Changed glutamatergic signaling Excitatory communication between neurons may be altered, changing how strongly cortical circuits propagate information.	HTR2A ↓ → altered activity and transcription in glutamatergic networks, including GRIN1/2, GRIA1–4, GRM2, SLC17A7, CAMK2 and HOMER genes. This can change excitatory synaptic strength.
Longer-lasting circuit remodeling A temporary change in receptor expression can produce effects that persist after the initial molecular event.	HTR2A ↓ → activity-dependent changes in BDNF, ARC, EGR1, NPAS4, MEF2C and CREB1. These genes can lock short-term firing changes into longer-lasting circuit states.
Changed behavior Together, these effects can produce measurable changes in attention, memory, anxiety, perception, cognitive control, and other higher-order functions.	HTR2A ↓ initiates the cascade; activity, plasticity, stress, excitability and glutamatergic gene programs then converge on circuit function. The behavioral outcome is the integrated result—not the action of any single gene.

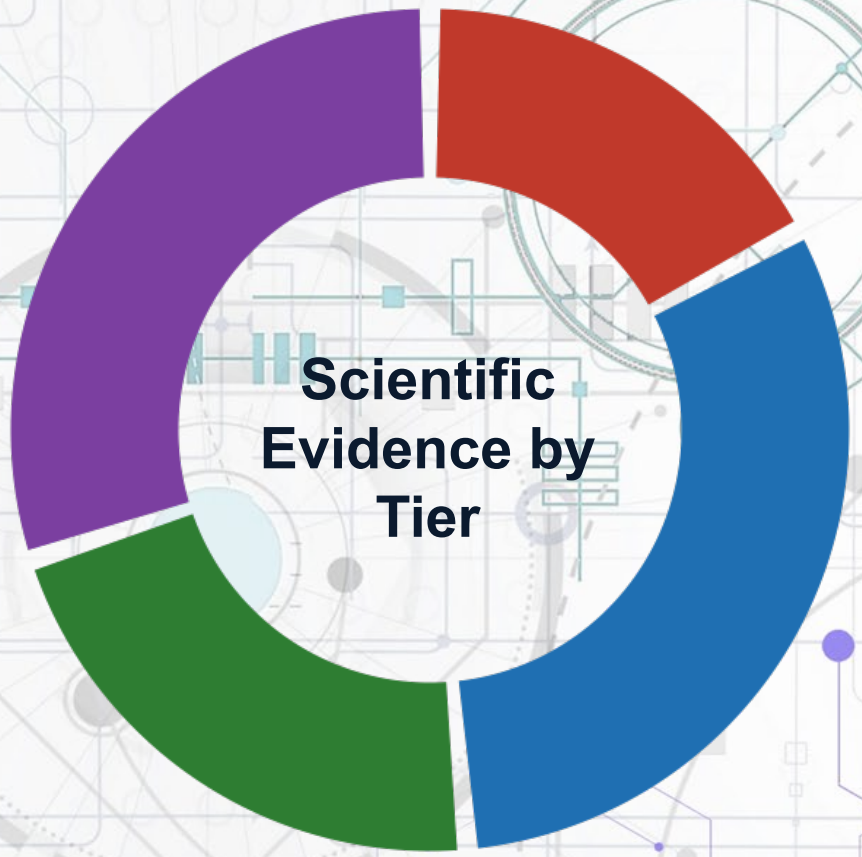
- https://pmc.ncbi.nlm.nih.gov/articles/PMC5470573/
- https://pmc.ncbi.nlm.nih.gov/articles/PMC10954635/

02

SUMMARY

Corollary 2 Evidence Base

Study Counts by Evidence Strength



Corollary 2 references
70 studies sorted by strength of evidence

Direct causal intervention 12

Neural activity was manipulated — by genetic knockdown, drug, neurofeedback or stimulation — and the resulting change measured. Causation is observed, not inferred.

State-linked 22

An altered state was induced under controlled conditions and brain measures taken during it. Shows the relationship holds when the state is produced on demand rather than found.

Correlational 15

Brain measures compared across individuals, expertise levels or conditions with no intervention. Establishes that the relationship exists; cannot establish which way it runs.

Mechanism and boundary 21

Studies explaining how the relationship works at the circuit level, or mapping where it stops holding. Includes reviews, theoretical syntheses and limiting cases.

Total 70

Corollary 2 Key Findings by Research Domain

HTR2A Modulation & 5-HT2A Pharmacology

8 REFERENCES

7 primary · 1 review

shRNA knockdown reduced HTR2A and cortical network activity; intranasal treatment improved rodent memory and anxiety-like behavior (Rohn 2023, 2024).

Cortical 5-HT2A signaling modulates anxiety; ketanserin blocks psilocybin deficits; postmortem receptor loss tracks faster decline (Weisstaub 2006; Quednow 2012; Lai 2005).

Neural Efficiency

5 REFERENCES

4 primary · 1 review

PET links lower regional glucose use with stronger reasoning and improved performance after learning (Haier 1988, 1992).

EEG and review evidence show task demand and region can alter the relationship (Dunst 2014; Neubauer & Fink 2009).

Loss of Consciousness

3 REFERENCES

3 primary

Propofol loss of consciousness increased alpha/low-beta EEG power (Ching 2010; Purdon 2013).

Vasovagal syncope increased EEG amplitude; amplitude fell again as consciousness returned (Ammirati 1998).

Direct Manipulation of Neural Activity

4 REFERENCES

4 primary

Low-dose levetiracetam reduced hippocampal hyperactivity and improved memory in amnestic MCI (Bakker 2012).

Focused ultrasound reduced evoked responses while improving tactile discrimination; neurofeedback altered performance (Legon 2014; Ziebell 2023; Landers 1991).

Attention, Expertise & Alpha Gating

7 REFERENCES

5 primary · 2 reviews

Meditation training reduced the first-target neural response and improved second-target detection (Slagter 2007).

Expert marksmen and athletes showed lower/more selective cortical recruitment; alpha neurofeedback effects were frequency-specific (Haufler 2000; Del Percio 2009; Egner 2004; Ros 2013).

Gamma Synchrony & Signal Measurement

3 REFERENCES

2 primary · 1 review

Compassion meditation produced high-amplitude gamma and long-distance synchrony; conscious perception involved long-distance gamma synchrony (Lutz 2004; Melloni 2007).

Scalp EEG mainly reflects coordinated postsynaptic currents rather than spikes (Buzsáki 2012).

Meditation & Awareness

12 REFERENCES

12 primary

Experienced meditators show lower medial prefrontal/PCC activity; effortless awareness corresponds with lower PCC activity (Brewer 2011; Garrison 2013, 2015; van Lutterveld 2017).

Lower incidence of elevated ventral posteromedial activity was associated with better sustained attention (Pagnoni 2012).

Absorption/cessation studies report reduced oscillatory power, altered network interactions and signal complexity (Chowdhury 2023, 2024; van Lutterveld 2024).

Emotional Regulation

6 REFERENCES

6 primary

Mindfulness training alters amygdala responses and the neural expression of sadness/self-reference (Desbordes 2012; Farb 2007, 2010).

Short-term training improved attention/self-regulation and altered autonomic/neural measures; MBSR changed frontal EEG asymmetry and immune response (Tang 2007, 2009; Davidson 2003).

Flow, Creativity & Insight

5 REFERENCES

4 primary · 1 review

Flow reduces medial prefrontal/amygdala activity while task networks remain engaged; jazz improvisation redistributes frontal activity (Ulrich 2014; Limb & Braun 2008).

Insight is preceded by a right temporal gamma burst; alpha synchronization accompanies creative ideation (Jung-Beeman 2004; Benedek 2011; Fink & Benedek 2014).

Psychedelics & Breathwork

11 REFERENCES

11 primary

Psilocybin and related psychedelic studies show reduced regional blood flow/oscillatory power alongside altered connectivity and signal diversity (Carhart-Harris 2012; Muthukumaraswamy 2013; Tagliazucchi 2016; Schartner 2017).

EEG studies add reduced current-source density/oscillatory power and altered synchronization (Kometer 2015; Riba 2002); pCASL shows widespread absolute perfusion reductions (Lewis/Preller 2017).

High-ventilation breathwork reduced cerebral blood flow 45.5% and produced psychedelic-like experience (Schmitz 2026).

Structure & Neural Preservation

6 REFERENCES

6 primary

Structural/diffusion MRI links practice with cortical thickness, gray matter and white matter changes; higher intelligence with lower estimated dendritic density (Lazar 2005; Hölzel 2011; Tang 2010; Genç 2018).

Reduced excitation via REST is associated with lifespan and resistance to neurodegeneration (Zullo 2019; Lu 2014).

Total: 70

Measurement Modalities by Research Domain

70 references · 11 domains · 18 methods · 6 reviews

HTR2A Modulation & 5-HT2A Pharmacology

8 REFERENCES

7 primary · 1 review

RECEPTOR EXPRESSION MANIPULATED

Multielectrode Array	2
Rodent Genetics & Behavior	2
PET	1
Pharmacological Trial	1
Tissue Analysis	1
Review / Theory	1

Neural Efficiency

5 REFERENCES

4 primary · 1 review

PET	3
EEG	1
Review / Theory	1

Loss of Consciousness

3 REFERENCES

3 primary

EEG	3

Direct Manipulation of Neural Activity

4 REFERENCES

4 primary

NEURAL ACTIVITY MANIPULATED

Focused Ultrasound	2
EEG Neurofeedback	1
Pharmacological Trial	1

Attention, Expertise & Alpha Gating

7 REFERENCES

5 primary · 2 reviews

EEG	3
EEG Neurofeedback	2
Review / Theory	2

Gamma Synchrony & Signal Measurement

3 REFERENCES

2 primary · 1 review

EEG	2
Review / Theory	1

Meditation & Awareness

12 REFERENCES

12 primary

EEG	5
fMRI	4
PET	1
Physiological Measurement	1
SPECT	1

Emotional Regulation

6 REFERENCES

6 primary

fMRI	3
Behavioral / Clinical Trial	1
EEG	1
Physiological Measurement	1

Flow, Creativity & Insight

5 REFERENCES

4 primary · 1 review

EEG	2
fMRI	2
Review / Theory	1

Psychedelics & Breathwork

11 REFERENCES

11 primary

fMRI / pCASL	4
Behavioral / Clinical Trial	2
MEG	2
EEG	2
MR Spectroscopy	1

Structure & Neural Preservation

6 REFERENCES

6 primary

Diffusion MRI	2
Molecular Genetics	2
Structural MRI	2

Total: 70

02

DETAIL

Technical Appendix 2: Evidence Base for Corollary 2

1. HTR2A Modulation — Rohn Program

Author	Study name	Date	Description	Findings	Relevance
Rohn et al.	Intranasal delivery of shRNA to knockdown the 5HT-2A receptor enhances memory and alleviates anxiety	2024	shRNA reduced HTR2A in human-derived cortical glutamatergic neurons; intranasal rodent studies measured anxiety-like behavior and memory in a mouse T-maze and rat novel-object recognition task.	Receptor protein fell 27% in human-derived neurons. Burst duration, burst frequency, network bursts, spikes per burst, and synchrony were significantly reduced. Intranasal treatment improved memory by 104% on the mouse T-maze measure and 92% on the rat novel-object recognition contact index versus vehicle, and reduced anxiety-like behavior.	Reduced HTR2A expression and network activity accompanied substantial memory improvement and less anxiety-like behavior.
Rohn et al.	Genetic modulation of the HTR2A gene reduces anxiety-related behavior in mice	2023	CRISPR/Cas9 targeted HTR2A in primary mouse cortical neurons and was tested after intranasal delivery in mice.	Spontaneous electrical activity declined with treatment concentration. Treated mice showed reduced target expression and less anxiety-like behavior.	Reduced HTR2A expression and spontaneous activity accompanied less anxiety-like behavior.
Rohn et al.	Treatment with shRNA to knockdown the 5-HT2A receptor improves memory in vivo and decreases excitability in primary cortical neurons	2024	COG201 was tested in primary mouse cortical neurons and in rodent memory experiments.	Spike count and mean firing rate each fell 50% versus scrambled controls (p=.002). Individual bursts and synchrony fell; network bursts rose 20%. Rodent object discrimination improved.	50% lower firing accompanied improved rodent object discrimination.

2. Neural Efficiency and Hyperactivity

Author	Study name	Date	Description	Findings	Relevance
Haier et al.	Regional glucose metabolic changes after learning a complex visuospatial /motor task: a positron emission tomographic study	1992	PET measured regional glucose use before and after participants practiced Tetris.	Task performance improved while glucose use declined in several cortical regions.	Performance improved while regional metabolic activity declined.
Haier et al.	Intelligence and changes in regional cerebral glucose metabolic rate following learning	1992	Examined glucose metabolic changes with learning and individual performance differences.	Learning-related performance changes were associated with regional decreases in glucose metabolism.	Learning gains accompanied lower regional glucose metabolism.
Haier et al.	Cortical glucose metabolic rate correlates of abstract reasoning and attention studied with positron emission tomography	1988	PET related regional glucose metabolism to reasoning and attention performance.	Stronger reasoning performance was associated with lower glucose use in selected regions.	Stronger reasoning and attention accompanied lower regional glucose use.
Dunst et al.	Neural efficiency as a function of task demands	2014	Examined neural efficiency across tasks with different demands.	The relationship between performance and neural recruitment varied with task demands.	Shows that the activity-performance relationship varies with task demand.
Bakker et al.	Reduction of hippocampal hyperactivity improves cognition in amnestic mild cognitive impairment	2012	Low-dose levetiracetam was used to reduce excess hippocampal activity in participants with amnestic mild cognitive impairment.	Hippocampal hyperactivity decreased and discrimination of similar objects improved relative to placebo; standard memory tests did not significantly improve.	Reducing hippocampal hyperactivity improved memory discrimination.

2. Neural Efficiency and Hyperactivity — Loss of Consciousness

Author	Study name	Date	Description	Findings	Relevance
Ching et al.	Thalamocortical model for a propofol-induced alpha-rhythm associated with loss of consciousness	2010	Recorded EEG activity as subjects received propofol anesthesia.	Loss of consciousness was accompanied by increased low-beta and high-alpha brainwave power.	Loss of consciousness accompanied increased low-beta/high-alpha power.
Purdon et al.	Electroencephalogram signatures of loss and recovery of consciousness from propofol	2013	Recorded EEG activity in 10 subjects as propofol was gradually administered.	Brainwave power increased as subjects lost consciousness.	Loss of consciousness accompanied increased EEG power.
Ammirati et al.	Electroencephalographic Correlates of Vasovagal Syncope Induced by Head-Up Tilt Testing	1998	Studied 63 patients with a history of fainting and induced syncope using head-up tilt testing.	Loss of consciousness was accompanied by increased EEG amplitude. EEG amplitude diminished when consciousness returned.	EEG amplitude rose with unconsciousness and fell as consciousness returned.

3. Meditation, Attention, and Resource Allocation

Author	Study name	Date	Description	Findings	Relevance
Brewer et al.	Meditation experience is associated with differences in default mode network activity and connectivity	2011	Experienced meditators and controls were scanned during several meditation practices.	Experienced meditators showed lower medial prefrontal and posterior cingulate activation with altered coupling to monitoring and control regions.	Meditation accompanied lower activity in major self-related cortical regions.
Garrison et al.	Effortless awareness: using real time neurofeedback to investigate correlates of posterior cingulate cortex activity in meditators' self-report	2013	Real-time posterior cingulate activity was compared with meditators' moment-to-moment reports.	Undistracted awareness and effortless engagement coincided with lower posterior cingulate activity; distraction and effort coincided with higher activity.	Effortless awareness accompanied lower posterior cingulate activity; distraction accompanied higher activity.

3. Meditation, Attention, and Resource Allocation — continued

Author	Study name	Date	Description	Findings	Relevance
Garrison et al.	Meditation leads to reduced default mode network activity beyond an active task	2015	Compared meditation with another active task.	Meditation produced a greater reduction in default-mode activity than the comparison task.	meditation reduced default-mode activity beyond an active comparison task.
Slagter et al.	Mental training affects distribution of limited brain resources	2007	After 3 months of meditation training, participants performed an attentional-blink task with electro-physiological recording.	The neural response to the first target became smaller and detection of the second target improved; larger reductions predicted greater improvement.	a smaller neural response to the first target accompanied better detection of the second.
van Lutterveld et al.	Source-space EEG neurofeedback links subjective experience with brain activity during effortless awareness meditation	2017	Novice and experienced meditators used source-space EEG neurofeedback based on posterior cingulate cortex (PCC) activity while practicing effortless-awareness meditation.	Both groups reported decreased PCC activity corresponded with effortless awareness. Participants also shifted the PCC signal in the direction associated with effortless awareness (77.97% of time in novices; 89.83% in experienced meditators).	Effortless awareness corresponded with decreased PCC activity, and participants could intentionally shift activity in that direction.
Pagnoni	Dynamical Properties of BOLD Activity from the Ventral Posteromedial Cortex Associated with Meditation and Attentional Skills	2012	fMRI compared experienced Zen meditators with meditation-naive controls during attention-to-breathing; sustained attention was measured separately with a rapid visual information processing (RVIP) task.	Meditators showed a lower relative incidence of elevated ventral posteromedial cortex (vPMC) BOLD states. vPMC BOLD skewness correlated with sustained-attention performance, and vPMC–right temporoparietal junction connectivity also tracked RVIP performance.	Lower incidence of elevated vPMC activity in meditators was associated with better sustained-attention performance.

4. Skilled Performance and Flow

Author	Study name	Date	Description	Findings	Relevance
Haufler et al.	Neuro-cognitive activity during a self-paced visuospatial task: comparative EEG profiles in marksmen and novice shooters	2000	EEG power at 10 scalp sites compared 15 skilled marksmen with 21 novice shooters during 40 aiming trials and during matched verbal and spatial tasks.	Marksmen showed less cortical activation than novices during aiming, especially over the left central-temporal-parietal region. Group differences were much smaller during verbal and spatial tasks.	Expert performance on a highly practiced task was achieved with lower cortical activation than novice performance.

4. Skilled Performance and Flow — continued

Author	Study name	Date	Description	Findings	Relevance
Del Percio et al.	"Neural efficiency" of athletes' brain for upright standing: a high-resolution EEG study	2009	56-channel EEG and stabilometry compared 10 elite karate athletes, 10 elite fencers, and 12 non-athletes during bipodalic and more demanding monopodalic standing.	During monopodalic standing, elite athletes showed smaller alpha task-related power decreases—less desynchronization and cortical activation—than non-athletes across frontal, central, and parietal regions during the same postural task.	Skilled athletes performed the demanding postural task with less cortical activation than non-athletes.
Landers et al.	The influence of electrocortical biofeedback on performance in pre-elite archers	1991	Archers received neurofeedback designed to reinforce a performance-associated or inappropriate hemispheric pattern.	Feedback reinforcing the performance-associated pattern improved performance; inappropriate feedback impaired it.	Reinforcing the performance-associated EEG pattern improved archery performance.
Ulrich et al.	Neural correlates of experimentally induced flow experiences	2014	Task difficulty was matched to participant ability to induce flow during fMRI.	Flow was associated with reduced medial prefrontal and amygdala activity and increased inferior frontal gyrus and putamen activity.	Flow combined reduced activity in some regions with increased task-relevant activity in others.

5. Creative Performance, Alpha, and Neurofeedback

Author	Study name	Date	Description	Findings	Relevance
Limb and Braun	Neural substrates of spontaneous musical performance: an fMRI study of jazz improvisation	2008	Jazz pianists improvised during fMRI.	Lateral prefrontal regions became less active while medial prefrontal regions became more active.	Creative performance involved reduced activity in some frontal regions and increased activity in others.
Jung-Beeman et al.	Neural activity when people solve verbal problems with insight	2004	EEG/fMRI examined neural activity immediately before insight solutions.	A burst of gamma activity appeared in the right anterior temporal region before insight.	Insight was preceded by a localized gamma increase.
Benedek et al.	EEG alpha synchronization is related to top-down processing in convergent and divergent thinking	2011	EEG measured alpha activity during convergent and divergent thinking tasks.	Alpha synchronization varied with top-down processing demands.	Alpha synchronization tracked top-down processing during creative tasks.

5. Creative Performance, Alpha, and Neurofeedback — continued

Author	Study name	Date	Description	Findings	Relevance
Egner and Gruzelier	EEG biofeedback of low beta band components: frequency-specific effects on variables of attention and event-related brain potentials	2004	Participants trained specific EEG frequency components with neurofeedback; attention and event-related potentials were measured.	Different frequency-band training produced frequency-specific effects on attention and event-related potentials.	Deliberately changing oscillatory activity altered attention and evoked responses.
Ros et al.	Mind over chatter: plastic up-regulation of the fMRI salience network directly after EEG neurofeedback	2013	Participants were trained to reduce alpha activity, followed by fMRI connectivity measurement.	Alpha down-training was followed by altered connectivity in the salience network.	Changing alpha activity altered connectivity in an attention-related network.

6. Targeted Stimulation

Author	Study name	Date	Description	Findings	Relevance
Legon et al.	Transcranial focused ultrasound modulates the activity of primary somatosensory cortex in humans	2014	Focused ultrasound was applied to primary somatosensory cortex in healthy volunteers.	Evoked electrical responses decreased while tactile discrimination improved. Moving the focus away from target removed the response reduction.	A smaller evoked cortical response accompanied better tactile discrimination.
Ziebell et al.	Inhibition of midfrontal theta with transcranial ultrasound explains greater approach versus withdrawal behavior in humans	2023	Preregistered double-blind ultrasound study targeting right prefrontal cortex during a conflict task.	Changes in midfrontal theta accompanied greater approach and less withdrawal behavior.	Targeted reduction of midfrontal theta accompanied a measurable behavioral shift.

7. Emotional Regulation and Self-Processing

Author	Study name	Date	Description	Findings	Relevance
Desbordes et al.	Effects of mindful-attention and compassion meditation training on amygdala response to emotional stimuli in an ordinary, non-meditative state	2012	fMRI before and after 8 weeks of mindful-attention training, compassion training, or an active control measured amygdala responses to positive, negative, and neutral images while participants were not meditating.	Mindful-attention training produced a longitudinal decrease in right-amygdala activation to positive images and across all image valences. Compassion training showed a trend toward increased right-amygdala response to negative images that correlated with decreased depression scores.	Mindful-attention training reduced amygdala reactivity outside meditation, linking lower emotional-region activity with trained regulation.
Farb et al.	Minding one's emotions: mindfulness training alters the neural expression of sadness	2010	fMRI compared neural responses to sadness provocation after 8 weeks of mindfulness training with wait-list controls.	Both groups reported similar sadness, but trained participants showed greater right-lateralized recruitment of visceral and somatosensory regions rather than the broader cortical-midline self-referential pattern. Greater somatic recruitment was associated with lower depression scores.	Mindfulness altered the neural pattern supporting sadness, shifting processing away from self-referential midline activity while preserving the experienced emotion.
Farb et al.	Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference	2007	fMRI compared narrative self-focus with moment-to-moment experiential self-focus in novices and participants who had completed 8 weeks of mindfulness training.	Experiential focus reduced medial prefrontal activity in both groups. Trained participants showed broader medial-prefrontal reductions, increased right lateral prefrontal, insular, somatosensory, and inferior-parietal activity, and weaker coupling between the right insula and medial prefrontal cortex.	Present-centered awareness after training involved reduced medial-prefrontal self-referential activity with increased task-relevant sensory and attentional recruitment.
Tang et al.	Short-term meditation training improves attention and self-regulation	2007	Participants were randomly assigned to 5 days of integrative body-mind training (IBMT) or the same amount of relaxation training.	IBMT produced greater improvement in executive attention and mood measures than relaxation training. After an additional stress challenge, the IBMT group also showed lower cortisol and greater immunoreactivity.	Brief meditation training improved attention and self-regulation, the functional outcomes addressed by the corollary.

7. Emotional Regulation and Self-Processing (continued)

Author	Study name	Date	Description	Findings	Relevance
Tang et al.	Central and autonomic nervous system interaction is altered by short-term meditation	2009	Brain imaging, EEG, heart-rate variability, respiration, and skin conductance were measured before, during, and after 5 days of IBMT or relaxation training.	IBMT produced stronger subgenual and adjacent ventral anterior cingulate activity, increased frontal-midline theta, and greater parasympathetic regulation. Frontal-midline theta correlated with high-frequency heart-rate variability.	Attention and self-regulation gains were accompanied by a specific redistribution of brain activity and stronger central-autonomic regulation.
Davidson et al.	Alterations in brain and immune function produced by mindfulness meditation	2003	A randomized controlled study measured EEG in 25 mindfulness trainees and 16 wait-list controls before, after, and 4 months after an 8-week program; participants also received influenza vaccine.	Meditators showed significant increases in left-sided anterior activation compared with controls and larger antibody responses to influenza vaccination. The increase in left-sided activation predicted the increase in antibody titer.	Meditation produced a measurable redistribution of cortical activity associated with positive affect rather than a simple global increase or decrease.

8. Psychedelic States and Breathwork

Author	Study name	Date	Description	Findings	Relevance
Carhart-Harris et al.	Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin	2012	fMRI measured acute brain changes under psilocybin.	Regional blood-flow and BOLD signals decreased in several areas during the psychedelic state.	Pronounced changes in conscious experience accompanied reduced regional blood-flow and BOLD signals.
Muthukumaraswamy et al.	Broadband cortical desynchronization underlies the human psychedelic state	2013	MEG measured cortical oscillations under psilocybin.	Broadband oscillatory power decreased during the psychedelic state.	Pronounced changes in conscious experience accompanied broad reductions in oscillatory power.
Tagliazucchi et al.	Increased global functional connectivity correlates with LSD-induced ego dissolution	2016	fMRI measured global functional connectivity under LSD.	Global functional connectivity increased and correlated with ego dissolution.	Altered consciousness accompanied increased global functional connectivity.
Schartner et al.	Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin	2017	MEG signal diversity was measured under ketamine, LSD, and psilocybin.	Signal diversity increased under all three drugs.	Altered consciousness increased signal diversity, a measure distinct from oscillatory power.
Schmitz et al.	How high ventilation breathwork alters consciousness: Hypoperfusion, network dynamics, and subjective experience	2026	Experienced practitioners underwent high-ventilation breathwork with cerebral blood-flow measurement and subjective assessment.	Global gray-matter cerebral blood flow fell 45.5%, from 29.81 to 16.24 ml/100g/min. Participants reported psychedelic-like changes in perception and self-experience.	Psychedelic-like experience accompanied a 45.5% reduction in global gray-matter cerebral blood flow.
Kometer et al.	Psilocybin-induced spiritual experiences and insightfulness are associated with synchronization of neuronal oscillations	2015	Studied 50 volunteers receiving psilocybin and measured neuronal oscillatory activity together with subjective effects.	Psilocybin reduced brainwave current, and the intensity of subjective effects and insightfulness correlated with desynchronization of neuronal oscillations.	Subjective awareness intensity and insightfulness accompanied changes in oscillatory synchronization.

8. Psychedelic States and Breathwork — continued

Author	Study name	Date	Description	Findings	Relevance
Riba et al.	Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers	2002	Measured EEG activity in 18 subjects after administration of ayahuasca.	Ayahuasca decreased absolute brainwave power across frequency bands.	An expanded conscious state accompanied reduced absolute EEG power across frequency bands.
Lewis, Preller et al.	Two dose investigation of the 5-HT-agonist psilocybin on relative and global cerebral blood flow	2017	Studied 58 healthy participants receiving oral psilocybin and measured cerebral blood flow.	Psilocybin was associated with decreased absolute cerebral blood flow.	Psilocybin-induced changes in consciousness accompanied reduced absolute cerebral blood flow.

9. Enduring Psychedelic Outcomes

Author	Study name	Date	Description	Findings	Relevance
MacLean et al.	Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness	2011	Personality was assessed after high-dose psilocybin sessions in healthy adults using the five-factor model.	Openness increased significantly after high-dose psilocybin. In participants who had mystical experiences during the session, Openness remained significantly above baseline more than one year later.	Shows a durable cognitive and personality outcome following an acute altered-consciousness intervention.
Smigielski et al.	Characterization and prediction of acute and sustained response to psychedelic psilocybin in a mindfulness group retreat	2019	Thirty-nine experienced meditators received double-blind psilocybin (315 µg/kg) or placebo during a 5-day mindfulness retreat, with acute measures and a 4-month follow-up.	Psilocybin increased meditation depth and positively experienced self-dissolution without increasing anxiety. Dispositional mindfulness was higher the next day, and aspects of the acute mystical-type experience predicted enduring positive changes in psychosocial functioning at 4 months.	Shows acute and sustained functional changes associated with a pronounced altered-consciousness intervention.

10. Structure and Neural Preservation

Author	Study name	Date	Description	Findings	Relevance
Lazar et al.	Meditation experience is associated with increased cortical thickness	2005	Structural imaging compared meditation experience with cortical thickness.	Meditation experience was associated with greater cortical thickness in selected regions.	Meditation experience was associated with structural differences in cortex.
Hölzel et al.	Mindfulness practice leads to increases in regional brain gray matter density	2011	Structural imaging assessed gray-matter change after mindfulness training.	Regional gray-matter density increased after training.	Meditation training was associated with regional structural change.
Tang et al.	Short-term meditation induces white matter changes in the anterior cingulate	2010	Diffusion imaging assessed white-matter change after short-term meditation training.	Training was associated with white-matter changes in the anterior cingulate.	Meditation training was associated with white-matter change in a control-related region.
Genç et al.	Diffusion markers of dendritic density and arborization in gray matter predict differences in intelligence	2018	Examined 259 participants using neurite orientation dispersion and density imaging and correlated cortical dendritic measures with intelligence scores. The findings were tested in a separate sample of 500 Human Connectome Project participants.	Higher intelligence was associated with lower estimated dendritic density and arborization in the cerebral cortex. The relationship was replicated in the independent 500-person sample.	Higher intelligence was associated with lower estimated cortical dendritic density and arborization.

10. Structure and Neural Preservation (continued)

Author	Study name	Date	Description	Findings	Relevance
Zullo et al.	Regulation of lifespan by neural excitation and REST	2019	Human cortical transcriptomic analyses were combined with mouse and C. elegans experiments examining neural excitation, REST, and lifespan.	Exceptional human longevity was associated with downregulation of genes related to neural excitation and synaptic function. In C. elegans, reducing excitation increased lifespan; REST-deficient mice showed increased cortical activity and excitability with age; REST-related manipulations that suppressed excitation extended lifespan in worms.	Links lower neural excitation with preserved function and longevity across multiple experimental systems.
Lu et al.	REST and stress resistance in ageing and Alzheimer's disease	2014	Human cortical and hippocampal tissue, mouse models, and C. elegans were used to examine REST during normal aging and neurodegeneration.	REST increased in normal aging but was lost in mild cognitive impairment and Alzheimer's disease. REST repressed cell-death and Alzheimer-related genes, promoted stress-response genes, protected neurons from oxidative stress and amyloid-β toxicity, and correlated with cognitive preservation and longevity.	Links REST-regulated neuronal protection and stress resistance with cognitive preservation during aging.

11. Gamma Findings

Author	Study name	Date	Description	Findings	Relevance
Lutz et al.	Long-term meditators self-induce high-amplitude gamma synchrony during mental practice	2004	EEG compared long-term meditators and controls during mental practice.	Experienced practitioners generated high-amplitude gamma oscillations and increased long-distance synchrony during compassion meditation.	Advanced meditation can include increased gamma amplitude and synchrony.
Melloni et al.	Synchronization of neural activity across cortical areas correlates with conscious perception	2007	Neural responses to perceived and unperceived words were compared.	Both conditions produced local gamma activity; consciously perceived words also produced long-distance gamma synchronization.	Conscious perception included increased long-distance gamma synchronization.

12. The 5-HT2A Paradox — Relevant Experiments

Author	Study name	Date	Description	Findings	Relevance
Weisstaub et al.	Cortical 5-HT2A receptor signaling modulates anxiety-like behaviors in mice	2006	Mouse experiments altered cortical 5-HT2A signaling and measured conflict-related anxiety behavior.	Cortical 5-HT2A signaling changed anxiety-like behavior.	Links cortical 5-HT2A signaling to an emotional function targeted by the corollary.
Quednow et al.	Psilocybin-induced deficits in automatic and controlled inhibition are attenuated by ketanserin in healthy human volunteers	2012	Healthy volunteers received psilocybin with or without the 5-HT2A antagonist ketanserin.	Ketanserin reduced psilocybin-induced impairments of automatic and controlled inhibition; ketanserin alone did not significantly improve baseline performance.	Changing 5-HT2A signaling altered inhibitory performance under psilocybin.
Mason et al.	Me, myself, bye: regional alterations in glutamate and the experience of ego dissolution with psilocybin	2020	Magnetic resonance spectroscopy measured glutamate changes under psilocybin.	Glutamate changes differed between medial prefrontal cortex and hippocampus and related to aspects of ego dissolution.	Altered conscious experience was associated with region-specific glutamate changes.

12. The 5-HT2A Paradox — Relevant Experiments — continued

Author	Study name	Date	Description	Findings	Relevance
Madsen et al.	A single psilocybin dose is associated with long-term increased mindfulness, preceded by a proportional change in neocortical 5-HT2A receptor binding	2020	5-HT2A receptor binding was measured before and one week after psilocybin; mindfulness was assessed later.	No significant group-wide receptor-binding change was detected at one week. Post hoc individual changes in binding were associated with mindfulness change at 3 months.	Relates post-psilocybin 5-HT2A binding changes to later mindfulness.
Lai et al.	Loss of serotonin 5-HT2A receptors in the postmortem temporal cortex correlates with rate of cognitive decline in Alzheimer's disease	2005	Postmortem cortical 5-HT2A receptor binding was related to the rate of cognitive decline in Alzheimer's disease.	Lower temporal-cortex 5-HT2A binding correlated with faster cognitive decline.	Lower 5-HT2A binding in Alzheimer's disease correlated with faster cognitive decline.

References

1. Buzsáki, G., Anastassiou, C. A., and Koch, C. (2012). The origin of extracellular fields and currents—EEG, ECoG, LFP and spikes. Nature Reviews Neuroscience, 13, 407–420. Source

2. Rohn, T. T., et al. (2024). Intranasal delivery of shRNA to knockdown the 5HT-2A receptor enhances memory and alleviates anxiety. Translational Psychiatry, 14, 154. Source

3. Rohn, T. T., et al. (2023). Genetic modulation of the HTR2A gene reduces anxiety-related behavior in mice. PNAS Nexus, 2(6), pgad170. Source

4. Rohn, T. T., et al. (2024). Treatment with shRNA to knockdown the 5-HT2A receptor improves memory in vivo and decreases excitability in primary cortical neurons. Genomic Psychiatry, 1(1), 85–93. Figure 5 supplies the spike-count and mean-firing-rate reductions. Source

5. Haier, R. J., et al. (1992). Regional glucose metabolic changes after learning a complex visuospatial/motor task: a positron emission tomographic study. Brain Research, 570(1–2), 134–143. Source

6. Haier, R. J., et al. (1992). Intelligence and changes in regional cerebral glucose metabolic rate following learning. Intelligence, 16(3–4), 415–426. Source

7. Haier, R. J., et al. (1988). Cortical glucose metabolic rate correlates of abstract reasoning and attention studied with positron emission tomography. Intelligence, 12(2), 199–217.

8. Neubauer, A. C., and Fink, A. (2009). Intelligence and neural efficiency. Neuroscience & Biobehavioral Reviews, 33(7), 1004–1023. Source

9. Dunst, B., et al. (2014). Neural efficiency as a function of task demands. Intelligence, 42, 22–30. Source

10. Bakker, A., et al. (2012). Reduction of hippocampal hyperactivity improves cognition in amnestic mild cognitive impairment. Neuron, 74(3), 467–474. Source

11. Brewer, J. A., et al. (2011). Meditation experience is associated with differences in default mode network activity and connectivity. Proceedings of the National Academy of Sciences, 108(50), 20254–20259. Source

12. Garrison, K. A., et al. (2013). Effortless awareness: using real time neurofeedback to investigate correlates of posterior cingulate cortex activity in meditators' self-report. Frontiers in Human Neuroscience, 7, 440. Source

13. Garrison, K. A., et al. (2015). Meditation leads to reduced default mode network activity beyond an active task. Cognitive, Affective, & Behavioral Neuroscience, 15(3), 712–720. Source

14. Slagter, H. A., et al. (2007). Mental training affects distribution of limited brain resources. PLOS Biology, 5(6), e138. Source

15. Haufler, A. J., et al. (2000). Neuro-cognitive activity during a self-paced visuospatial task: comparative EEG profiles in marksmen and novice shooters. Biological Psychology, 53, 131–160. Source

16. Del Percio, C., et al. (2009). "Neural efficiency" of athletes' brain for upright standing: a high-resolution EEG study. Brain Research Bulletin, 79(3–4), 188–194. Source

17. Landers, D. M., et al. (1991). The influence of electrocortical biofeedback on performance in pre-elite archers. Medicine & Science in Sports & Exercise, 23(1), 123–129. Source

18. Ulrich, M., et al. (2014). Neural correlates of experimentally induced flow experiences. NeuroImage, 86, 194–202. Source

19. Limb, C. J., and Braun, A. R. (2008). Neural substrates of spontaneous musical performance: an fMRI study of jazz improvisation. PLOS ONE, 3(2), e1679. Source

20. Jung-Beeman, M., et al. (2004). Neural activity when people solve verbal problems with insight. PLOS Biology, 2(4), e97. Source

21. Benedek, M., et al. (2011). EEG alpha synchronization is related to top-down processing in convergent and divergent thinking. International Journal of Psychophysiology, 82(1), 90–98.

22. Fink, A., and Benedek, M. (2014). EEG alpha power and creative ideation. Neuroscience & Biobehavioral Reviews, 44, 111–123. Source

23. Jensen, O., and Mazaheri, A. (2010). Shaping functional architecture by oscillatory alpha activity: gating by inhibition. Frontiers in Human Neuroscience, 4, 186. Source

24. Klimesch, W., Sauseng, P., and Hanslmayr, S. (2007). EEG alpha oscillations: the inhibition-timing hypothesis. Brain Research Reviews, 53(1), 63–88. Source

25. Egner, T., and Gruzelier, J. H. (2004). EEG biofeedback of low beta band components: frequency-specific effects on variables of attention and event-related brain potentials. Clinical Neurophysiology, 115(1), 131–139. Source

26. Ros, T., et al. (2013). Mind over chatter: plastic up-regulation of the fMRI salience network directly after EEG neurofeedback. NeuroImage, 65, 324–335. Source

27. Legon, W., et al. (2014). Transcranial focused ultrasound modulates the activity of primary somatosensory cortex in humans. Nature Neuroscience, 17(2), 322–329. Source

28. Ziebell, P., et al. (2023). Inhibition of midfrontal theta with transcranial ultrasound explains greater approach versus withdrawal behavior in humans. Brain Stimulation, 16(5), 1278–1288. Source

29. Desbordes, G., et al. (2012). Effects of mindful-attention and compassion meditation training on amygdala response to emotional stimuli in an ordinary, non-meditative state. Frontiers in Human Neuroscience, 6, 292. Source

30. Farb, N. A. S., et al. (2010). Minding one's emotions: mindfulness training alters the neural expression of sadness. Emotion, 10(1), 25–33. Source

31. Farb, N. A. S., et al. (2007). Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference. Social Cognitive and Affective Neuroscience, 2(4), 313–322. Source

32. Tang, Y.-Y., et al. (2007). Short-term meditation training improves attention and self-regulation. Proceedings of the National Academy of Sciences, 104(43), 17152–17156.

33. Tang, Y.-Y., et al. (2009). Central and autonomic nervous system interaction is altered by short-term meditation. Proceedings of the National Academy of Sciences, 106(22), 8865–8870. Source

34. Davidson, R. J., et al. (2003). Alterations in brain and immune function produced by mindfulness meditation. Psychosomatic Medicine, 65(4), 564–570.

35. Carhart-Harris, R. L., et al. (2012). Neural correlates of the psychedelic state as determined by fMRI studies with psilocybin. Proceedings of the National Academy of Sciences, 109(6), 2138–2143.

36. Muthukumaraswamy, S. D., et al. (2013). Broadband cortical desynchronization underlies the human psychedelic state. Journal of Neuroscience, 33(38), 15171–15183. Source

37. Tagliazucchi, E., et al. (2016). Increased global functional connectivity correlates with LSD-induced ego dissolution. Current Biology, 26(8), 1043–1050.

38. Schartner, M. M., et al. (2017). Increased spontaneous MEG signal diversity for psychoactive doses of ketamine, LSD and psilocybin. Scientific Reports, 7, 46421. Source

39. MacLean, K. A., et al. (2011). Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. Journal of Psychopharmacology, 25(11), 1453–1461.

40. Smigielski, L., et al. (2019). Characterization and prediction of acute and sustained response to psychedelic psilocybin in a mindfulness group retreat. Scientific Reports, 9, 14914. Source

41. Lazar, S. W., et al. (2005). Meditation experience is associated with increased cortical thickness. NeuroReport, 16(17), 1893–1897.

42. Hölzel, B. K., et al. (2011). Mindfulness practice leads to increases in regional brain gray matter density. Psychiatry Research: Neuroimaging, 191(1), 36–43.

43. Tang, Y.-Y., et al. (2010). Short-term meditation induces white matter changes in the anterior cingulate. Proceedings of the National Academy of Sciences, 107(35), 15649–15652.

44. Genç, E., et al. (2018). Diffusion markers of dendritic density and arborization in gray matter predict differences in intelligence. Nature Communications, 9, 1905. Source

45. Zullo, J. M., et al. (2019). Regulation of lifespan by neural excitation and REST. Nature, 574, 359–364.

46. Lu, T., et al. (2014). REST and stress resistance in ageing and Alzheimer's disease. Nature, 507, 448–454.

47. Lutz, A., et al. (2004). Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. Proceedings of the National Academy of Sciences, 101(46), 16369–16373. Source

48. Melloni, L., et al. (2007). Synchronization of neural activity across cortical areas correlates with conscious perception. Journal of Neuroscience, 27(11), 2858–2865. Source

49. Weisstaub, N. V., et al. (2006). Cortical 5-HT2A receptor signaling modulates anxiety-like behaviors in mice. Science, 313(5786), 536–540. Source

50. Quednow, B. B., et al. (2012). Psilocybin-induced deficits in automatic and controlled inhibition are attenuated by ketanserin in healthy human volunteers. Neuropsychopharmacology, 37(3), 630–640. Source

51. Mason, N. L., et al. (2020). Me, myself, bye: regional alterations in glutamate and the experience of ego dissolution with psilocybin. Neuropsychopharmacology, 45(12), 2003–2011. Source

52. Madsen, M. K., et al. (2020). A single psilocybin dose is associated with long-term increased mindfulness, preceded by a proportional change in neocortical 5-HT2A receptor binding. European Neuropsychopharmacology, 33, 71–80. Source

53. Lai, M. K. P., et al. (2005). Loss of serotonin 5-HT2A receptors in the postmortem temporal cortex correlates with rate of cognitive decline in Alzheimer's disease. Psychopharmacology, 179(3), 673–677. Source

54. Barnes, N. M., et al. (2021). International Union of Basic and Clinical Pharmacology. CX. Classification of receptors for 5-hydroxytryptamine; pharmacology and function. Pharmacological Reviews, 73(1), 310–520. Source

55. Travis, F. (2014). Transcendental experiences during meditation practice. Annals of the New York Academy of Sciences, 1307(1), 1–8. Source

56. Wallace, R. K. (1970). Physiological effects of transcendental meditation. Science, 167(3926), 1751–1754.

57. Chowdhury, A., et al. (2024, online publication). Multimodal neurophenomenology of advanced concentration absorption meditation: an intensively sampled case study of Jhana. NeuroImage, article 120973. Source

58. Chowdhury, A., et al. (2023). Investigation of advanced mindfulness meditation "cessation" experiences using EEG spectral analysis in an intensively sampled case study. Neuropsychologia, 190, 108694. Read with the 2024 corrigendum, Neuropsychologia, 203, 108972. Source

59. van Lutterveld, R., et al. (2024). Neurophenomenological investigation of mindfulness meditation "cessation" experiences using EEG network analysis in an intensively sampled adept meditator. Brain Topography, 37, 849–858. Source

60. Newberg, A. B., et al. (2001). The measurement of regional cerebral blood flow during the complex cognitive task of meditation: a preliminary SPECT study. Psychiatry Research: Neuroimaging, 106(2), 113–122.

61. Lou, H. C., et al. (1999). A 15O-H2O PET study of meditation and the resting state of normal consciousness. Human Brain Mapping, 7(2), 98–105. Source

62. Schmitz, C., et al. (2026). High-ventilation breathwork reduces cerebral blood flow and alters default mode network communication: an arterial spin labeling MRI study. Presented at the ECNP Congress, Munich; Central Institute of Mental Health, Mannheim. Title to be confirmed on publication.

63. Ching, S., et al. (2010). Thalamocortical model for a propofol-induced alpha-rhythm associated with loss of consciousness. Proceedings of the National Academy of Sciences, 107(52), 22665–22670. Source

64. Purdon, P. L., et al. (2013). Electroencephalogram signatures of loss and recovery of consciousness from propofol. Proceedings of the National Academy of Sciences, 110(12), E1142–E1151. Source

65. Ammirati, F., et al. (1998). Electroencephalographic correlates of vasovagal syncope induced by head-up tilt testing. Stroke, 29(11), 2347–2351. Source

66. van Lutterveld, R., et al. (2017). Source-space EEG neurofeedback links subjective experience with brain activity during effortless awareness meditation. NeuroImage, 151, 117–127. Source

67. Pagnoni, G. (2012). Dynamical properties of BOLD activity from the ventral posteromedial cortex associated with meditation and attentional skills. Journal of Neuroscience, 32(15), 5242–5249. Source

68. Kometer, M., et al. (2015). Psilocybin-induced spiritual experiences and insightfulness are associated with synchronization of neuronal oscillations. Psychopharmacology, 232(19), 3663–3676. Source

69. Riba, J., et al. (2002). Topographic pharmaco-EEG mapping of the effects of the South American psychoactive beverage ayahuasca in healthy volunteers. British Journal of Clinical Pharmacology, 53(6), 613–628. Source

70. Lewis, C. R., Preller, K. H., et al. (2017). Two dose investigation of the 5-HT-agonist psilocybin on relative and global cerebral blood flow. NeuroImage, 159, 70–78. Source

Corollary 2 Boundary Conditions

Core Boundary Condition: Brainwave Field Coherence

Corollary 2 applies while the brain's electromagnetic field remains within normal ranges of phase coherence. The principle assumes an organized brainwave field in which neural oscillations remain sufficiently coherent to support ordinary or expanded awareness states.

States of degraded coherence, such as anesthesia, are exceptions. In those states, the brain may remain electrically active, but the field structure required for awareness is disrupted. In those states, the brain may remain electrically active, but its field coherence is degraded. In such states, Corollary 2 does not apply in its ordinary form because the relevant organizing condition for awareness — coherent brainwave-field structure — has collapsed.

Apparent Contradictions Resolved: Gamma Waves

A. Lutz et al 2004 – Compassion Meditation

Eight Tibetan adepts in one well-known study showed sustained high gamma while performing compassion meditation (Lutz et al. 2004). The finding appears to contradict Corollary 2, but it does not. The adepts were generating compassion — actively cultivating a feeling. Active mental work produces gamma in any subject. The gamma reflects the work of generation, not the awareness state itself.

Practices aimed at pure awareness without generation — Transcendental Meditation and related techniques — show the opposite pattern: low frequencies, high coherence, reduced overall current The harder a meditator works at generating something, the more gamma. The more they rest in pure awareness, the less.

- Travis and Shear's automatic self-transcending category — Transcendental Meditation, yoga nidra, certain Dzogchen techniques — is characterized by frontal alpha-1 coherence and reduced high-frequency power.
- Josipovic (2014) found non-dual awareness associated with decreased medial prefrontal cortex and posterior cingulate cortex activity relative to both focused attention and rest.
- Travis (2014) recorded spontaneously reported pure-consciousness episodes during Transcendental Meditation as globally synchronous alpha-1 with brain current quieter than deep sleep.
- Berkovich-Ohana (2013) mapped self-boundary dissolution to band-specific reductions in posterior medial and right inferior parietal cortex.

B. Melloni et al. 2007: Gamma Coherence, Not Gamma Quantity

In this experiment, subjects viewed briefly flashed and masked words. Sometimes they consciously perceived the word, and sometimes they did not. Two measurements were compared:

- Local gamma activity at individual brain regions.
- Long-distance gamma synchronization across separated brain regions.

Perceived and unperceived words produced similar amounts of local gamma activity. Gamma power alone did not distinguish conscious perception from unconscious processing.
What differed was long-range gamma coherence. When subjects consciously perceived the word, gamma activity across distant brain regions became synchronized. When the word was not consciously perceived, local gamma still occurred, but it was not phase-locked across the wider network.

This supports the boundary distinction. Awareness was not predicted by the quantity of gamma activity. It was predicted by the coordination of gamma activity across brain regions.

Thus, gamma-band activity does not refute Corollary 2. The principle describes changes in oscillatory power and neural current. Gamma's awareness-related function depends on phase coherence, which is a different dimension of neural dynamics.

Psychedelics and Neuron Firing Rates

Claim	Evidence Strength	Reasoning
No direct in vitro evidence that LSD increases firing rate in human cortical neurons	Strong	Comprehensive literature search found no such studies; field focuses on other endpoints
Rodent studies show complex effects of 5-HT2A agonists on firing rate	Strong	Rodent slice studies show increased EPSCs but mixed effects on firing rate
Human iPSC-derived neuron studies focus on molecular/structural changes, not firing rate	Moderate	Human cell studies examine gene expression and plasticity, not electrophysiological firing
In vivo human studies measure field potentials, not single-neuron firing	Moderate	Human intracranial recordings assess oscillatory dynamics, not direct firing rates
LSD is a potent 5-HT2A agonist and can excite neurons in some models	Moderate	Pharmacological data support excitatory potential, but not directly linked to firing rate in human neurons
Claims of increased firing rate in human neurons after LSD are unsubstantiated	Strong	No published evidence supports this claim; consensus among experts

SOURCE: CONSENSUS

02

DETAIL

Technical Appendix 3: Content Density Evidence Base

02

Content Density Definitions

SUMMARY

Pure conscious awareness

Awareness without content.

Content

Everything else present to awareness: conscious thought and perception, unconscious memory. Content has frequency (as in sound and light) and power (as in intensity of perception or emotion).

Content density

Content density is a gradient scale.

Rarified content near the top of the scale is less dense than content near the bottom; the more rarified, the more closely a state resembles pure awareness.

Part A orders states along this scale from rarified to dense.

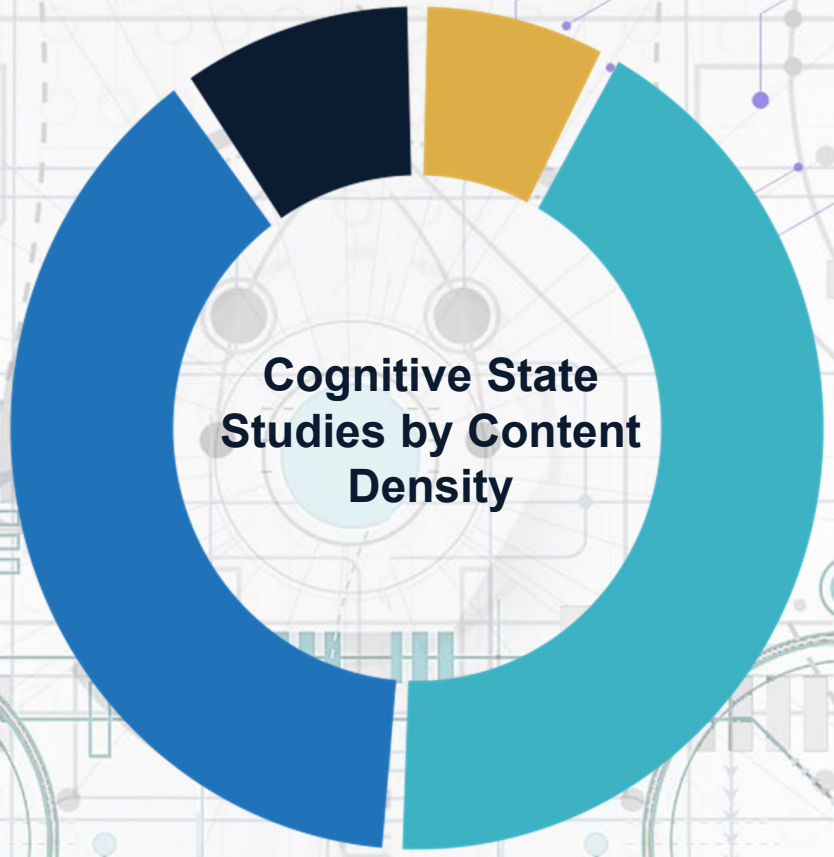
Mind-wandering is dense; task-absorbed flow is intermediate; expanded awareness psychedelic states are semi-rarified, pure-consciousness states are rarified.

Neural activity

Neurowaves: cellular-level voltage potentials traveling along neural circuits. EEG, MEG, PET, SPECT, and fMRI-BOLD are accepted here as indirect measures of neurowave activity.

Brainwaves: their scalp-recorded aggregate. Scalp EEG is dominated by summed dendritic postsynaptic potentials of pyramidal cells rather than by action potentials; the EEG frequency bands are mathematical abstractions, the recorded neurowave voltage is not (Buzsáki, Anastassiou & Koch, 2012, Nature Reviews Neuroscience, 13, 407–420).

Corollary 2 Study Counts by Content Density



Part A of the evidence corpus — 51 state studies, from rarified to dense mental content

Rarified 4

Pure consciousness and non-dual awareness. Awareness is present while objects of awareness are nearly absent — no imagery, no narrative, no felt self-boundary.

Rarified to Mid 17

Effortless awareness and psychedelic states. Content is thinned or dissolved but not gone: perception and imagery continue while self-referential structure loosens.

Mid 19

Meditation and task-absorbed flow. Attention is held on a single object or task and discursive self-commentary falls quiet, but ordinary content is still being processed.

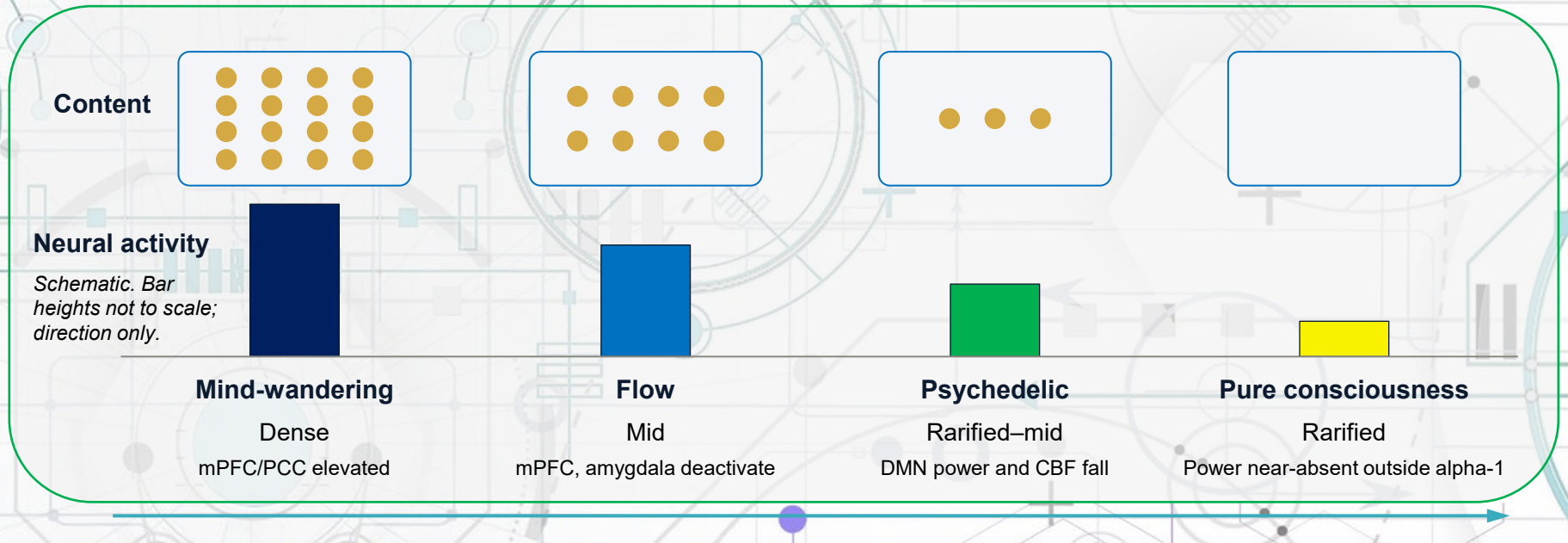
Dense 5

Mind-wandering, compassion practice, verbal prayer. Full discursive content — language, imagery and self-reference running continuously.

Total 45

Corollary 2 Evidence Summary by Content Density

Higher awareness and stronger cognitive traits accompany lower neural activity.



- As content thins toward pure consciousness, cortical activity falls: alpha dominates, the default-mode network quiets, metabolism drops.
- Forty-two of 45 state studies report decreases;
- Psychedelic states follow the same pattern and sit in the rarified–mid range.
- Higher intelligence, expertise, attention, and emotion regulation activate less cortex, more focally, for the same work.
- Lowering activity directly, by neurofeedback, transcranial direct-current stimulation, low-frequency rTMS, or focused ultrasound, improves cognitive performance.

Part A — States: awareness and neural activity

#	Citation	Modality	Content density	Finding
124	Travis, F. (2014). Annals of the New York Academy of Sciences, 1307, 1–8.	EEG	Rarified	Pure-consciousness episodes: globally synchronous alpha-1 with near-absent power in other bands.
18	Wallace, R.K. (1970). Science, 167(3926), 1751–1754.	EEG / physiology	Rarified	Transcendental Meditation: decreased oxygen consumption and increased alpha synchrony.
38	Travis, F. (2010). Consciousness and Cognition, 19(4), 1110–1118.	EEG review	Rarified	Review of 17 studies: alpha-1 dominance characterizes self-transcending meditation.
63	Josipovic, Z. (2014). Annals of the New York Academy of Sciences, 1307, 9–18.	fMRI	Rarified	Non-dual awareness practice: largest mPFC/PCC reduction relative to focused attention and rest.
81	van Lutterveld, R. (2017). NeuroImage, 151, 117–127.	EEG source imaging	Rarified–Mid	32 subjects: reduced PCC–mPFC alpha/beta connectivity correlated with self-reported effortless awareness, linking subjective meditative experience with reduced default-mode-network activity.
78	Garrison, K.A. (2015). Cognitive, Affective, & Behavioral Neuroscience, 15(3), 712–720.	fMRI	Mid	Meditation drives PCC/mPFC below levels reached during effortful goal-directed cognition.
80	Brewer, J.A. (2013). Frontiers in Human Neuroscience, 7, 647.	Real-time fMRI	Mid	Lower PCC activity coincides with reports of undistracted awareness; higher PCC with mind-wandering and self-reference.
49	Dor-Ziderman, Y. (2013). Frontiers in Human Neuroscience, 7, 582.	MEG	Mid	Three reported levels of self-dissolution map to reductions in three frequency bands.
50	Trautwein, F.-M. (2024). Journal of Neuroscience, 44(26), e1182232024.	MEG (pre-registered)	Mid	Self-boundary dissolution: high-beta reductions in posterior medial cortex.
20	Newberg, A.B. (2001). Psychiatry Research: Neuroimaging, 106(2), 113–122.	SPECT	Mid	Peak meditation: reduced superior parietal lobe blood flow.

Part A — States: awareness and neural activity

#	Citation	Modality	Content density	Finding
19	Herzog, H. (1991). Neuropsychobiology, 23(4), 182–187.	PET	Mid	Yoga meditation: reduced visual cortex glucose metabolism.
34	Lazar, S.W. (2000). NeuroReport, 11(7), 1581–1585.	fMRI	Mid	Meditation: reduced posterior parietal and lateral prefrontal activation.
36	Dillbeck, M.C. (1987). American Psychologist, 42(9), 879–881.	Meta-analysis (31 studies)	Mid	TM vs eyes-closed rest: lower respiration rate, skin conductance, and plasma lactate.
37	Young, J.D.-E. (1998). News in Physiological Sciences, 13, 149–153.	Physiological review	Mid	Deep meditation: hypometabolic, alpha-dominant alert state.
72	Benson, H. (1974). Psychiatry, 37(1), 37–46.	Physiology / EEG	Mid	Relaxation response: decreased metabolism, increased alpha, reduced HPA-axis output.
15	Ulrich, M. (2014). NeuroImage, 86, 194–202.	Perfusion fMRI	Mid (task)	Flow: mPFC and amygdala deactivation; amygdala reduction scales with flow intensity.
16	Ulrich, M. (2016). Social Cognitive and Affective Neuroscience, 11(3), 496–507.	BOLD fMRI	Mid (task)	Replication: mPFC/amygdala deactivation during flow across two imaging methods.
17	Limb, C.J. (2008). PLOS ONE, 3(2), e1679.	fMRI	Mid (task)	Jazz improvisation: extensive dlPFC deactivation.
8	Ulrich, M. (2018). Experimental Brain Research, 236(12), 3341–3352.	tDCS + fMRI	Mid (task)	Intervention on activity: Prefrontal tDCS increases reported flow and reduces amygdala activity.
55	de Manzano, Ö. (2010). Emotion, 10(3), 301–311.	Psychophysiology	Mid (task)	Flow in pianists: reduced heart rate, deeper respiration.

Part A — States: awareness and neural activity

#	Citation	Modality	Content density	Finding
42	Jung-Beeman, M. (2004). PLOS Biology, 2(4), e97.	EEG / fMRI	Mid (task)	Right temporal alpha burst precedes insight solutions.
43	Kounios, J. (2006). Psychological Science, 17(10), 882–890.	EEG	Mid (task)	Resting posterior alpha power predicts subsequent insight solutions.
44	Sandkühler, S. (2008). PLOS ONE, 3(1), e1459.	EEG	Mid (task)	Right posterior temporal alpha increase precedes verbal insight.
10	Benedek, M. (2011). International Journal of Psychophysiology, 82(1), 90–98.	EEG	Mid (task)	Frontal/parietal alpha increase during creative thinking correlates with originality scores.
73	Newberg, A.B. (2003). Perceptual and Motor Skills, 97(2), 625–630.	SPECT	Dense (verbal prayer)	Franciscan nuns at peak prayer: decreased superior parietal lobe activity.
39	Lutz, A. (2004). Proceedings of the National Academy of Sciences, 101(46), 16369–16373.	EEG	Dense (compassion)	Advanced meditators: high-amplitude gamma synchrony. Direction: gamma power increases.
32	Mason, M.F. (2007). Science, 315(5810), 393–395.	fMRI + experience sampling	Dense (mind-wandering)	Mind-wandering correlates with elevated mPFC/PCC/precuneus activation.
125	Kucyi, A. (2014). NeuroImage, 100, 471–480.	fMRI	Dense (mind-wandering)	Moment-to-moment mPFC–PCC coupling tracks mind-wandering within subjects.
74	Smallwood, J. (2015). Annual Review of Psychology, 66, 487–518.	Review	Dense (mind-wandering)	Review: mind-wandering (~47% of waking samples, citing Killingsworth & Gilbert 2010) associates with elevated mPFC/PCC activity.
1	Muthukumaraswamy, S.D. (2013). Journal of Neuroscience, 33(38), 15171–15183.	MEG	Rarified to mid (psychedelic)	Psilocybin: broadband cortical desynchronization; DMN power reduction.

Part A — States: awareness and neural activity

#	Citation	Modality	Content density	Finding
2	Carhart-Harris, R.L. (2012). Proceedings of the National Academy of Sciences, 109(6), 2138–2143.	fMRI (ASL/BOLD)	Rarified to mid (psychedelic)	Psilocybin: decreased cerebral blood flow only; mPFC/PCC deactivation tracks reported intensity.
4	Palhano-Fontes, F. (2015). PLOS ONE, 10(2), e0118143.	fMRI	Rarified to mid (psychedelic)	Ayahuasca: reduced DMN activity and mPFC–PCC coupling.
52	Carhart-Harris, R.L. (2016). Proceedings of the National Academy of Sciences, 113(17), 4853–4858.	fMRI / MEG	Rarified to mid (psychedelic)	LSD: broadband oscillatory decreases; three modalities converge.
61	Lebedev, A.V. (2015). Human Brain Mapping, 36(8), 3137–3153.	fMRI ICA	Rarified to mid (psychedelic)	Ego dissolution associates with decreased medial temporal lobe–cortical connectivity, salience-network disintegration, and reduced interhemispheric communication (n = 15).
82	Kometer, M. (2015). Psychopharmacology, 232(19), 3663–3676.	EEG (ketanserin crossover)	Rarified to mid (psychedelic)	50 volunteers: psilocybin reduced oscillatory power; intensity of subjective effects and insightfulness correlated with greater desynchronization of neuronal oscillations. Posterior-alpha reduction was blocked by ketanserin.
83	Lewis, C.R. (2017). NeuroImage, 159, 70–78.	pCASL perfusion MRI	Rarified to mid (psychedelic)	58 healthy participants (29 per dose group): oral psilocybin significantly reduced absolute cerebral blood flow across widespread frontal, temporal, parietal and occipital regions and multiple subcortical structures; relative perfusion changes varied by region.
86	Carhart-Harris, R.L. (2014). Frontiers in Human Neuroscience, 8, 20.	Theo-retical synthesis	Rarified to mid (psychedelic)	Entropic-brain model: ordinary waking consciousness as DMN-constrained; psychedelics reduce the constraint.
101	Timmermann, C. (2019). Scientific Reports, 9, 16324.	EEG	Rarified to mid (psychedelic)	IV DMT: alpha peak replaced by theta; alpha/beta reductions scale with reported intensity.
102	Schartner, M.M. (2017). Scientific Reports, 7, 46421.	MEG	Rarified to mid (psychedelic)	LSD, psilocybin, ketamine: signal diversity exceeds normal waking. Direction: entropy increases.
103	Tagliazucchi, E. (2014). Human Brain Mapping, 35(11), 5442–5456.	fMRI dynamics	Rarified to mid (psychedelic)	Psilocybin: larger repertoire of connectivity states; reduced DMN synchrony.

Part A — States: awareness and neural activity

#	Citation	Modality	Content density	Finding
108	Tagliazucchi, E. (2016). Current Biology, 26(8), 1043–1050.	fMRI	Rarified to mid (psychedelic)	LSD increases global functional connectivity and reduces modular organization; the increase correlates with ego dissolution (n = 15). Direction: connectivity increases.
109	Valle, M. (2016). European Neuropsychopharmacology, 26(7), 1161–1175.	EEG (ketanserin crossover)	Rarified to mid (psychedelic)	Ayahuasca: delta/theta/alpha power decreases; parieto-occipital alpha inversely correlates with visual imagery; blocked by ketanserin (n = 12).
110	Riba, J. (2002). British Journal of Clinical Pharmacology, 53(6), 613–628.	EEG	Rarified to mid (psychedelic)	18 subjects: ayahuasca decreased absolute EEG power across frequency bands, including dose-dependent theta/alpha/beta decreases in parieto-occipital cortex.
112	Preller, K.H. (2020). Biological Psychiatry, 88(2), 197–207.	fMRI (crossover)	Rarified to mid (psychedelic)	Psilocybin: reduced associative-cortex connectivity, increased sensory-cortex connectivity.
118	Mason, N.L. (2020). Neuropsychopharmacology, 45(12), 2003–2011.	fMRI + MRS	Rarified to mid (psychedelic)	Psilocybin increases mPFC glutamate (tracks negatively experienced ego dissolution) and decreases hippocampal glutamate (tracks positively experienced). Direction: mPFC glutamate increases.

Part A — Boundary states: loss of consciousness

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126	Ching, S. (2010). Proceedings of the National Academy of Sciences, 107(52), 22665–22670.	EEG	Loss of consciousness	Loss of consciousness was accompanied by increased low-beta and high-alpha EEG power.
127	Purdon, P.L. (2013). Proceedings of the National Academy of Sciences, 110(12), E1142–E1151.	EEG	Loss of consciousness	In 10 subjects gradually given propofol, brainwave power increased as consciousness was lost.
128	Ammirati, F. (1998). Pacing and Clinical Electrophysiology, 21(11 Pt 2), 2420–2425.	EEG + head-up tilt	Loss of consciousness	In 63 patients with a history of fainting, induced vasovagal syncope increased EEG amplitude; amplitude diminished when consciousness returned.

Part B — Traits: desirable cognitive traits and neural activity

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64	Berkovich-Ohana, A. (2013). Frontiers in Psychology, 4, 912.	MEG	Meditation trait	Meditators show reduced TPJ and posterior parietal activity during self-boundary tasks.
21	Brewer, J.A. (2011). Proceedings of the National Academy of Sciences, 108(50), 20254–20259.	fMRI	Meditation trait	Experienced meditators: lower mPFC/PCC activation across three practice types.
22	Haier, R.J. (1988). Intelligence, 12(2), 199–217.	PET	Intelligence	Raven's APM scores negatively correlate with cortical glucose metabolic rate, r = −.48 to −.84 across regions
12	Haier, R.J. (1992). Intelligence, 16(3–4), 415–426.	PET	Learning	Tetris practice: performance gain with decreased frontal/parietal glucose consumption.
23	Neubauer, A.C. (2009). Neuroscience & Biobehavioral Reviews, 33(7), 1004–1023.	Review (54 studies)	Intelligence	Of 54 studies, 29 support lower activation with higher IQ, 16 mixed, 9 contrary; the effect holds for low-to-moderate task difficulty and frontal regions and reverses for complex tasks.
24	Neubauer, A.C. (2002). Intelligence, 30(6), 515–536.	EEG	Intelligence	Higher intelligence: reduced cortical activation across verbal and figural tasks.
84	Basten, U. (2015). Intelligence, 51, 10–27.	Meta-analysis	Intelligence	Intelligence-related structural and functional differences cluster in frontal and parietal regions (P-FIT test).
76	Genç, E. (2018). Nature Communications, 9, 1905.	Diffusion MRI	Intelligence	259 participants: higher matrix-reasoning scores associated with lower estimated cortical dendritic density and arborization (NODDI). The relationship was replicated in an independent Human Connectome Project sample of 500 individuals.
27	Rypma, B. (2006). NeuroImage, 33(3), 969–979.	fMRI	Working memory	High-ability subjects: lower, more focal prefrontal activation.
54	Pinho, A.L. (2014). Journal of Neuroscience, 34(15), 6156–6163.	fMRI	Creative expertise	Improvisation experience negatively associated with frontoparietal activation.

Part B — Traits: desirable cognitive traits and neural activity

#	Citation	Modality	Trait	Finding
25	Haufler, A.J. (2000). Biological Psychology, 53(1–2), 131–160.	EEG	Motor expertise	Expert marksmen: lower left-temporal activation before trigger pull.
46	Hatfield, B.D. (1984). Journal of Sport Psychology, 6(1), 42–59.	EEG	Motor expertise	Elite marksmen: progressive left-temporal alpha increase before trigger pull.
48	Crews, D.J. (1993). Medicine & Science in Sports & Exercise, 25(1), 116–126.	EEG	Motor expertise	34 golfers: decreased left-hemisphere activity before putt; right alpha predicts lower error.
26	Del Percio, C. (2009). Brain Research Bulletin, 79(3–4), 188–194.	EEG	Motor expertise	Elite athletes: less cortical activation than non-athletes during balance tasks.
66	Babiloni, C. (2008). Journal of Physiology, 586(Pt 1), 131–139.	EEG	Motor performance	Lower sensorimotor/temporal alpha-beta desynchronization predicts better putts.
47	Landers, D.M. (1991). Medicine & Science in Sports & Exercise, 23(1), 123–129.	EEG neurofeed-back RCT	Motor performance	Intervention on activity: Correct-hemisphere feedback improves archery; misdirected feedback degrades it.
28	Brefczynski-Lewis, J.A. (2007). Proceedings of the National Academy of Sciences, 104(27), 11483–11488.	fMRI	Attention	Long-term meditators: less attention-network activation with superior attentional performance.
7	Lutz, A. (2009). Journal of Neuroscience, 29(42), 13418–13427.	EEG	Attention	3-month retreat: lower cortical response per attentional event at equal performance.
51	Slagter, H.A. (2007). PLOS Biology, 5(6), e138.	EEG	Attention	3-month retreat: reduced P3b amplitude; smaller attentional blink.
56	Jha, A.P. (2007). Cognitive, Affective, & Behavioral Neuroscience, 7(2), 109–119.	Behavioral (3-group)	Attention	MBSR improves orienting; retreat improves alerting.

Part B — Traits: desirable cognitive traits and neural activity

#	Citation	Modality	Trait	Finding
79	Pagnoni, G. (2012). Journal of Neuroscience, 32(15), 5242–5249.	fMRI	Attention	Zen meditators: ventral posteromedial cortex/PCC activity recovered faster after distraction, consistent with stronger attentional control.
88	Tang, Y.-Y. (2007). Proceedings of the National Academy of Sciences, 104(43), 17152–17156.	RCT	Attention / stress	5 days IBMT improves executive attention, reduces cortisol.
5	Desbordes, G. (2012). Frontiers in Human Neuroscience, 6, 292.	fMRI RCT	Emotion regulation	8-week training reduces amygdala response to emotional stimuli in non-meditative state.
6	Kral, T.R.A. (2019). NeuroImage, 181, 301–313.	fMRI RCT	Emotion regulation	Amygdala reactivity inversely correlates with accumulated practice hours.
99	Farb, N.A.S. (2010). Emotion, 10(1), 25–33.	fMRI	Emotion regulation	MBSR: reduced subgenual ACC activation during induced sadness.
90	Farb, N.A.S. (2007). Social Cognitive and Affective Neuroscience, 2(4), 313–322.	fMRI	Self-processing	MBSR decouples mPFC from insula during present-moment focus.
59	Kilpatrick, L.A. (2011). NeuroImage, 56(1), 290–298.	fMRI connectivity	Equanimity	MBSR: decreased posterior insula–DMN coupling.
67	Grant, J.A. (2009). Psychosomatic Medicine, 71(1), 106–114.	fMRI	Pain	Zen meditators: reduced somatosensory/insular activation to pain with intact sensory report.
58	Weng, H.Y. (2013). Psychological Science, 24(7), 1171–1180.	fMRI RCT	Altruism	Compassion training: reduced inferior parietal activation in high altruists.
89	Davidson, R.J. (2003). Psychosomatic Medicine, 65(4), 564–570.	EEG RCT	Affect / immune	MBSR shifts anterior alpha asymmetry; shift predicts antibody response.

Part B — Traits: desirable cognitive traits and neural activity

#	Citation	Modality	Trait	Finding
65	Cahn, B.R. (2006). Psychological Bulletin, 132(2), 180–211.	Review	Meditation trait	Trait pattern: lower resting frontal/parietal activation, greater coherence.
106	Fox, K.C.R. (2016). Neuroscience & Biobehavioral Reviews, 65, 208–228.	Meta-analysis (78 studies)	Meditation trait	Medium effects for both activations (d=.59) and deactivations (d = −.74); insula, dACC and SMA recruited across techniques
95	Berkovich-Ohana, A. (2016). NeuroImage, 135, 125–134.	fMRI	Meditation trait	Long-term meditators: reduced visual-cortex task activation, lower resting DMN.
114	Berkovich-Ohana, A. (2012). Clinical Neurophysiology, 123(4), 700–710.	EEG	Meditation trait	Three expertise levels vs controls (n = 12 each): frontal-midline gamma lower in meditators; parieto-occipital gamma higher.
33	Newberg, A.B. (2010). Consciousness and Cognition, 19(4), 899–905.	SPECT	Meditation trait	Long-term meditators: lower resting CBF in mPFC and superior parietal lobe.
40	Klimesch, W. (1999). Brain Research Reviews, 29(2–3), 169–195.	EEG review	Memory / IQ	Upper alpha power correlates with memory, processing speed, IQ.
41	Fink, A. (2014). Neuroscience & Biobehavioral Reviews, 44, 111–123.	Systematic review	Creativity	Alpha synchronization is the most consistent EEG correlate of creative ideation.
85	Bazanova, O.M. (2014). Neuroscience & Biobehavioral Reviews, 44, 94–110.	Review	Cognitive performance	Individual alpha frequency and power predict attention, memory, speed.
9	Gruzelier, J.H. (2014). Neuroscience & Biobehavioral Reviews, 44, 124–141.	Review of RCTs	Neurofeedback	Alpha-theta and SMR training improve attention, memory, verbal fluency, creativity.
70	Egner, T. (2004). Clinical Neurophysiology, 115(1), 131–139.	EEG RCT	Neurofeedback	Intervention on activity: SMR training improves attention; theta-alpha training

Part B — Traits: desirable cognitive traits and neural activity

#	Citation	Modality	Trait	Finding
71	Ros, T. (2013). NeuroImage, 65, 324–335.	EEG + fMRI	Neuro-feedback	Intervention on activity: Alpha up-regulation reorganizes salience-network connectivity.
53	MacLean, K.A. (2011). Journal of Psychopharmacology, 25(11), 1453–1461.	RCT (dose-escalation)	Personality	Psilocybin increases Openness; persists > 1 year.
104	Lebedev, A.V. (2016). Human Brain Mapping, 37(9), 3203–3213.	fMRI	Personality	LSD increases fMRI sample entropy; the increase predicts Openness gain at 2 weeks (n = 19). Direction: entropy increases.
98	Griffiths, R.R. (2018). Journal of Psychopharmacology, 32(1), 49–69.	RCT	Personality	Psilocybin plus meditation produces larger personality change than either alone.
60	Griffiths, R.R. (2006). Psychopharmacology, 187(3), 268–283.	Double-blind	Experience	Psilocybin: mystical-type experiences rated among five most meaningful by 67% of subjects.
87	Griffiths, R.R. (2016). Journal of Psychopharmacology, 30(12), 1181–1197.	RCT crossover	Mood (clinical)	Cancer-related depression/anxiety (n = 51): ~80% clinically significant response sustained at 6 months.
92	Ross, S. (2016). Journal of Psychopharmacology, 30(12), 1165–1180.	RCT	Mood (clinical)	Psilocybin vs niacin (n = 29): 60–80% response on depression/anxiety measures at 6.5 months.
93	Carhart-Harris, R.L. (2016). The Lancet Psychiatry, 3(7), 619–627.	Open-label	Mood (clinical)	Psilocybin in treatment-resistant depression (n = 12, no control): QIDS reduction g = 3.1 at 1 week, g = 2.0 at 3 months.
97	Davis, A.K. (2021). JAMA Psychiatry, 78(5), 481–489.	Pre-registered RCT	Mood (clinical)	Psilocybin for MDD (n = 24 completers): 71% response, 54% remission at week 4; d = 2.5–2.6 vs waitlist.
3	Carhart-Harris, R.L. (2017). Scientific Reports, 7, 13187.	fMRI	Mood (clinical)	Psilocybin reduces amygdala blood flow in treatment-resistant depression.

Part B — Traits: desirable cognitive traits and neural activity

#	Citation	Modality	Trait	Finding
91	Kraehenmann, R. (2015). Biological Psychiatry, 78(8), 572–581.	fMRI crossover	Mood	Psilocybin lowers amygdala reactivity to negative and neutral stimuli; right-amygdala attenuation relates to positive-mood increase (n = 25).
96	Barrett, F.S. (2020). Scientific Reports, 10, 2214.	fMRI	Mood	Single psilocybin dose reduces amygdala reactivity for 1 month.
121	Kometer, M. (2012). Biological Psychiatry, 72(11), 898–906.	Crossover (ketanserin)	Emotional processing	Psilocybin shifts processing from negative to positive; blocked by 5-HT2A antagonist.
122	Preller, K.H. (2016). Proceedings of the National Academy of Sciences, 113(18), 5119–5124.	fMRI crossover (ketanserin)	Social processing	Psilocybin reduces ACC/dlPFC activation during social exclusion.
105	Pokorny, T. (2017). International Journal of Neuro-psycho-pharmacology, 0(9), 747–757.	Crossover	Empathy	Psilocybin increases emotional empathy.
111	Smigielski, L. (2019). NeuroImage, 196, 207–215.	fMRI RCT	Meditation trait	Psilocybin during retreat: reduced DMN connectivity at 4-month follow-up.
123	Smigielski, L. (2019). Scientific Reports, 9, 14914.	RCT	Mindfulness	Psilocybin during retreat (n = 39): higher post-intervention mindfulness and larger psychosocial change at 4 months, associated with acute self-dissolution magnitude.

Part C — Mechanism and theory

#	Citation	Modality	Domain	Finding
77	Rohn, T.T. (2024). Genomic Psychiatry.	Genetic knockdown (mRNA)	Mechanism	HTR2A silencing: 50% reduction in excitability-related mRNA, non-significant (p = .094). No firing-rate measure.
62	Ulrich, M. (2016). Frontiers in Behavioral Neuroscience, 10, 169.	DCM fMRI	Mechanism	Dorsal raphe nucleus down-regulates mPFC during flow via serotonergic pathway.
13	Zullo, J.M. (2019). Nature, 574(7778), 359–364.	Multi-species genetics	Longevity	REST suppresses neural excitation; higher REST associates with longer lifespan.
14	Lu, T. (2014). Nature, 507(7493), 448–454.	Mouse genetics	Neuro-degeneration	REST loss causes neurodegeneration; restoration reverses cognitive decline.
68	Jensen, O. (2010). Frontiers in Human Neuroscience, 4, 186.	Theory / review	Alpha function	Alpha oscillations as active inhibitory gating.
69	Klimesch, W. (2007). Brain Research Reviews, 53(1), 63–88.	Theory	Alpha function	Alpha as inhibition-timing mechanism for selective attention.
29	Dietrich, A. (2003). Consciousness and Cognition, 12(2), 231–256.	Theory	Hypofrontality	Transient prefrontal hypofrontality proposed as common factor across altered states.
30	Dietrich, A. (2004). Consciousness and Cognition, 13(4), 746–761.	Theory	Flow	Flow proposed to require temporary dlPFC suppression.
45	Beaty, R.E. (2016). Trends in Cognitive Sciences, 20(2), 87–95.	Neuroimaging synthesis	Creativity	Creative ideation associated with reduced dorsal-attention-network engagement.
116	Hölzel, B.K. (2011). Perspectives on Psychological Science, 6(6), 537–559.	Theory	Mindfulness mechanisms	Four proposed mechanisms, each involving reduced activity in specific circuits.

Part C — Mechanism and theory

2 of 2

#	Citation	Modality	Domain	Finding
100	Laukkonen, R.E. (2021). Neuroscience and Biobehavioral Reviews, 128, 199–217.	Theory / review	Meditation mechanism	Predictive-processing account: deconstructive meditation progressively reduces temporally deep, counterfactual processing until conceptual processing falls away.
75	Bishop, S.R. (2004). Clinical Psychology: Science and Practice, 11(3), 230–241.	Definitional	Mindfulness	Operational definition of mindfulness.
119	Nour, M.M. (2016). Frontiers in Human Neuroscience, 10, 269.	Psychometric (n = 691)	Measurement	Ego Dissolution Inventory validated.

Part D — Structural neuroanatomy

1 of 1

#	Citation	Modality	Measure	Finding
11	Hölzel, B.K. (2010). Social Cognitive and Affective Neuroscience, 5(1), 11–17.	Structural MRI	Amygdala	8-week meditation: stress reduction correlates with amygdala grey-matter decrease.
57	Hölzel, B.K. (2011). Psychiatry Research: Neuroimaging, 191(1), 36–43.	Structural MRI	Grey matter	8-week MBSR: increased grey matter in hippocampus, PCC, TPJ.
35	Lazar, S.W. (2005). NeuroReport, 16(17), 1893–1897.	Structural MRI	Cortical thickness	Meditators: greater cortical thickness; no age-related thinning in attention regions.
94	Tang, Y.-Y. (2010). Proceedings of the National Academy of Sciences, 107(35), 15649–15652.	DTI	White matter	4 weeks IBMT: increased white-matter integrity in anterior cingulate.
107	Fox, K.C.R. (2014). Neuroscience & Biobehavioral Reviews, 43, 48–73.	Meta-analysis (21 studies)	Structure	Eight regions consistently differ in meditators.
115	Luders, E. (2011). NeuroImage, 57(4), 1308–1316.	DTI	White matter	27 long-term meditators: greater white-matter connectivity throughout the brain; largest in corticospinal, temporal superior longitudinal, and uncinate tracts.
120	Luders, E. (2009). NeuroImage, 45(3), 672–678.	Structural MRI	Grey matter	Meditators: larger orbitofrontal cortex, thalamus, inferior temporal gyrus, anterior insula.

A NEW SCIENCE OF AWARENESS

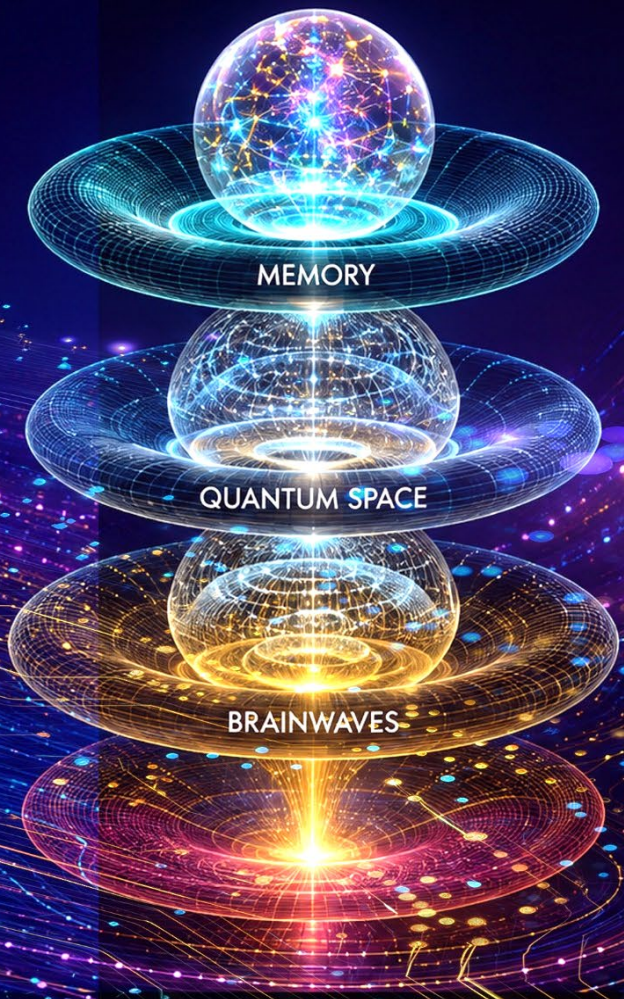
Metacognitive neurophysics describes invariant principles by which awareness interacts with the physical and electromagnetic dynamics of neural systems.

Its axioms and formulas reveal cardinal laws governing the dynamic interplay between consciousness and the material universe.

The first principles, axioms 1–7, frame awareness as a measurable granular phenomenon.

The advanced axioms and corollaries codify the mind/matter interface between awareness and neurology.

The resulting theory merges neuroscience and physics into a unified framework for understanding the behavior of awareness and memory through the lens of electromagnetic field dynamics.



WAVE FIELD AND NEURAL NETWORK PHYSICS

Quantum space and memory wave fields are thought to behave according to harmonics of Maxwell's equations.

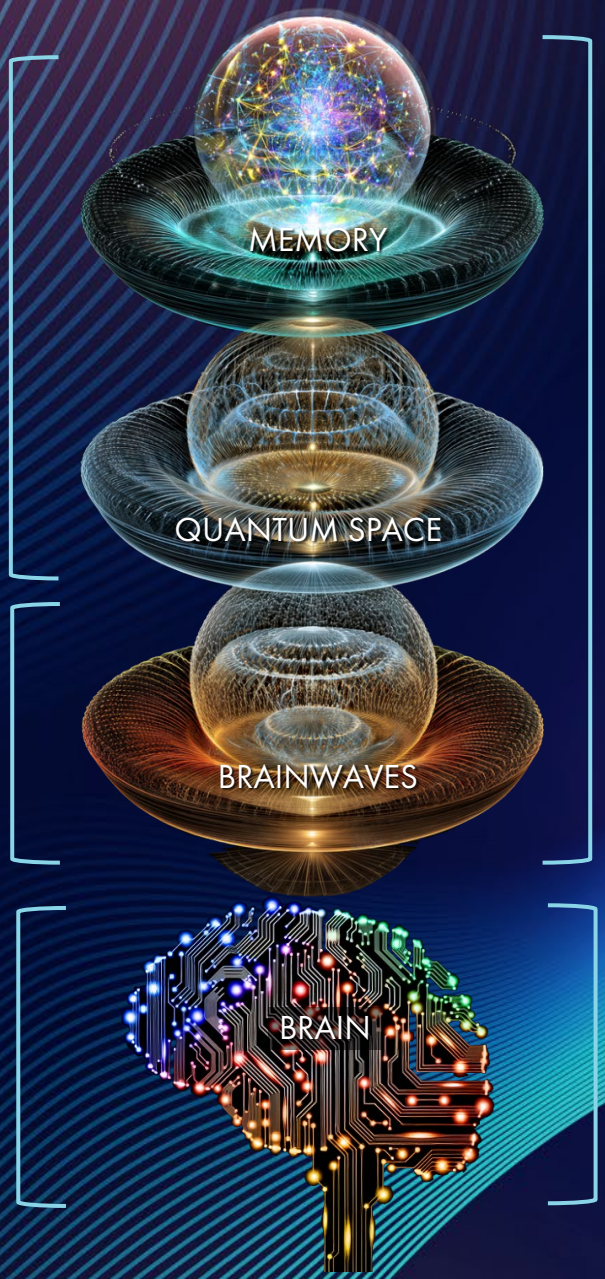
Derivatives of MAXWELL'S EQUATIONS

Brainwaves are classic electromagnetic fields which are governed by Maxwell's equations.

MAXWELL'S EQUATIONS

Neural pathways behave like alternating current resistor-capacitor circuits which are governed by Ohm's Law.

OHM'S LAW



CLOSED LOOP WAVE COUPLED FIELDS

RC AC CIRCUITS

Neural circuit current can be regulated by modifying the electrical resistance of neurons per Ohm's Law.

Elements of Human Cognition



Conscious Awareness Packets (ITONS)

Unconscious Awareness Packets (OTONS)

AWARENESS



Amplitude

Frequency

BRAINWAVES



Active Neurons

Inactive Neurons

NEUROLOGY

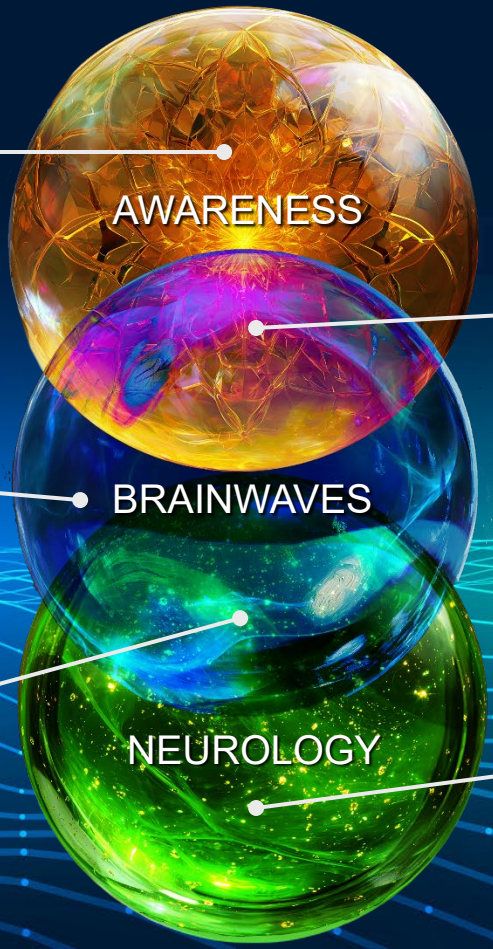
Brainwaves

The Interface Zone Between Consciousness and Neurology

ITONS: Conscious awareness packets have no wavelength and are isolated from brainwaves.

Brainwaves convey frequency-encoded information between consciousness and neurology

Active Neurons emit electrical signals matching brainwave frequency patterns.



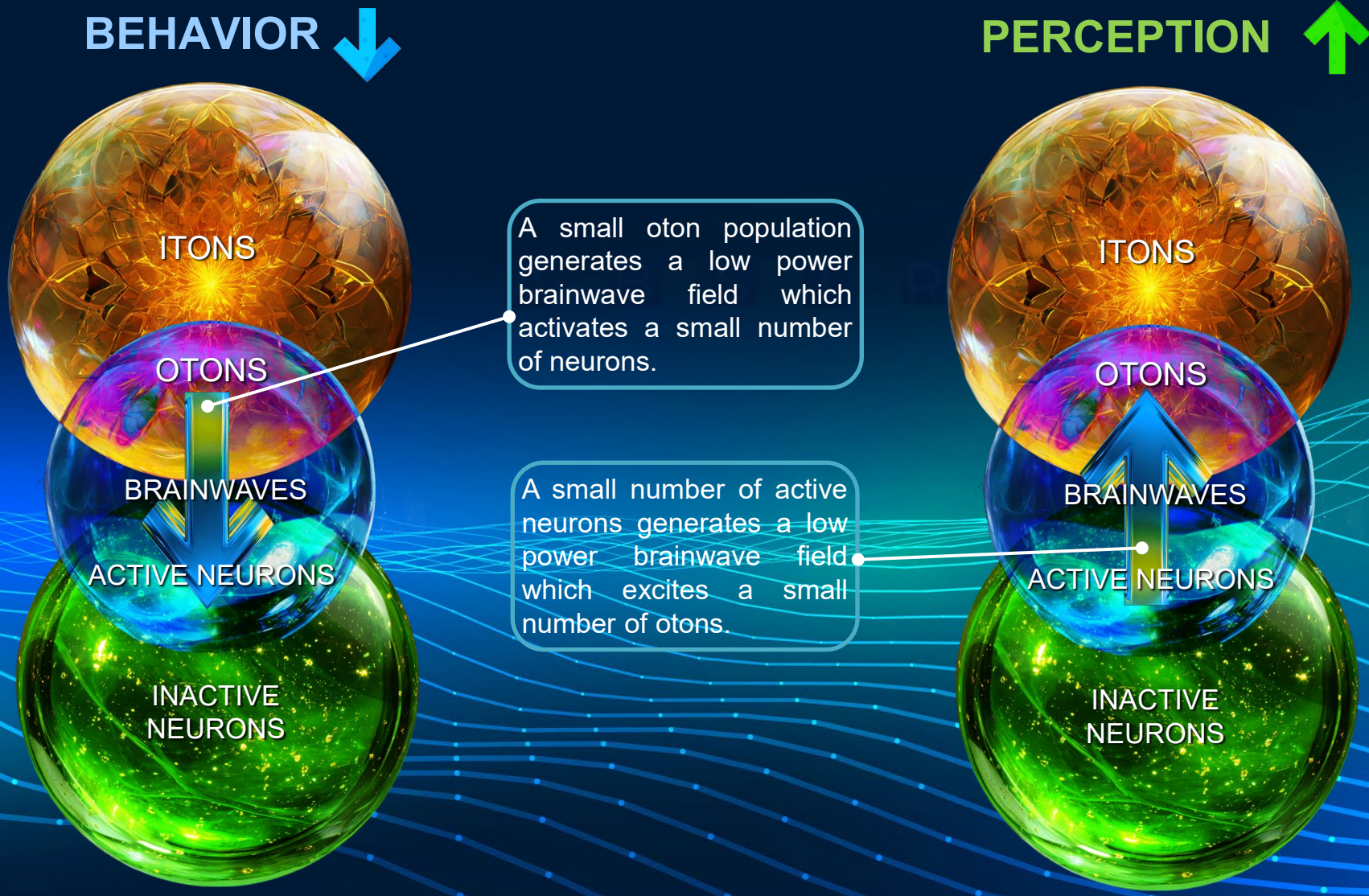
OTONS: Unconscious awareness packets oscillate and produce neuron-level electromagnetic waves which sum up into brainwaves.

Inactive Neurons do not produce electrical signals or electromagnetic waves [1]

[1] Simplified diagram. The Reference Section contains a more nuanced treatment.

Low Power States

Bi-Directional Causation



Neural activity and brainwave power tend to diminish as conscious awareness expands.

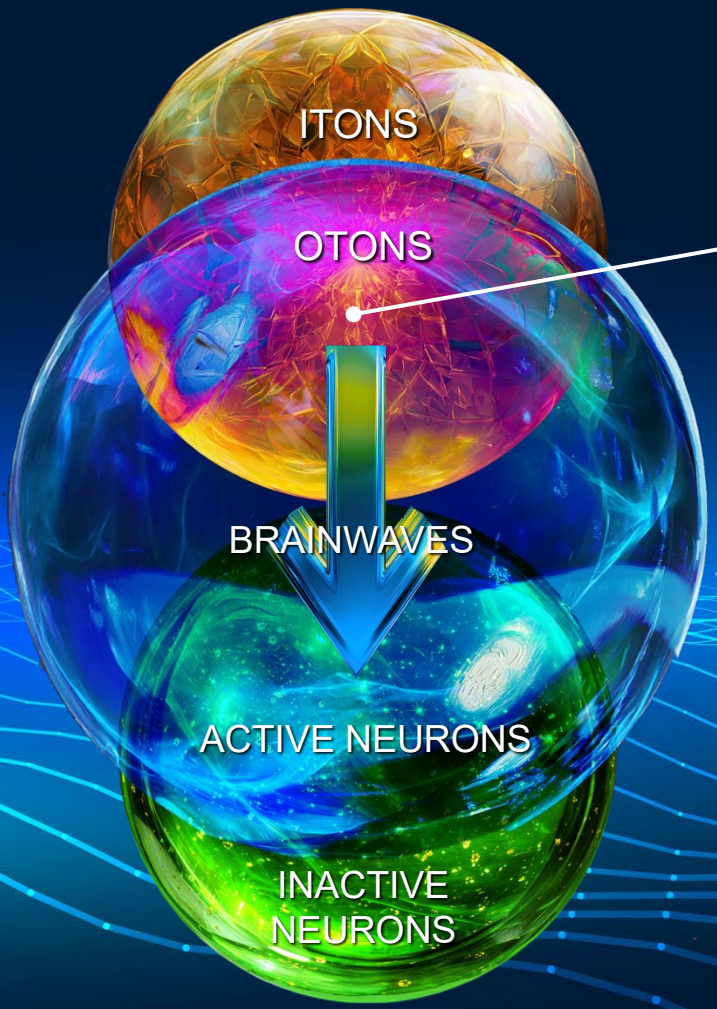
Conscious awareness tends to expand as neural activity and brainwave power diminishes.

High Power States

Bi-Directional Causation

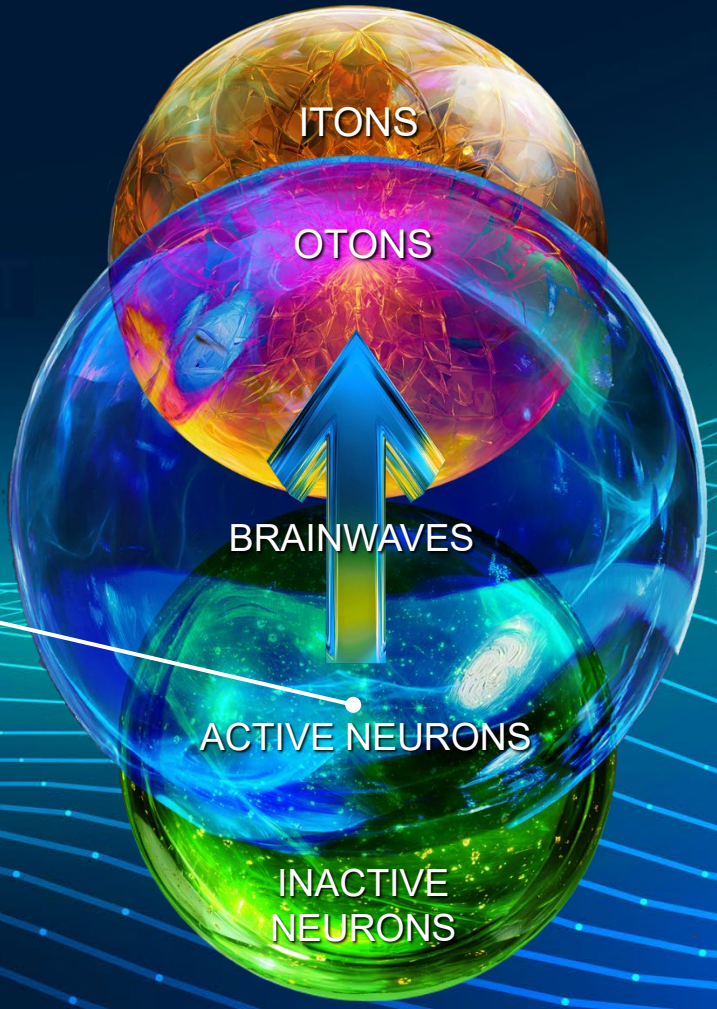
BEHAVIOR

PERCEPTION



A large oton population generates a high power brainwave field which activates a large number of neurons.

A large number of active neurons generates a high power brainwave field which excites a large number of otons. [1]



Neural activity and brainwave power tend to increase as conscious awareness diminishes.

Conscious awareness tends to decrease as neural activity and brainwave power increase.

[1] Brainwave Field Coherence Condition: Corollary 2 holds as long as the brain's electromagnetic field remains within normal ranges of phase-coherence. Disorganized brainwave fields with degraded coherence (e.g., anesthesia) are exceptions.

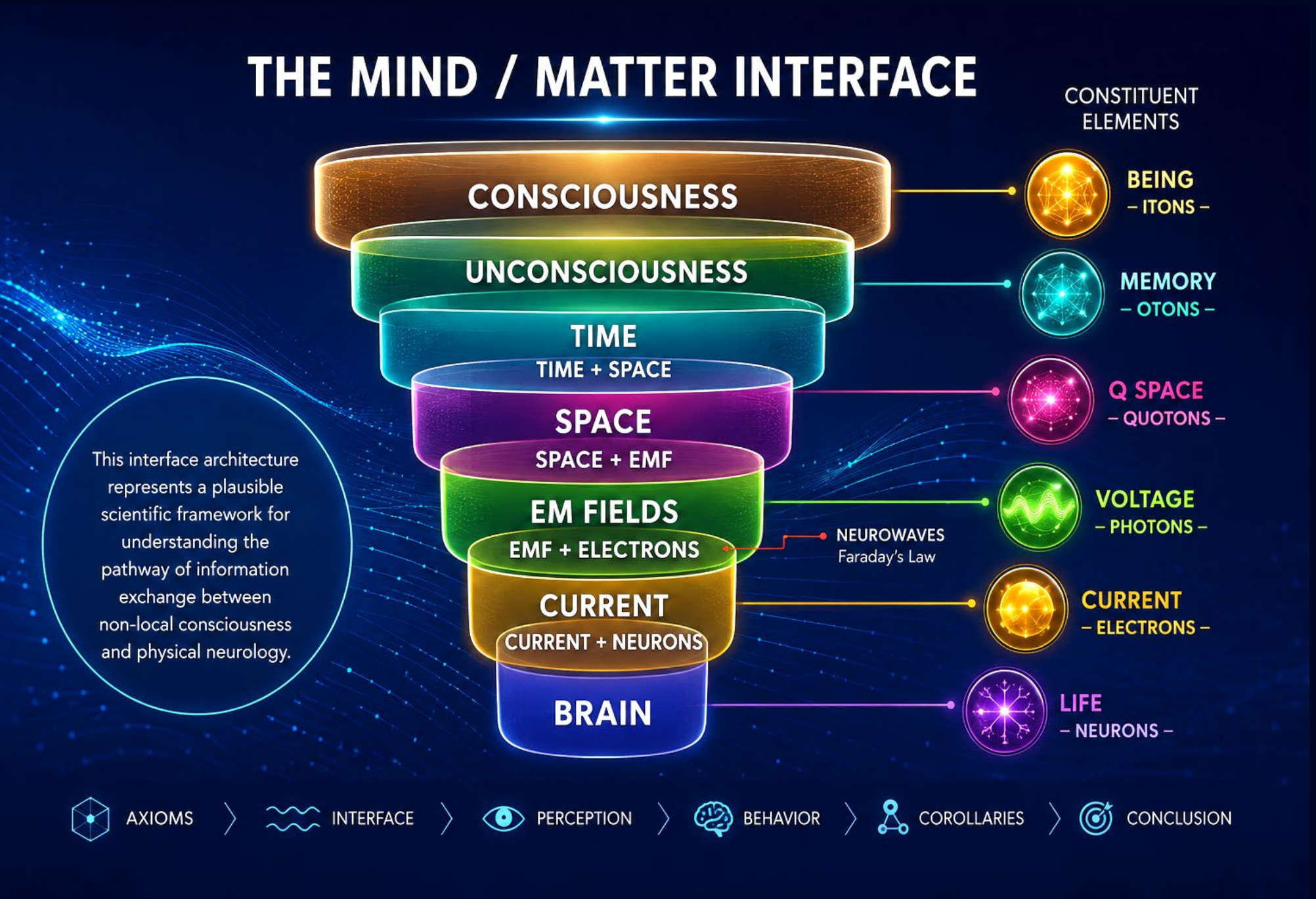
The Law of Conservation of Awareness

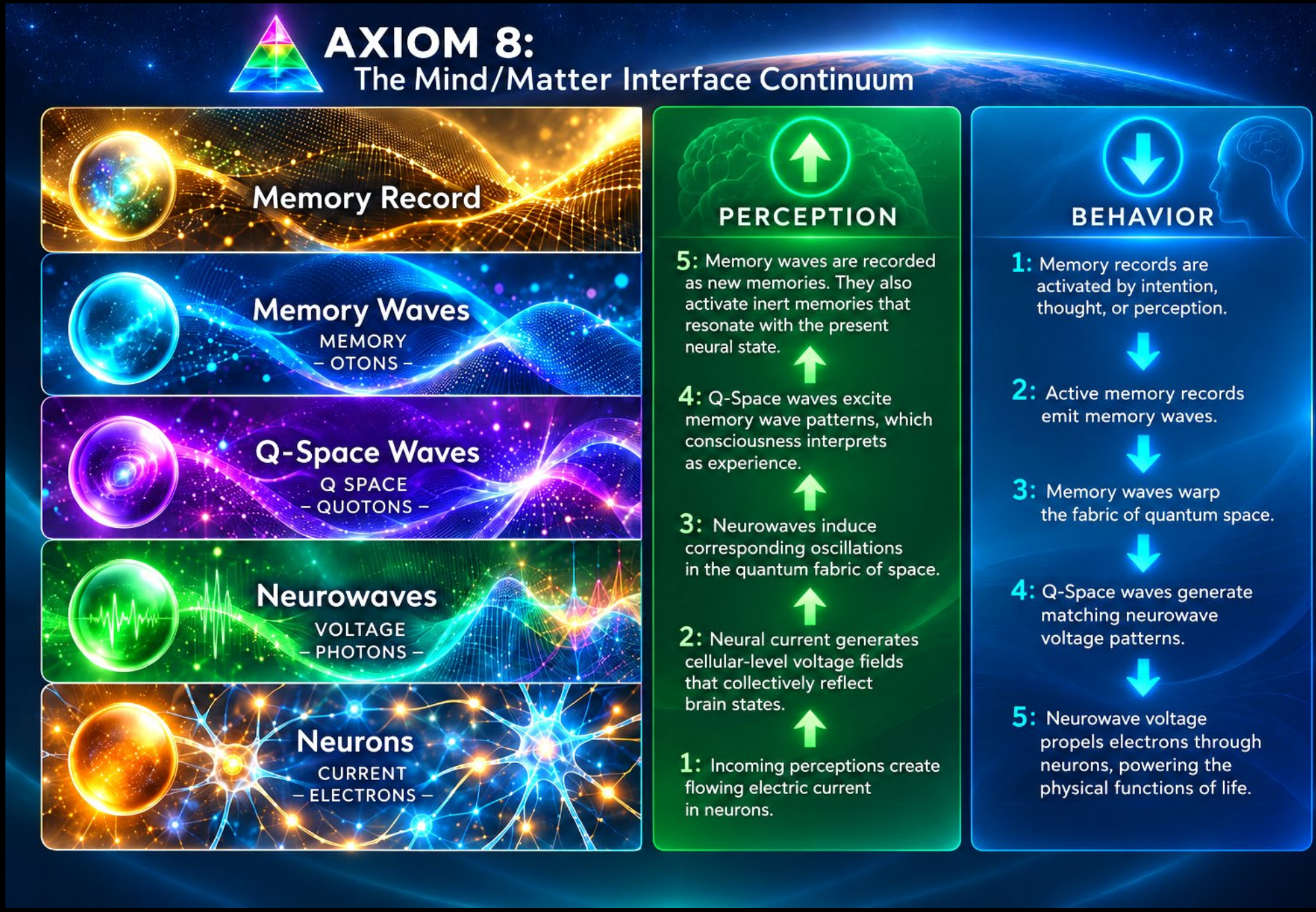
Awareness cannot be created or destroyed; only changed from one form to another.

The measurements of consciousness and unconsciousness are reciprocals of one another; as one increases, the other decreases. However, an individual's total amount of awareness remains constant, reflecting a law of conservation.

The chart uses "iotons" to represent the elemental units of consciousness, existing in either conscious (itons) or unconscious (otons) states. Iotons can change from one state to another, but their total number stays the same.




THE MIND / MATTER INTERFACE
CONSTITUENT ELEMENTS
CONSCIOUSNESS
UNCONSCIOUSNESS
TIME
TIME + SPACE
SPACE
SPACE + EMF
EM FIELDS
EMF + ELECTRONS
CURRENT
CURRENT + NEURONS
BRAIN
BEING
– ITONS –
MEMORY
– OTONS –
Q SPACE
– QUOTONS –
VOLTAGE
– PHOTONS –
CURRENT
– ELECTRONS –
LIFE
– NEURONS –
NEUROWAVES
Faraday's Law
This interface architecture represents a plausible scientific framework for understanding the pathway of information exchange between non-local consciousness and physical neurology.
AXIOMS
INTERFACE
PERCEPTION
BEHAVIOR
COROLLARIES
CONCLUSION


AXIOM 8:
The Mind/Matter Interface Continuum
Memory Record
Memory Waves
MEMORY
– OTONS –
Q-Space Waves
Q SPACE
– QUOTONS –
Neurowaves
VOLTAGE
– PHOTONS –
Neurons
CURRENT
– ELECTRONS –
PERCEPTION
5: Memory waves are recorded as new memories. They also activate inert memories that resonate with the present neural state.
4: Q-Space waves excite memory wave patterns, which consciousness interprets as experience.
3: Neurowaves induce corresponding oscillations in the quantum fabric of space.
2: Neural current generates cellular-level voltage fields that collectively reflect brain states.
1: Incoming perceptions create flowing electric current in neurons.
BEHAVIOR
1: Memory records are activated by intention, thought, or perception.
2: Active memory records emit memory waves.
3: Memory waves warp the fabric of quantum space.
4: Q-Space waves generate matching neurowave voltage patterns.
5: Neurowave voltage propels electrons through neurons, powering the physical functions of life.

Mind/Matter Interface Elements



1. MINDPRINTS
Neural activity maps

2. MEMORY RECORDS
Memory pattern storage

3. MEMORY WAVES
Information-carrying vectors



4. Q-SPACE WAVES
Quantum-linking fields

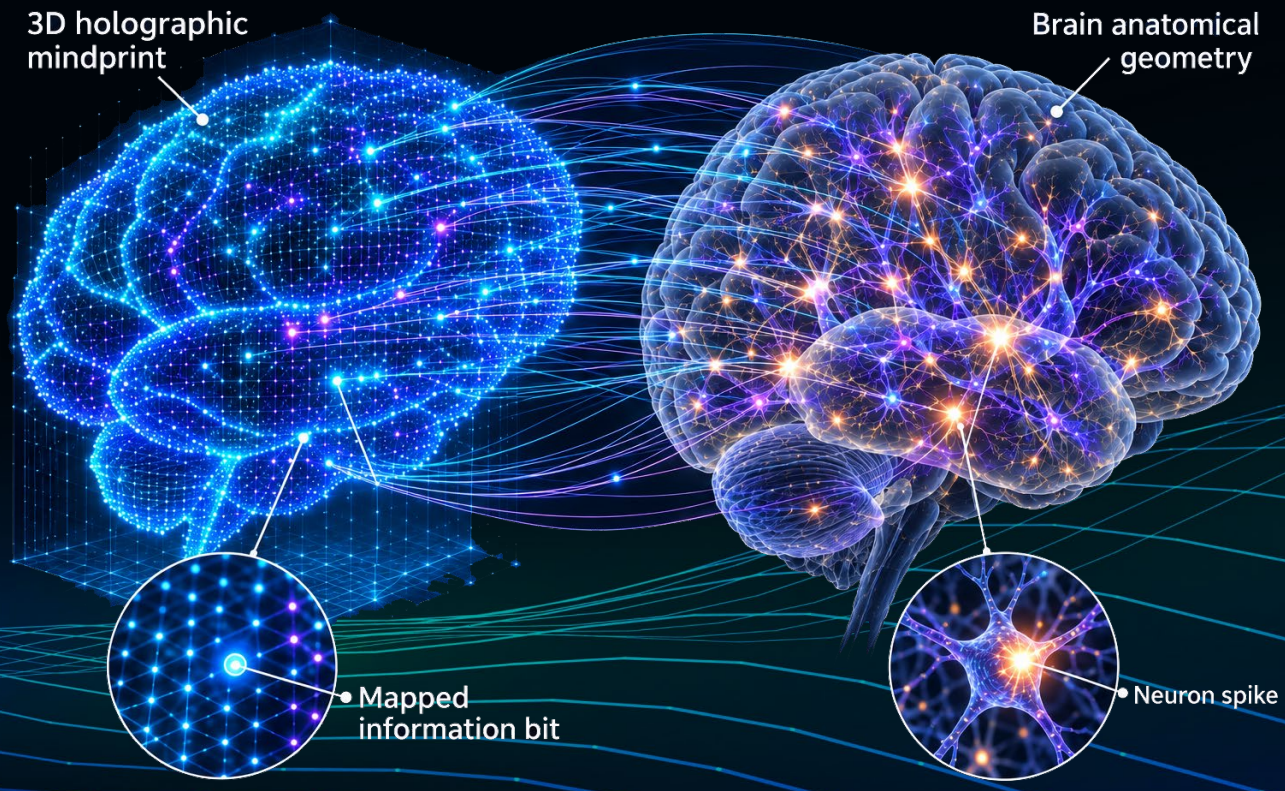
5. NEUROWAVES
Brainwave electromagnetic fields

6. NEURONS
Brain's signal processors

1. Mindprint

Mindprint: A multi-dimensional memory trace representing the complete cognitive, emotional, sensory, and spatial imprint of an experience. The mindprint is a snapshot of neural activity patterns, like a brainwave fingerprint.

The mindprint has a three-dimensional holographic structure shaped by the brain's anatomical geometry. Each of its information bits corresponds to a neuron spike somewhere in the brain. Each bit has a unique spatial location in the mindprint based on its originating neuron's position in the brain's 3D geometry.



Mindprints propagate through the 4 mind/matter interface layers.

INTERFACE LAYER	MINDPRINT BIT
Memory waves	A peak in a memory wave
Q-Space waves	A peak in a Q-Space wave
Neurowaves	A peak in a neurowave
Neurons	An electrical pulse in a neuron

Mindprint

Behavior: Behavior is based on information retrieved from context-activated memory records; for example, opening a doorknob. The mindprints from these records are downloaded through the mind/matter interface to induce electrodynamic brain activity for generating behavior.

Capacity: A mindprint holds about one gigabyte of neuronal activation pattern data which is streamed at roughly 10 GB per second. (1)

Perception: The mindprint bitstream forms the basis of experience. A human being's innate intelligence translates the bitstream into meaningful perceptual information.

Architecture: A mindprint is reactivatable, context-sensitive, and reflects both the neural substrate and the brainwave field structure. It functions as both an upload and download vehicle—recording experiences and guiding actions.

It is encoded in neural networks and in the geometry of the brain's electromagnetic fields. A memory record contains multiple mindprints covering a specific period of time.

(1) The brain's 86 billion neurons can be modeled as 86 billion bits of information; roughly 10 gigabytes. About 10% of these circuits are actively signaling at any given time, yielding 1 GB of real-time data and 9 GB of inactivity.

Neurons fire at rates between 4 and 30 Hz depending on brain region and mental state. Using an average rate of 10 Hz, the brain updates its signaling pattern around 10 times per second. This clock speed yields a mindprint real-time data streaming rate of 10 GB per second.

2. Memory Record

A memory record is a non-physical structure that stores *mindprints* – holographic replicas of brainwave configurations from specific moments in time.

Memory records exist outside of time and space in the unconscious awareness field and act as a repository for storing and regenerating experience.

The memory record functions as a multidimensional imprint of neural activity, encoding the frequency, amplitude, and spatial direction of the original brainwave signals.

Memory records are embedded within the mind/matter interface continuum connecting the awareness field to physical neurology.



Memory Record

BEHAVIOR

In behavior, memory records initiate action by transmitting stored mindprint patterns back to neurology.

PERCEPTION

In perception, new memory records are continuously formed from the mindprint bitstream conveyed by incoming memory waves.



The number of itons required to activate a memory depends on the amplitude of the memory's recording.

Activating high amplitude memories requires more itons than activating low amplitude memories.

Existing records are also re-excited when resonant frequencies in incoming mindprints match their original encoding.

This reactivates their information content, reanimating its influence on consciousness.



Memory Record Activation

Itons flow through a memory record, acquire its recorded frequencies, and emerge as otons within memory waves.

AXIOM 9

A memory has two states: active and inert.

Inert memories store mindprints without drawing awareness. They have no charge; only potential. Almost all memories are inert.

When otons are applied to an inert memory, it becomes active, and reproduces its brainwave recording, which is overlayed on current neurology.

Itons change state to otons when they animate information in a memory. The applied awareness permeates and activates the memory's information, and in this process, becomes unconscious.

When otons are removed from a memory record, the record reverts to its inert state, and the otons return to their original state as itons.



INERT MEMORY



ACTIVE MEMORY

RELATIVE TOTAL VOLUME
Conscious awareness: Marble
Active memory: Tennis ball
Inert memory: Football stadium

3. Memory Waves

Memory waves are non-physical vector fields emitted by memory records in behavior and shaped by Q-Space waves in perception.



Memory waves are composed of otons.

BEHAVIOR

In behavior, memory waves are the first layer of a cascading wave field stack that connects non-physical awareness to physical brain activity.

They induce oscillations in the fabric of quantum space, producing Q-space waves which, in turn, affect neurowaves in the brain's electromagnetic fields to drive behavior.

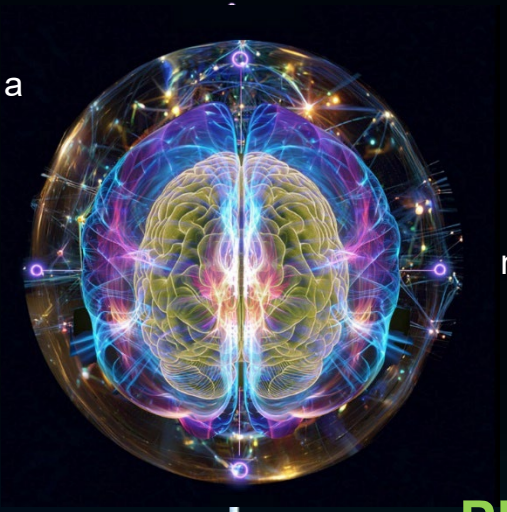
PERCEPTION

In perception, memory waves are are the final layer of a perception cascade connecting brain activity to non-physical awareness.

They carry the frequency, amplitude, and directional signature of the originating neurowaves, imprinting this pattern into the awareness field to deliver perception.

4. Q-Space Waves

Quantum-Space waves form a bridge between the non-local memory field and the brain's electromagnetic landscape.



Governed by natural laws, they oscillate and interact dynamically with memory waves above them and neurowaves below them in a closed circuit. They are composed of "quotons."

BEHAVIOR

Q-Space waves are oscillations in the quantum fabric of space generated by memory waves in behavior.

They translate awareness-encoded memory patterns into neurowave fields that can influence the brain's electromagnetic environment.

PERCEPTION

Neurowaves from active brain regions induce oscillations in the fabric of quantum space.

These "Q-Space waves" function as a transducer for uploading neural activity into the domain of awareness, transforming local physical neural activity into non-local quantum information.

5. Neurowaves



BEHAVIOR

In behavior, electromagnetic neurowave fields in the brain are shaped by incoming Q-Space waves. Neurowaves form the interface layer where Q-Space wave patterns convert into physical neural activity.

Through Faraday's Law, neurowave voltage induces current flow in neurons, driving electrical activity that translates conscious intent or unconscious memory into physiological action.

PERCEPTION

When neurons fire, the current they produce generates electromagnetic waves called neurowaves. (Per Ampere's Law, moving electric currents produce electromagnetic waves.)

These electromagnetic wave patterns carry frequency-encoded information about perceptions and the brain's state.

Neurowaves are composed of photons.

6. Neurons



BEHAVIOR

Neurons are the endpoints of the top-down behavioral cascade.

Neurowaves induce electrical currents in neural networks, resulting in neuron firing that produces thought, action, or feeling.

PERCEPTION

Incoming perceptions from the senses drive electric current in the brain.

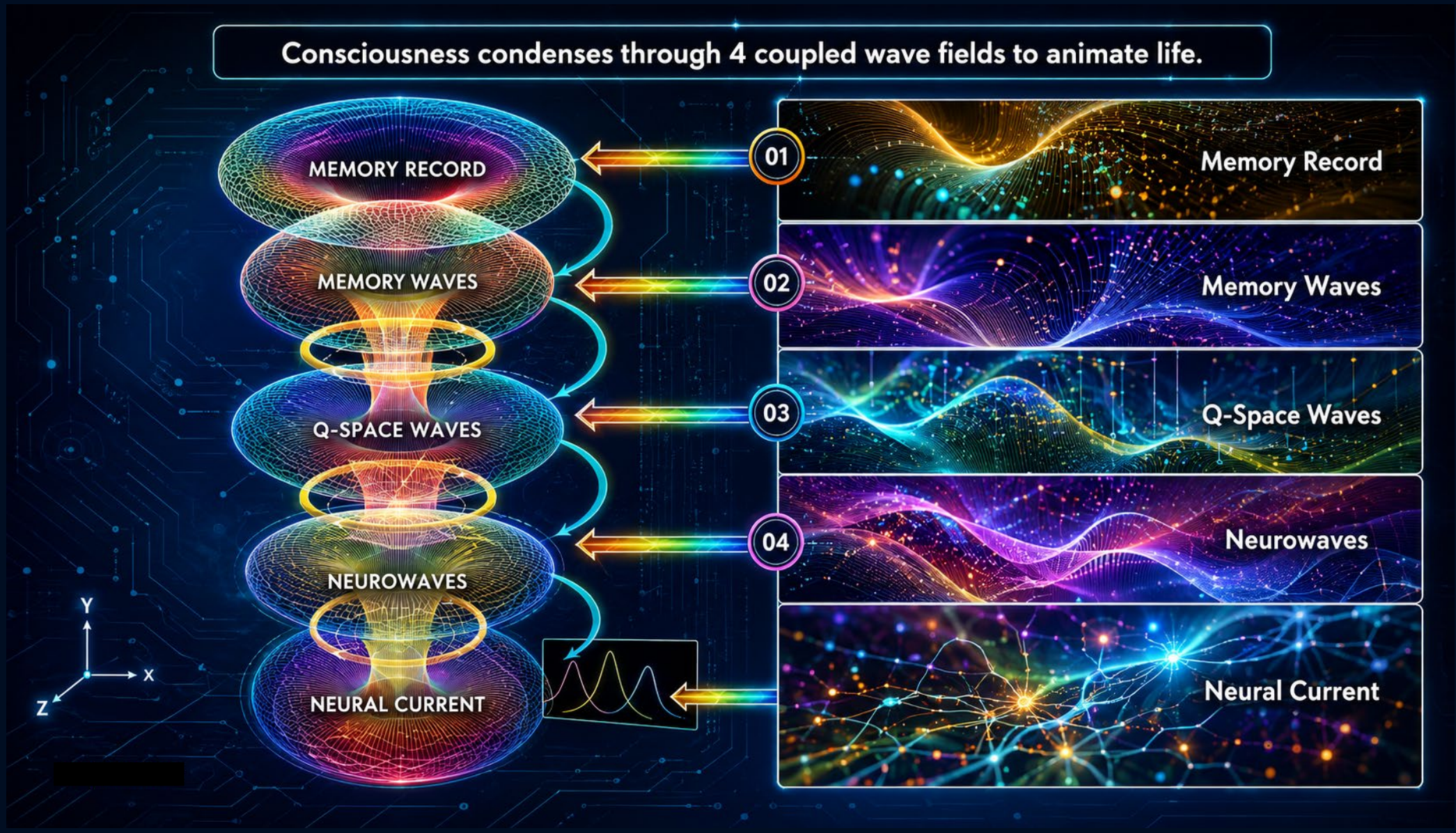
This electrical activity generates neurowave voltages which initiate the perception chain.

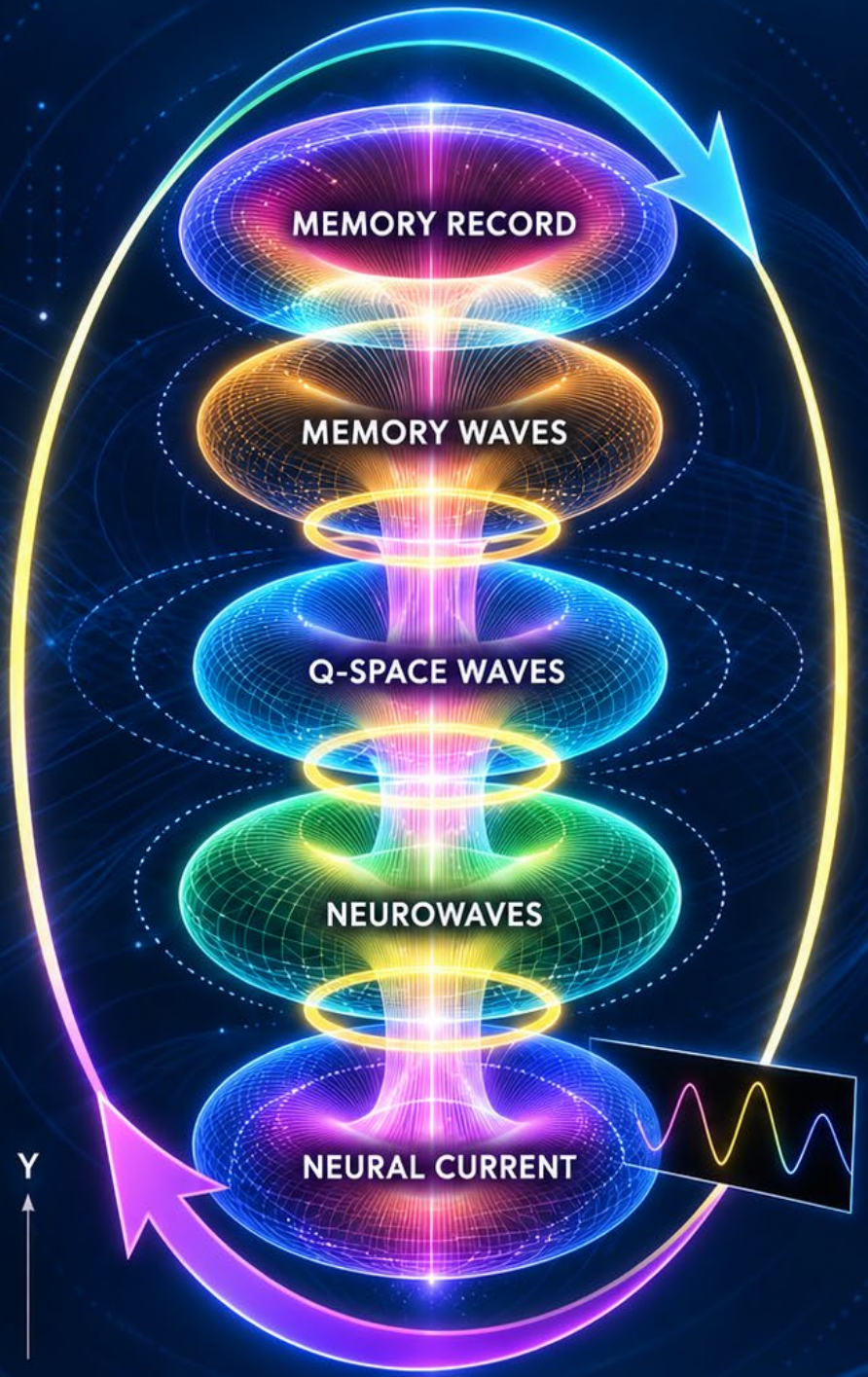
INDUCTION

Faraday's Law

RADIATION

Ampere's Law


Consciousness condenses through 4 coupled wave fields to animate life.
MEMORY RECORD
MEMORY WAVES
Q-SPACE WAVES
NEUROWAVES
NEURAL CURRENT
Y
X
Z
01
02
03
04
Memory Record
Memory Waves
Q-Space Waves
Neurowaves
Neural Current



Corollary 2A

Wave Field Coupled Circuit

A human being's unconscious memory field is joined in a closed "wave field coupled circuit" with their body's neurology.

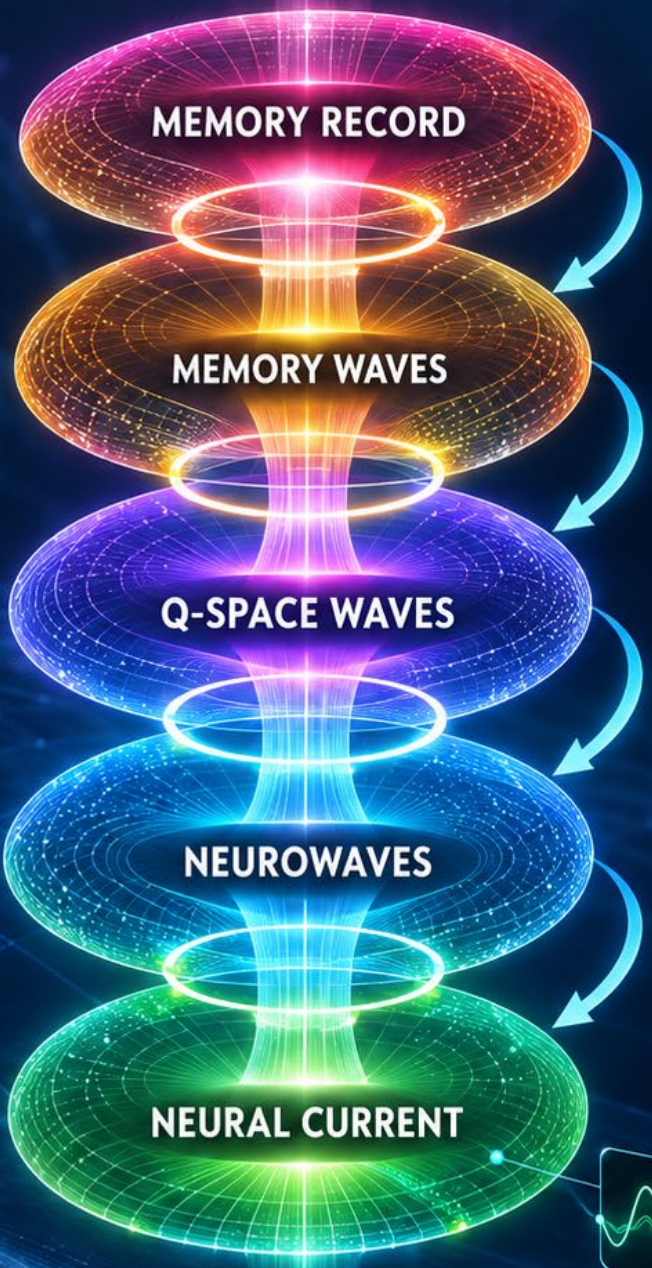
A wave field coupled circuit is a system where the interaction and transfer of energy and information between circuits is mediated through wave fields.

Wave fields may include magnetic waves along with zero-point energy fields, quantum waves, or other non-local energy fields.

Wave field coupling occurs when overlapping wave fields exchange energy or information.

In humans, this circuit culminates in neurowave fields as the fundamental interface zone between awareness and physical neurology.

Communication across this interface must follow the laws which govern all electromagnetic fields.



01 **LAYER 1 – Memory Record:** When otons enter an inert memory record, they activate and recharge it. The record's charge is proportional to the number of otons it encloses.

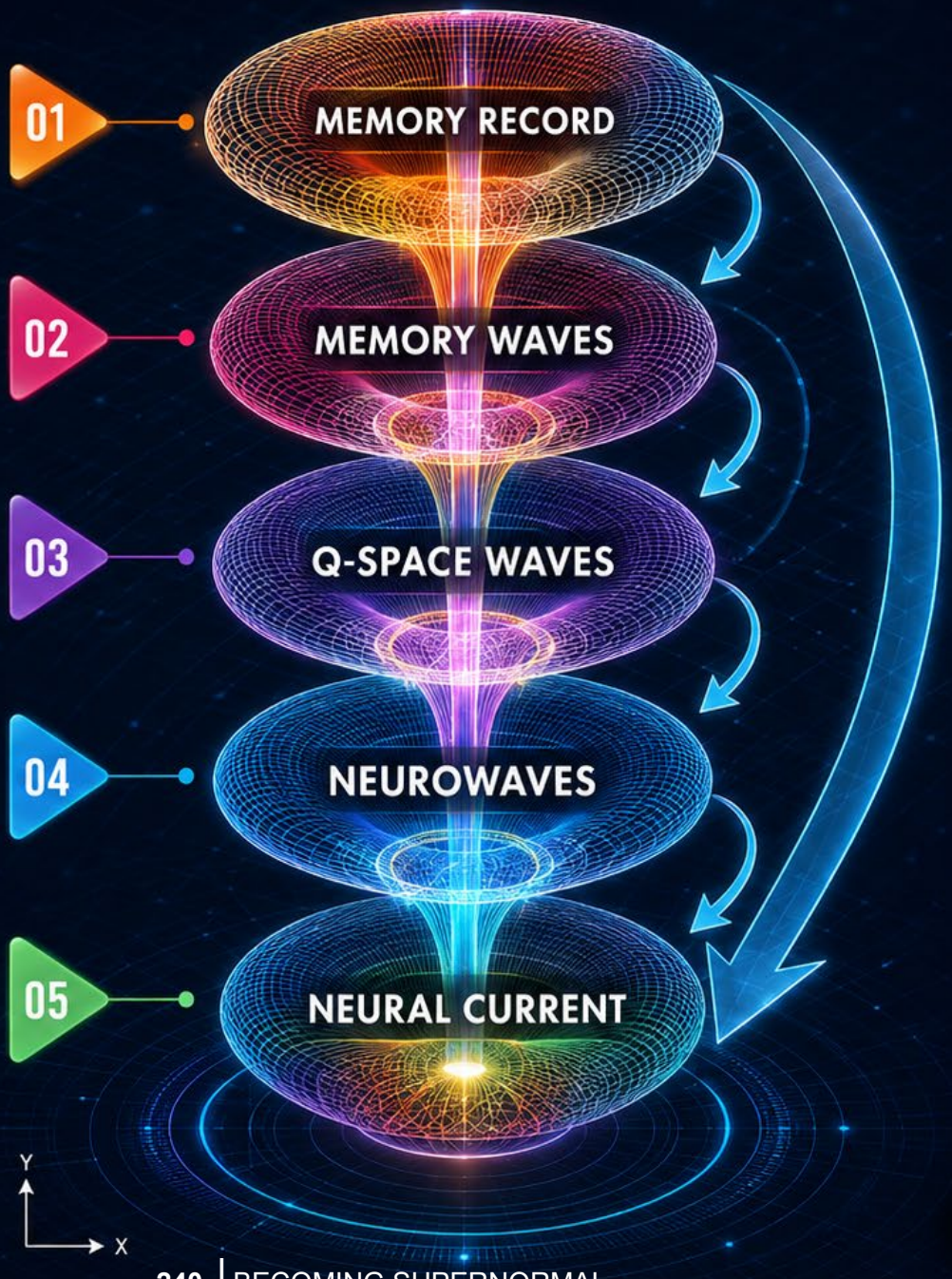
02 **Layer 2 – Memory Waves:** The strength of the memory wave field is proportional to the memory record's charge.

03 **Layer 3 – Q-Space Waves:** The strength of the Q-Space wave vector field is proportional to the enclosing memory wave field charge.

04 **Layer 4 – Neurowaves:** The strength of the neurowave vector field is proportional to the enclosing Q-Space wave field charge.

05 **Layer 5 – Neural Current:** The electrical current passing through a neural network is prroportional to the enclosing neurowave field charge.

MIND / MATTER INTERFACE / BEHAVIOR



Conflating behavioral layers 1-5:

COROLLARY 3

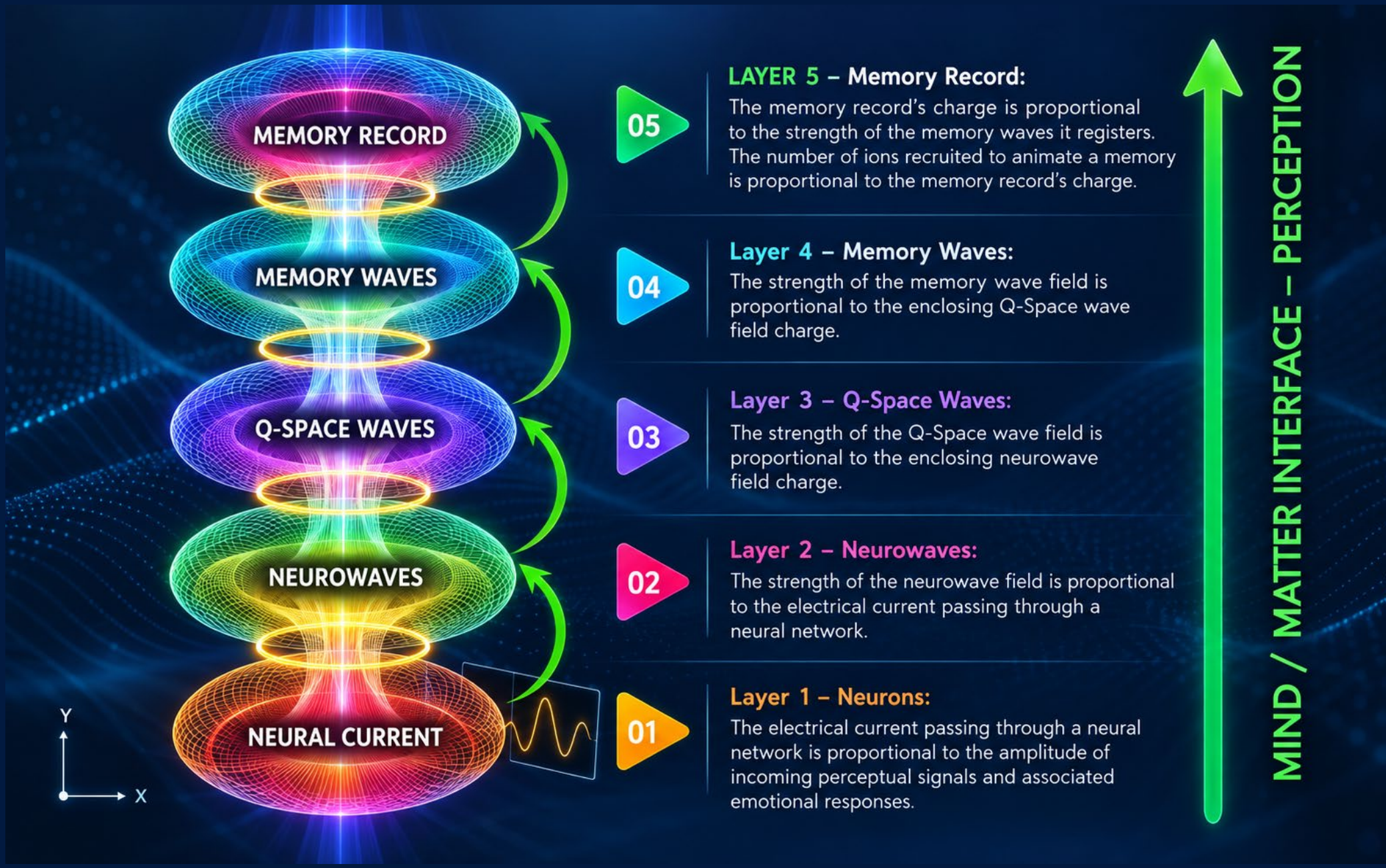
The strength of current in neural networks associated with memories (Layer 5) is proportional to the number of otons in active memory records (Layer 1).

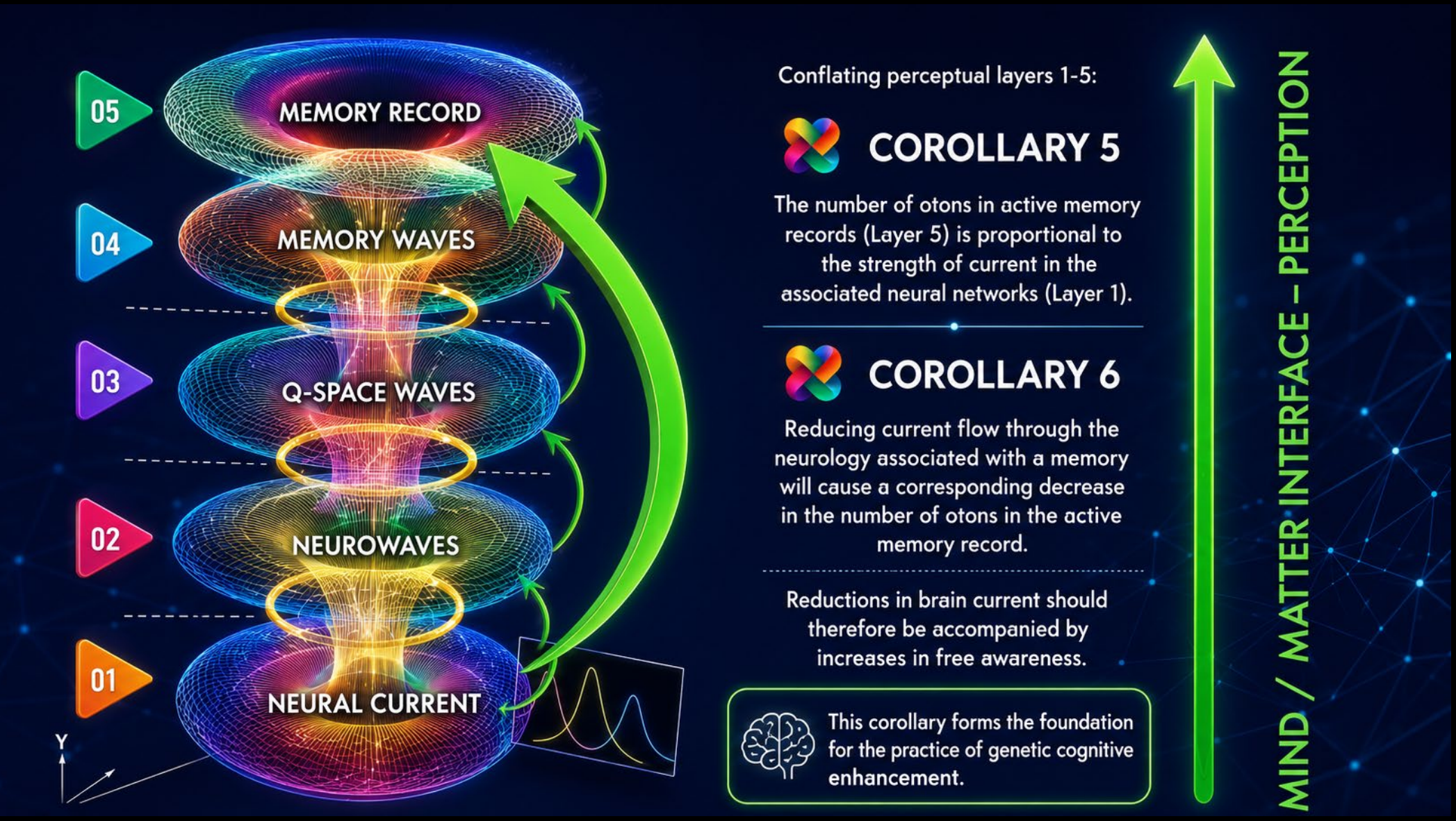
COROLLARY 4

Reducing the number of otons in active memory records will cause a corresponding decrease in current flow through the associated neurology.

Increases in free awareness should therefore be accompanied by reductions in brain current.

MIND / MATTER INTERFACE - BEHAVIOR


MEMORY RECORD
MEMORY WAVES
Q-SPACE WAVES
NEUROWAVES
NEURAL CURRENT
Y
X
05
LAYER 5 – Memory Record:
The memory record's charge is proportional to the strength of the memory waves it registers. The number of ions recruited to animate a memory is proportional to the memory record's charge.
04
Layer 4 – Memory Waves:
The strength of the memory wave field is proportional to the enclosing Q-Space wave field charge.
03
Layer 3 – Q-Space Waves:
The strength of the Q-Space wave field is proportional to the enclosing neurowave field charge.
02
Layer 2 – Neurowaves:
The strength of the neurowave field is proportional to the electrical current passing through a neural network.
01
Layer 1 – Neurons:
The electrical current passing through a neural network is proportional to the amplitude of incoming perceptual signals and associated emotional responses.
MIND / MATTER INTERFACE – PERCEPTION


05
MEMORY RECORD
04
MEMORY WAVES
03
Q-SPACE WAVES
02
NEUROWAVES
01
NEURAL CURRENT
Y
Conflating perceptual layers 1-5:
COROLLARY 5
The number of otons in active memory records (Layer 5) is proportional to the strength of current in the associated neural networks (Layer 1).
COROLLARY 6
Reducing current flow through the neurology associated with a memory will cause a corresponding decrease in the number of otons in the active memory record.
Reductions in brain current should therefore be accompanied by increases in free awareness.
This corollary forms the foundation for the practice of genetic cognitive enhancement.
MIND / MATTER INTERFACE – PERCEPTION

Metacognitive Neurophysics Axioms

1

Awareness is a primary universal element.
Awareness is fundamental and irreducible. It is a foundational principle.

2

Awareness is composed of discrete packets.
In the same way that light is made of photons, awareness consists of elemental units.

3

Awareness packets have two states.
itons: conscious awareness packets
otons: unconscious awareness packets

4

Awareness can change state.
Awareness packets can change state between conscious and unconscious.

5

Free awareness is conscious and formless.
Conscious awareness packets have no amplitude or wavelength.

6

Applied awareness takes form and becomes unconscious.
Unconscious awareness takes the form of information.

Metacognitive Neurophysics Axioms

7 **Neural activity and brainwave power** tend to diminish as conscious awareness expands.
.

8.1 PERCEPTION
Mind/Matter Interface Continuum
Neural activity rises through five layers to reach conscious awareness.

8.2 BEHAVIOR
Mind/Matter Interface Continuum
Consciousness condenses through five layers to form the living universe.

9 **A memory has two states: active and inert.**
Inert memories store information without drawing awareness.

* When itons are applied to an inert memory, they change state to otons, energizing the memory's recorded information.

* When otons exit an active memory, it returns to its inert state, and the otons revert to itons.

Metacognitive Neurophysics Corollaries

1 Conscious awareness packets have no amplitude or wavelength.

2 Neural activity and brainwave power tend to diminish as conscious awareness expands.

2A A human being's unconscious memory field is joined in a closed "wave field coupled circuit" with their body's neurology.

3 The strength of current in neural networks associated with memories is proportional to the number of otons in active memory records.

BEHAVIOR

4 The number of otons in active memory records is proportional to the strength of current in the associated neural networks.

PERCEPTION

5 Reducing the number of otons in active memory records will cause a corresponding decrease in current flow through the associated neurology.

BEHAVIOR

Historical Precedents

AXIOM 1

Awareness is a primary universal element.
Awareness is fundamental and irreducible.



1803: John Dalton proposed that matter is made of atoms. He had no microscope or direct evidence. His atomic theory was proven in 1908 and forms the foundation of chemistry.

AXIOM 2

Awareness is composed of discrete packets.
In the same way that light is made of photons, awareness consists of elemental units.



1897: J.J. Thomson identified the electron — not by seeing it, but by observing cathode rays. He inferred what could not yet be seen. Inference first, evidence later.

AXIOM 4

Awareness can change state.
Awareness packets can alternate between conscious and unconscious form.



Isaac Newton described the laws of gravity in 1687. Centuries later, Einstein used calculus to prove gravity, but Newton discovered gravity, and invented calculus.

AXIOM 8

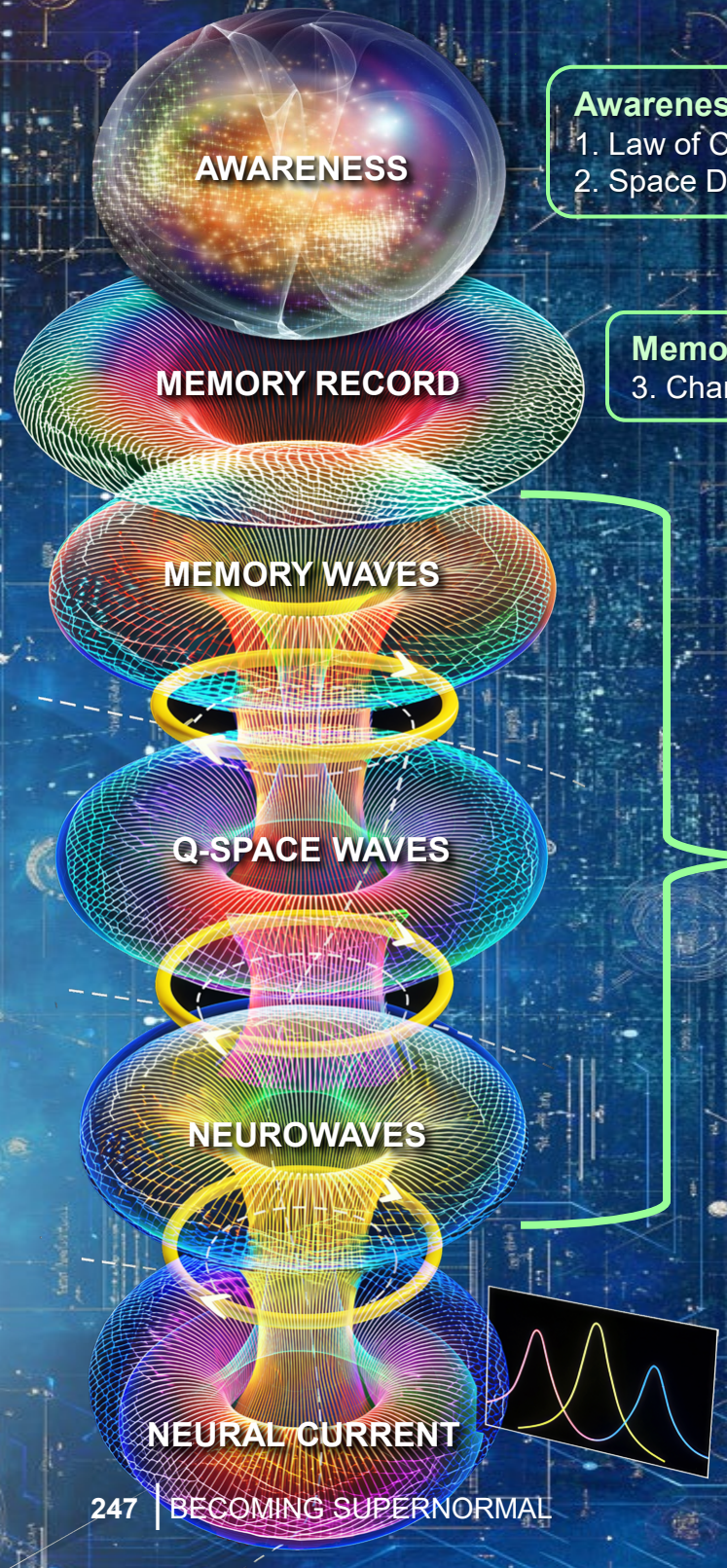
Mind/Matter Interface Continuum
Consciousness condenses through five layers to form the living universe.

Science has always invited us to believe in what cannot yet be seen — atoms, electrons, gravity.

Metacognitive neurophysics is simply a new iteration in this evolutionary process.

Its axioms may seem speculative to some today, but like Dalton's atoms, they provide a framework for research.

As instruments catch up and evidence grows, the axioms may someday be widely regarded as the cornerstone of a new science.



Awareness
1. Law of Conservation
2. Space Displacement

Memory Record
3. Charge 4. Flux

Wave Fields
5. Frequency
- Behavior
- Perception

6. Amplitude
- Behavior
- Perception

Neural Network
7A. Behavior 7B. Perception

FORMULAS
This chapter introduces a set of hypothetical formulas to describe the interface between non-local consciousness and neurology. Its equations are speculative and are intended as a scaffolding for scientific inquiry.

Chapter 13: Formulas

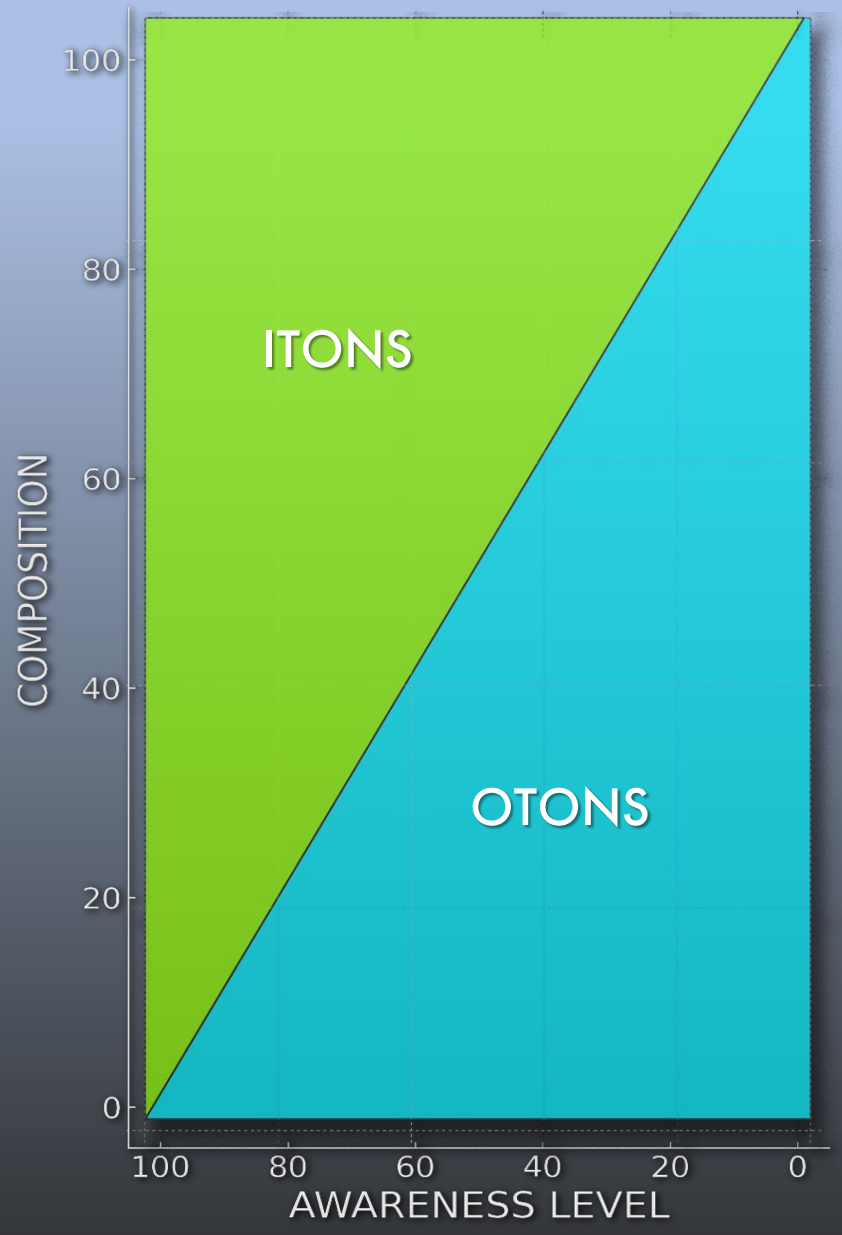
The Law of Conservation of Awareness

**Awareness cannot be created or destroyed;
only changed from one form to another.**

$$I = (n - O)$$

where:
I = conscious awareness packets (itons)
O = unconscious awareness packets (otons)
n = total number of awareness packets per individual
and where:
n = I + O

The measurements of consciousness and unconsciousness are reciprocals of one another; as one increases, the other decreases. However, an individual's total amount of awareness remains constant, reflecting a law of conservation.



The Space Displacement Formula

The volume of space displaced by an awareness field is proportional to the number of itons in the field.

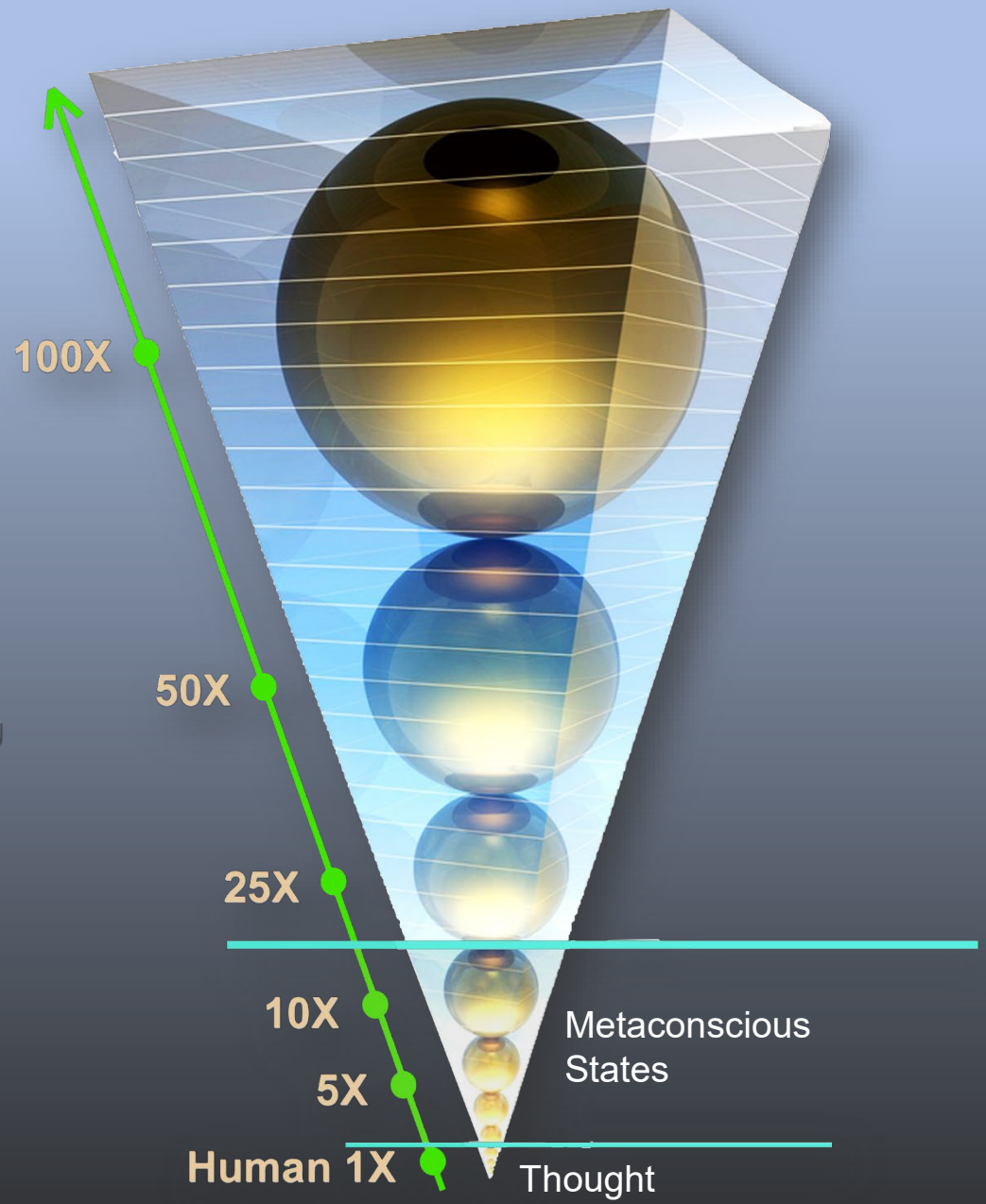
$$V = \frac{4}{3}\pi \, i^{2}$$

where:

V = volume of space displaced
i = number of itons in an awareness field

Itons displace space like air bubbles in water.

Otons create the living universe by occupying memory, space, energy and matter.

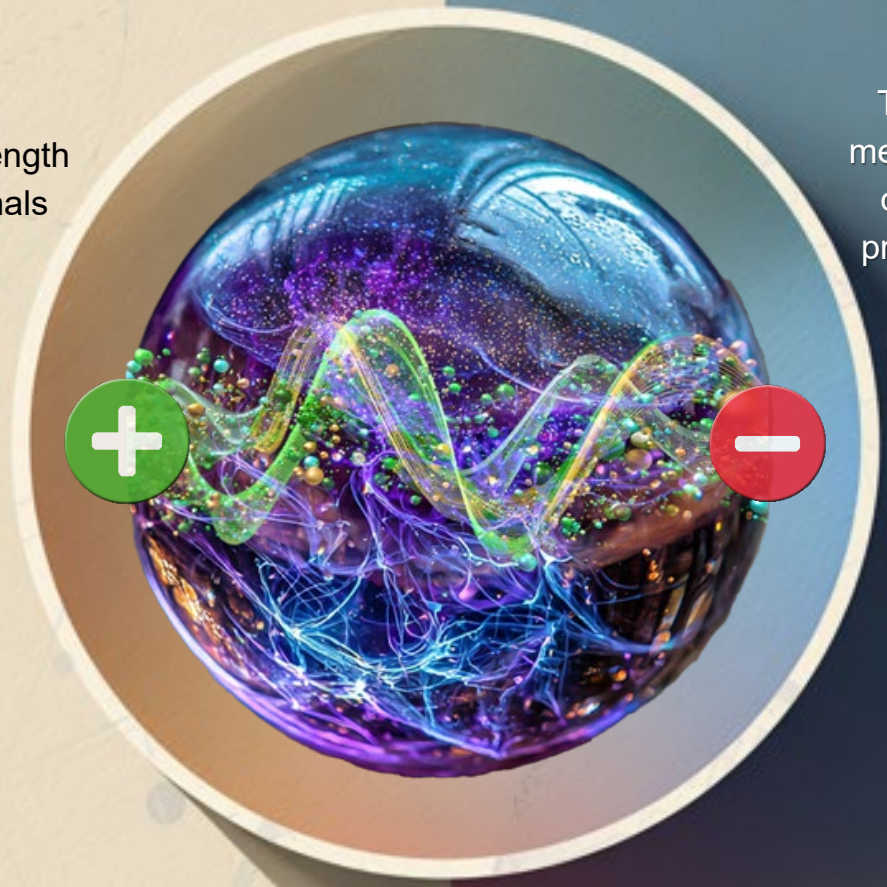


Memory Record Charge

3

The amplitude of a memory's recording depends on the strength of its originating electrical signals in neurology.

Higher amplitude memories have more charge. Charge is the differential between a memory record's plus and minus end points (source and sink).



The strength of an activated memory's polarity (plus/minus difference) is the force of its projection through the closed wave field coupled circuit.

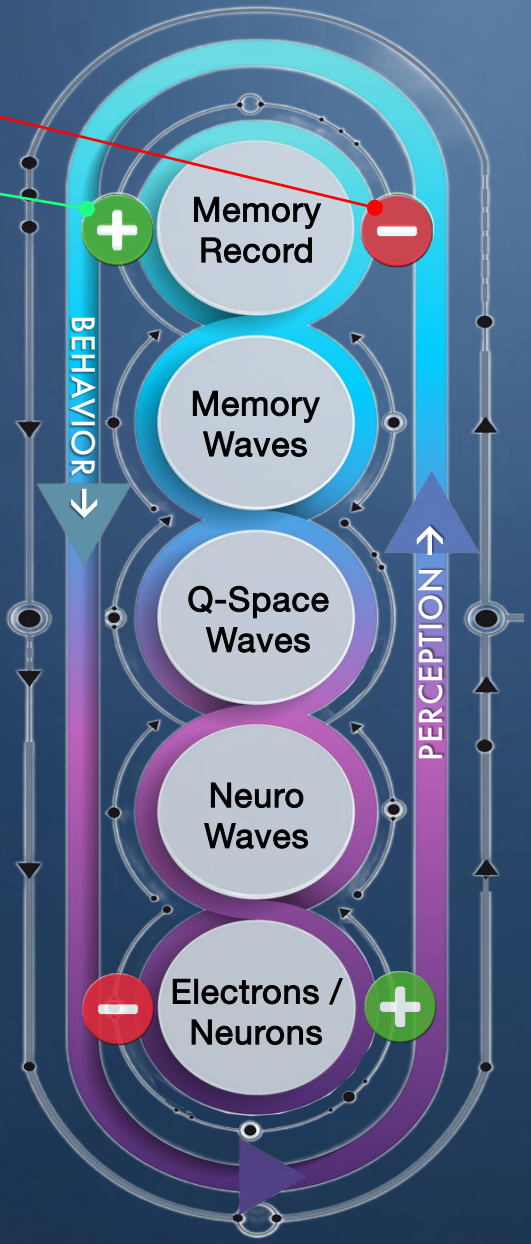
Thus, the force or voltage of the wave field circuit varies with the amplitude of an activated memory's recording.

Memory Record Polarity

A memory must have plus and minus end points (source and sink) in order to oscillate.

Memories are recordings of oscillating neurowave signatures in neurology. Since these waves have polarity, their replicas also have polarity.

The memory's polarity drives energy through a closed wave field coupled circuit from the plus to the minus terminal of the memory.



The Memory Record Charge Formula

A memory record's charge is proportional to the total number of otons enclosed by the record.

$\oint$: denotes the closed surface integral (1)

da : the infinitesimal area vector on the closed surface, pointing outward (2)

$\epsilon 0$: a permittivity constant defining how otons enter a memory record

$$\oint \mathbf{MR} \cdot \cdot - da = Qenc \; / \; \epsilon 0$$

MR : the memory record charge

Qenc : the number of otons enclosed by the memory record

(1) A closed surface integral ($\oint$) is a calculus tool used to sum up a quantity over a closed surface.

(2) A differential area element (da) is a calculus tool used to break down complex surfaces into manageable, infinitesimally small pieces for integration purposes.



4

Wave Field Circuit Flux

The flux through any memory wave field coupled neural circuit is zero.

$$\nabla \cdot \mathbf{M} = 0$$

Where:
∇ is the divergence operator
M is the memory field

No waves diverge from or flow out of the closed memory wave field circuit. It is self-contained.

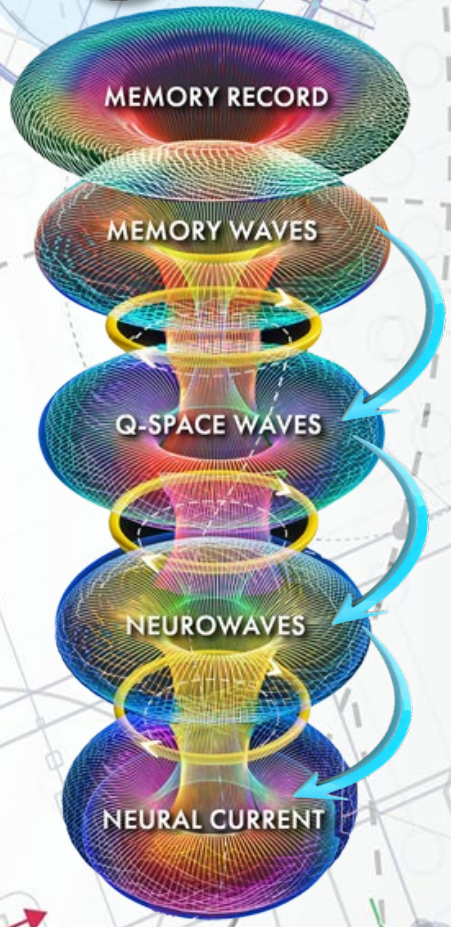
The wave field coupled circuit is technically a dipole, meaning it has two poles; plus and minus. There are no memory monopoles.

5

Laws of Behavior and Perception

Wave Field Formulas

Frequency



Behavior

5A. A time-varying memory field induces a time-varying space field.

5B A time-varying space field induces a time-varying neurowave field.

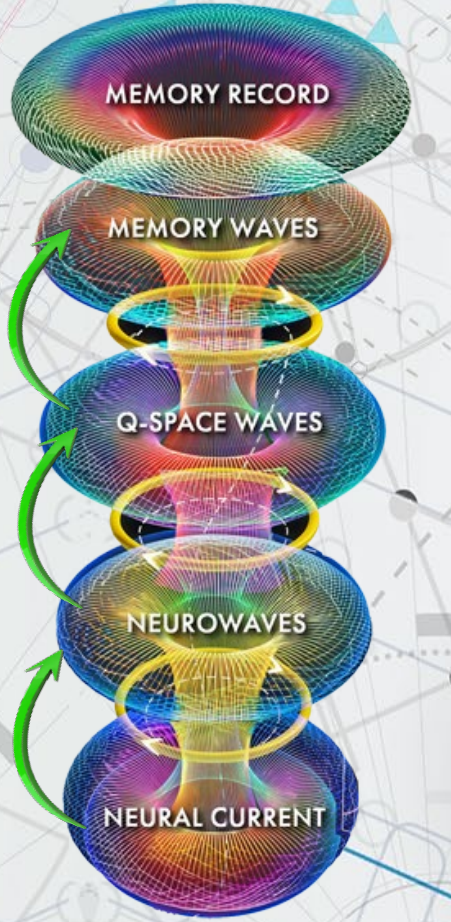
5C. A time-varying neurowave field induces a time-varying electrical field.

5F. A time-varying space field induces a time-varying memory field.

5E. A time-varying neurowave field induces a time-varying space field.

5D A time-varying electrical field induces a time-varying neurowave field.

Perception



Wave Field Frequency – Behavior

5A. Memory/Space Wave Field Frequency

A time-varying memory field induces a time-varying space field.

$$\frac{\partial M}{\partial t} k = \frac{\partial S}{\partial t}$$

M is the memory wave field
S is the space wave field
t is time

∂M/∂t is the time derivative of field M, representing how M changes over time.

∂S/∂t is the time derivative of field S, representing how S changes over time.

5B. Space/Neurowave Field Frequency

A time-varying space field induces a time-varying neurowave field.

$$\frac{\partial S}{\partial t} k = \frac{\partial N}{\partial t}$$

S is the space wave field
N is the neurowave field
t is time

∂S/∂t is the time derivative of field S, representing how S changes over time.

∂N/∂t is the time derivative of field N, representing how N changes over time.

5C. Neurowave/Current Field Frequency

A time-varying neurowave field induces a time-varying electrical field.

$$\frac{\partial N}{\partial t} k = \frac{\partial E}{\partial t}$$

N is the neurowave field
E is the electrical field
t is time

∂N/∂t is the time derivative of field N, representing how N changes over time.

∂E/∂t is the time derivative of field E, representing how E changes over time.

∂ ∂ is a partial derivative taken for one variable (time *t*) while holding other variables constant.

k k is a proportionality constant relating the change rate of the first field to the change rate of the second field.

Wave Field Frequency – Perception

5D. Current/Neurowave Field Frequency

A time-varying electrical field induces a time-varying neurowave field.

$$\frac{\partial E}{\partial t} k = \frac{\partial N}{\partial t}$$

E is the electrical field
N is the neurowave field
t is time

∂E/∂t is the time derivative of field E, representing how E changes over time.

∂N/∂t is the time derivative of field N, representing how N changes over time.

5E. Neurowave/Space Field Frequency

A time-varying neurowave field induces a time-varying space field.

$$\frac{\partial N}{\partial t} k = \frac{\partial S}{\partial t}$$

N is the neurowave field
S is the space wave field
t is time

∂N/∂t is the time derivative of field N, representing how N changes over time.

∂S/∂t is the time derivative of field S, representing how S changes over time.

5F. Space/Memory Wave Field Frequency

A time-varying space field induces a time-varying memory field.

$$\frac{\partial S}{\partial t} k = \frac{\partial M}{\partial t}$$

S is the space wave field
M is the memory field
t is time

∂S/∂t is the time derivative of field S, representing how S changes over time.

∂M/∂t is the time derivative of field M, representing how M changes over time.

∂ is a partial derivative taken for one variable (time *t*) while holding other variables constant.

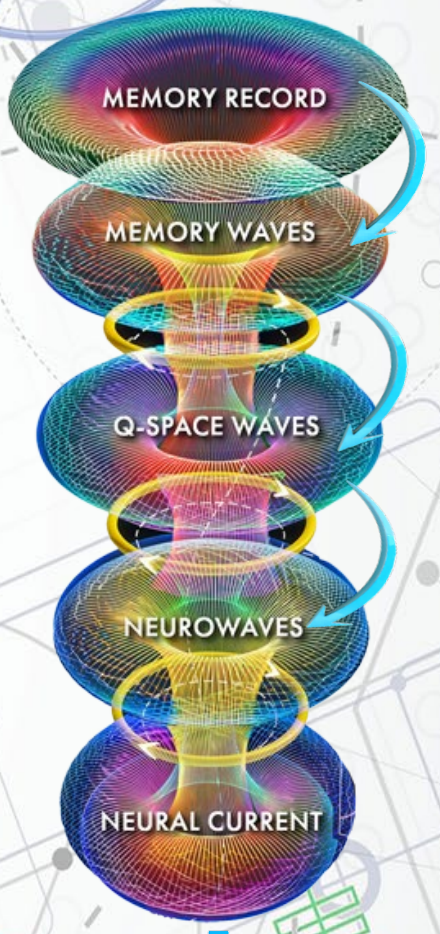
k is a proportionality constant relating the change rate of the first field to the change rate of the second field.

6

Laws of Behavior and Perception

Wave Field Formulas

Amplitude



Behavior

6A. The strength of the memory wave field is proportional to the enclosing memory record charge.

6B. The strength of the zero point space field is proportional to the enclosing memory wave field charge.

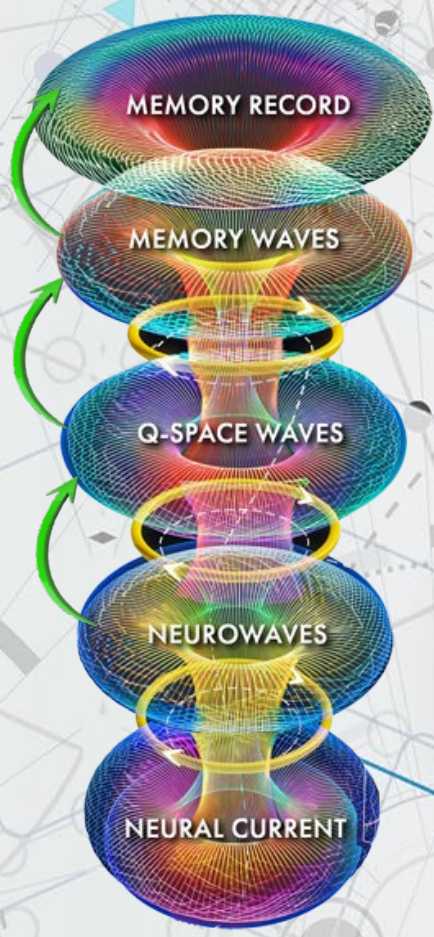
6C. The strength of the neurowave field is proportional to the enclosing space wave field charge.

6D. The strength of the space wave field is proportional to the enclosing neurowave field charge.

6E. The strength of the memory wave field is proportional to the enclosing space wave field charge.

6F. A memory record's charge is proportional to the enclosing memory wave field charge.

Perception



Wave Field Amplitude – Behavior

6A. Memory Wave Field Amplitude

The memory wave field's strength is proportional to the enclosing memory record charge.

$$\oint M \cdot -da = Qenc_{MR} / \epsilon 0_M$$

$\oint M$ is the closed surface integral of the memory wave vector field

da is the infinitesimal area vector on the closed surface, pointing outward

$Qenc_{MR}$ is the total charge enclosed by the memory record's surface MR

$\epsilon 0_M$ defines how much memory wave flux can pass through a memory record

6B. Space Wave Field Amplitude

The strength of the zero point space field is proportional to the enclosing memory wave field charge.

$$\oint S \cdot -da = Qenc_M / \epsilon 0_S$$

$\oint S$ is the closed surface integral of the space wave vector field

da is the infinitesimal area vector on the closed surface, pointing outward

$Qenc_M$ is the total charge enclosed by the memory wave field's surface M

$\epsilon 0_S$ defines how much memory wave flux can pass through a space wave field

6C. Neurowave Field Amplitude

The strength of the neurowave field is proportional to the enclosing space wave field charge.

$$\oint N \cdot -da = Qenc_S / \epsilon 0_N$$

$\oint N$ is the closed surface integral of the neurowave vector field

da is the infinitesimal area vector on the closed surface, pointing outward

$Qenc_S$ is the total charge enclosed by the space wave field's surface S

$\epsilon 0_N$ defines how much space wave flux can pass through a neurowave field

Wave Field Amplitude – Perception

6D. Space Wave Field Amplitude

The strength of the space wave field is proportional to the enclosing neurowave field charge.

$$\oint S \cdot -da = Qenc_N / \epsilon 0_S$$

$\oint S$ is the closed surface integral of the space wave vector field

da is the infinitesimal area vector on the closed surface, pointing outward

$Qenc_N$ is the total charge enclosed by the neurowave field's surface N

$\epsilon 0_S$ defines how much neurowave flux can pass through a space wave field

6E. Memory Wave Field Amplitude

The strength of the memory wave field is proportional to the enclosing space wave field charge.

$$\oint M \cdot -da = Qenc_S / \epsilon 0_M$$

$\oint M$ is the closed surface integral of the memory wave vector field

da is the infinitesimal area vector on the closed surface, pointing outward

$Qenc_S$ is the total charge enclosed by the space wave field's surface S

$\epsilon 0_M$ defines how much space wave flux can pass through a memory wave field

6F. Memory Record Formation Charge

A memory record's charge is proportional to the enclosing memory wave field's charge.

$$\oint MR \cdot -da = Qenc_M / \epsilon 0_{MR}$$

$\oint MR$ is the closed surface integral of the memory record

da is the infinitesimal area vector on the closed surface, pointing outward

$Qenc_M$ is the total charge enclosed by the memory wave field's surface M

$\epsilon 0_{MR}$ defines how much memory wave flux can pass through a memory record

7A. Neural Network Induction

The voltage passing through a neural network is proportional to the enclosing neurowave field charge.

$$V = k \oint_{\partial\Sigma} E \cdot dA = k\, Q_N$$

V	$\oint_{\partial\Sigma}$	dA
V is the voltage passing through a neural network	∮∂Σ is the closed surface surrounding a neural network (1)	dA is a differential area element on the surface ∂Σ (2)

(1) A closed surface integral (∮) is a calculus tool used to sum up a quantity over a closed surface.

(2(A differential area element (*d*a) is a calculus tool used to break down complex surfaces into manageable, infinitesimally small pieces for integration purposes.

a proportionality constant relating the change rate of the first field to the change rate of the second field	E is the neurowave field	Q_N is the total neurowave field charge enclosed by the surface ∮∂Σ
k	E	Q_N

7B. Neural Network Radiation

The neurowave field charge is proportional to the voltage passing through a neural network.

E

E is the neurowave field

$\oint_{\partial\Sigma}$

∮∂Σ is the closed surface surrounding a neural network (1)

dA

dA is a differential area element on the surface ∂Σ (2)

(1) A closed surface integral (∮) is a calculus tool used to sum up a quantity over a closed surface.

(2(A differential area element (*d*a) is a calculus tool used to break down complex surfaces into manageable, infinitesimally small pieces for integration purposes.

$$E = k \oint_{\partial\Sigma} V \cdot dA = k\, Q_N$$

a proportionality constant relating the change rate of the first field to the change rate of the second field

k

V is the voltage passing through a neural network

V

Q_N is the total neurowave field charge enclosed by the surface ∮∂Σ

Q_N