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Experimental Hypnosis: State of the Art and Position Paper of a Panel of Experts

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THEORY AND PREMISES. MENTAL IMAGES CERTAINLY EXIST, FOR THE REST OF THE WORLD ONE MUST EXPERIMENT

WHO IS PARTICIPATING IN THIS STATE OF THE ART AND POSITION PAPER

The authors of this paper are scientists from diverse backgrounds who have experience in the field of experimental hypnosis and have been interested for years in the search for scientific truth, particularly in the fields of the *ψυχή* (psyche), consciousness, and hypnosis. They know each other, have already collaborated actively, and have come together because they share a common interest in moving hypnosis from the realm of narrative disciplines to that of Galilean science. To this aim they converge in a panel representing 17 fields of expertise, 4 universities, 1 superior institute and 4 hospitals and joined a nascent, grassroots movement that has struggled to gain traction. They have decided to produce this paper in an effort to move hypnosis out of the realm of narrative disciplines and into the fold of Galilean scientific ones. While hypnotism originated in an era when little was known about the mind and almost nothing about hypnosis itself, we now live in the *age of neuroscience*, possessing cultural approaches and technological tools unavailable to the founding fathers. The opinion of the experts is that hypnosis cannot exist in ignorance of its underlying scientific bases. Even those who employ it in a non-scientific manner will benefit from an understanding of the underlying mechanisms. Indeed, it is also important to know what is real in the physical world and what, conversely, is merely real as a subjective experience of the patient. Furthermore, experimental research in the field of hypnosis has shed light on many aspects of the mind.

Why the Focus on Experimental Hypnosis? Experimental Research and the Galilean Method

Hypnosis – defined as a state[1] of focused attention, reduced contact with the environment, and a slight reduction in critical judgment [108] – probably is a *physiological modified state of consciousness* that occurs either spontaneously or in a dedicated setting through the use of techniques [235] or even in their absence [31]. This definition, along with many others proposed over time [34,42,75,125,145,280] – too numerous to summarize here and often definitely wrong – fails to clarify the nature of hypnosis or explain what the *trance state* actually entails. Even when definitions do address the nature of the phenomenon, they tend to limit themselves to describing the phenomenology of hypnosis without delving into the underlying mechanisms. While useful in some settings[2], this approach does not help bring hypnosis into the realm of Galilean science.

Galilean science is the modern model of scientific inquiry established by Galileo Galilei [1383,139,255], combining empirical observation with mathematical analysis [268]. Under this approach, for a statement to be considered a scientific law, it must: 1) abandon dogmas based on authority; 2) be grounded in criteria of objectivity, measurability, and verifiability; and 3) remain open to potential falsification (i.e., being contradicted by more compelling data). It therefore focuses on the primary, measurable properties of physics and uses subjective qualities merely as an initial guide. Every law of the naturalistic universe[4] must be expressible through equations ranging from simple to highly complex. Verifiability requires the formulated law to pass what Galileo [138] termed *il vaglio del cimento* (the testing of a series of trials) reproducible in the laboratory by other researchers. From this perspective, the truth value of a statement does not depend on who makes it, but solely on empirical facts. Furthermore, every statement must be predictive and causal; that is, it must identify the underlying biological or mechanical cause→effect relationships, thereby enabling the prediction of future phenomena under identical conditions [39].

Not all these characteristics of scientific research necessarily appear simultaneously; research is a dynamic process that unfolds over time, sometimes spanning generations, and certain assertions are considered true *pro tempore* until potentially falsified. Many laws once held to be true *pro tempore* have subsequently been disproven or refined. The two pillars of the Galilean method are *sensate experiences* rooted in an analytical/inductive phase (the careful, systematic observation of natural phenomena, aided by technological instruments to gather numerical data), and *necessary demonstrations* rooted in a

1 It has long been discussed whether hypnosis is a discrete state of mind in line with experimental evidence from imaging techniques [63,68,72,73] spontaneously or a mere skill metaphor [83,181], and there is ongoing debate as to whether degrees of hypnotic depth exist or whether it is an *all-or-nothing* phenomenon [83]. AI may well contribute to this area of inquiry in the very next future.

2 In its September 2009 *Position Statement on Hypnosis*, the APA [8] established that the practice of hypnotism and the use of hypnosis do not, in themselves, constitute forms of psychotherapy. In a subsequent 2015 statement, the APA clarified that while hypnosis does not qualify as a therapy in its own right, it should be employed by psychiatrists or other healthcare professionals (in Italy, this category includes physicians, psychologists, and likely dentists) who have undergone appropriate training and certification – as is the case with hypnosis training schools – and who operate within the scope of their respective professional competencies. (https://www.psychiatry. org /File%20Library/About-APA/Organization-Documents-Policies/Policies/Position-Hypnosis.pdf).

3 Also available in: https://www2.museogalileo.it/it/biblioteca-e-istituto-di-ricerca/progetti/incontra-galileo/31-opere /460-dialogo-sopra-i-due-massimi-sistemi-del-mondo-1632.html and in https://liberliber.it/autori/autori-g/galileo-galilei/dialogo-sopra-i-duemassi mi-sistemi-del-mondo-tolemaico-e-copernicano/ o anche in https://archive.org/details/dialogo sopraidue01gali.

4 Everything extending from the initial singularity (often called the *Big Bang*) to the present, including the experimenter.

synthetic/deductive phase (leading to the formulation of a logical-mathematical hypothesis, which is then tested *via* a thought experiment or a real-world experiment to confirm or refute the law). The Galilean process represents a continuous synthesis of these phases.

Today, all scientific and technological discoveries across every field are achieved in this manner. An assertion not demonstrated according to the criteria outlined above is not necessarily false; it is simply indeterminate, i.e. potentially true or false. It does not constitute science; rather, it is a descriptive statement, an opinion that may be either useful or misleading, yet adds nothing to our understanding of the nature of the universe.

Since the days of Mesmer [111] and the early psychoanalysts [169,170,211], hundreds if not thousands of theoretical claims regarding hypnosis have been put forward; unsupported by controlled research, these claims have often proven absurd and lack any authority other than the subjective view of the author in question. In the absence of scientific data, *any content* can be attributed to a theory, content that often simply *reflects the spirit of the times* [274] *or the author's projected inner world*. Even today, some believe that hypnosis is a magnetic phenomenon or involves the transfer of something5 from the operator to the subject, that the operator rather than the subject is the focal point of the action6, or that it is possible to induce someone to perform actions against their will7 while under hypnosis. All these theories have been proven false, yet they continue to circulate and appear in books and at conferences. Until recently, much effort went into teaching what hypnosis *is not*; today, it is far more consistent to teach what hypnosis *is* (§ 2.1 to start, and the entire paper to continue). Nowadays, there is no longer any need to dwell on outdated definitions of hypnosis formulated in the past, definitions that were appropriate for the times in which they were conceived but have often been superseded, if not refuted, by subsequent experimental evidence.

Tools for Experimental Research on Hypnosis

First of all, hypnosis is in itself a tool [55,62]. Furthermore, research employs a variety of technological instruments – ranging from the very simple to the highly complex – to render results objective, measurable, and reproducible. Unlike in clinical practice, where the hypnotist's conviction suffices [74], experimentally demonstrating that induction has occurred (§ 2.3) or that a hypnotic state has been achieved is a significant challenge that has only recently been resolved (§ 2.5). Although modern understanding acknowledges that the seat of the psyche, higher functions, and the Ego is not necessarily the brain [43], experimental studies of hypnosis tend to rely on electrical methods such as EEG8 (Table 2)

5 It seems that for some, the theory of the *subtle or luminiferous ether* which posited the existence of an extremely tenuous, impalpable, and pervasive *fluid or material medium* serving to fill space and explain the transmission of forces or light has not yet been superseded, as if the advances in physics during the 19th and 20th centuries had never occurred [104,105] and as if Michelson and Morley had not already disproven its existence back in 1887.

6 As if Braid had never existed [24,25].

7 As if subjective free will, even outside of hypnosis, had not been refuted by scientific studies, in addition to being incompatible with the determinism of the naturalistic universe [39,46,146,178-180,254].

8 Many hypnotic-related EEG changes classically consist of an increase in ß-HF and δ-LF components and a reduction in the α component [76,77]. However, in hypnosis research, EEG analysis now routinely relies on processing systems and automated projection onto standard anatomical atlases, such as LORETA [62] to facilitate the interpretation and visualization of results.

or on more refined, precise brain imaging techniques like fMRI or PET9 [73,97]. PET (the only technology enabling cerebral receptor neuroimaging) (§ 2.2), delivering a dose of 10-20 mSv due to the radioactive tracers ^{18}F or ^{15}O [77], entails a risk considered acceptable in routine medical practice associated with but questionable in research 10; fMRI is considered harmless, offers better resolution11 than PET, and allows for the visualization of the temporal stages of brain activation [77]. Since both methods are complex, expensive, and time-consuming, the research protocol must be meticulously organized before commencement (§ 1.3-1.8).

Hypnotic *trance (hypnosis)* develops when *plastic monoideism12* [271] (§ 2.5) is triggered. In specific tasks, hypnotic depth can be measured using indices that employ an alternative description of the EEG by quantifying its sinusoidal components13 (§ 2.4). Sometimes, a hypnotic effect that is not directly measurable can be quantified indirectly by assessing its secondary effects, such as cardiovascular, autonomic, or biohumoral changes. From a cardiovascular perspective, useful tools include the ECG, spectral analysis of the R-R interval, HRV, and devices for measuring total [57] and segmental [59] arterial flow14; the same methods, when applied to veins, allow for the measurement of flow and resistance within the capacitance system (§ 2.15) [140]. Internal medicine ultrasound allows for the assessment of the diameter and flow of visceral vessels (mesenteric artery, renal arteries) and the portal vein (§ 2.15). Experiments investigating mental performance and reactivity utilize cardiovascular methods and electronic measurement of reaction times (§ 2.14). And so on.

In short, any task in which an attempt is made to demonstrate an effect *via* hypnosis requires that the effect be quantified using instruments generally available only to large institutions rather than individuals, and that it be measured not arbitrarily or subjectively, but in standard units of human physiology. This enables the effect to be incorporated into equations describing its behavior15. The following sections will provide a detailed description of various phenomena induced during hypnosis that have been scientifically demonstrated and accurately measured within an experimental setting.

9 The positron is the antiparticle of the electron, possessing the same mass but a positive electric charge. In PET, positron-emitting radioactive substances injected into the body annihilate upon colliding with electrons, transforming into γ rays that are detected by sensors to create detailed images of organs and their metabolism.

10 Activated brain areas require more oxygen and glucose. Cerebral blood flow in a given area or region is proportional to activation, which can be inferred by measuring β-decay using external sensors [77].

11 A resolution, however, that does not go so far as to distinguish between adjacent or very closely spaced brain nuclei [77,78].

12 A phenomenon whose demonstration has only recently become possible thanks to fMRI and a creative protocol (§ 2.5)

13 Widely used by anesthesiologists particularly for assessing deep sedation, but also applicable to hypnosis [27,158,167,233,253].

14 When arterial pressure values are known, these allow for the calculation of arteriolar resistances, which are proportional to the level of adrenergic stimulation (§ 2.14).

15 Although standardized tests and visual-analogue scales [123] are frequently used in hypnosis research (§ 2.10), their results are not free from ambiguity and should be viewed merely as complementary: subjecting subjective data to statistical analysis does not render them objective, nor does it constitute a purely experimental method.

Table 2: ECG waves and their meaning.

Sensorium	Waves	Frequency (Hz)	Related to
HIGH ⇩	β	23-30	active wakefulness (but also stress, anxiety, arousal)
	γ	30-42	higher cognitive functions (learning, insight, arousal)
	α	8-13	closed-eye waking relaxation
	θ	4-8	drowsiness, light sleep (even in REM phase), imagination, mind turned inward
	δ	5-4	deep dreamless sleep (stage N3)

Incidents in Experimental Hypnosis, Informed Consent and Other Ethical Aspects

Experimental hypnosis carries less risk than clinical hypnosis because participants are selected with extreme care; unlike in clinical practice, there is no requirement to accept or even test just about anyone [86]. Research in the field of hypnosis consists predominantly, if not exclusively, of experiments of physiology; consequently, participants are generally selected to be free not only from major medical conditions but also from psychiatric disorders including the latent ones [276,297-300]. Thus, working with individuals suffering from overt psychosis (acute or chronic) or uncompensated affective disorders (such as bipolar disorder) – scenarios that might occur or be chosen in clinical practice [1] – is ruled out. Furthermore, the likelihood of encountering subjects with severe cluster A or B personality disorders (such as *borderline personality*) is minimized, as these individuals are preliminarily carefully screened by psychiatrists, psychotherapists, or both. However, baseline functioning is not assessed in the same way; the essential element here is its complete preservation and maintenance, regardless of specific personality traits 16 . Secondly, hypnosis experiments are invariably conducted not by a lone researcher but by a large team, creating a critical mass that serves as a safeguard against mishaps. Thirdly, bioethics committees, which must grant prior approval for the experiment and are already highly cautious by nature, exercise particular scrutiny regarding hypnosis experiments; this is due to the aura of suspicion that still surrounds this type of research, particularly within academic circles. Consequently, it often takes many months and numerous adjustments before a hypnosis experiment receives approval. Nevertheless, experimental hypnosis, like any healthcare practice, is not without risk. Much depends on how the experiment is conducted17. It is strongly recommended that experimental hypnosis not be performed by

16 In cases where experimental work involves patients, the subjects typically present with *neurotic-type personalities* or *neurotic-range borderline states*16 (e.g., *character neurosis*); in such instances, subjects – who are already aware of their condition – can only benefit from the hypnotic state and the subsequent, cautious suggestions16. Traumas are generally brought to conscious awareness prior to the experiment (in a clinical setting, separate from the research team) or are incorporated into the experiment itself with all due precautions, at which point the procedure also takes on the nature of a treatment. In reality, such experiments are infrequent.

17 For example, in a research laboratory, hypnosis can easily be used both to elicit and to resolve clinically relevant phenomena, in order to study their characteristics in a controlled environment [63,90,110,191,207,210,247,248]. Here, the symptoms are deliberately induced rather than accidental, but the example serves to illustrate that this is possible.

anyone lacking the specific expertise or working outside of a team within a qualified institution.

In any healthcare activity, preventing accidents is essential for both moral and legal reasons. This rule is particularly relevant in healthcare research; when the research involves hypnosis, the need becomes even more pressing, as the practice of hypnotism is viewed with suspicion and finding a court-appointed expert is difficult.

Any experimental research, including studies involving hypnotism, must be approved by the competent Bioethics Committee. This presents the first major hurdle, as these committees (like people) often know little or nothing about hypnotism, frequently equating the hypnotic state with a loss of consciousness (which is not the case). Consequently, getting a study protocol accepted is generally more difficult than obtaining approval for other types of research involving human subjects. The recent EU-GDPR regarding personal data protection, in force since May 25, 2018, and immediately binding for all EU member states, mandates that anyone processing data on EU residents must do so transparently and securely, and solely for legitimate purposes. It also grants individuals the right to know what data is being collected, to access and correct it, and to have it deleted (the *right to be forgotten*). While many of these rules existed previously, the GDPR has significantly tightened enforcement.

Bioethics Committees are composed of members from highly diverse backgrounds, and apply laws and regulations strictly, leaving little room for personal initiative. A crucial aspect is their intense focus on statistical details; they employ expert statisticians and often raise objections in this area (for instance, regarding practical feasibility, sample sizes, or proposed data analysis methods). Since weeks or months can elapse each time a protocol is returned to the Committee for modification, the protocol itself must be drafted with almost obsessive precision. Some hold that failing to consult the Bioethics Committee does not constitute a serious legal offense; however, it is unwise to test the judiciary with such conduct, not least because, even if criminal liability were avoided, there would still be civil liability issues regarding compensation (and it is not always certain that professional liability RC insurance covers the practice of hypnosis, especially for experimental purposes).

What everyone agrees upon is the absolute importance of *informed consent*[18], an aspect regarding which many researchers are not adequately trained. *No medical treatment may be initiated or continued without the patient's free and informed consent*. Informed consent is not merely a form signed by the participant (even though such a signature is required in clinical trials); rather, it is a procedure comprising a series of coordinated, sequential acts. Through this process, it must become evident that the participant has gradually reached the decision to take part in the research, exercising their right to dispose of their own body (e.g., Art. 5 of the Italian Civil Code), a right that is restricted when such acts cause a permanent impairment of physical integrity or otherwise violate the law, public order, or public decency. Consent must be free[19], informed, and revocable at any time (even while the research is underway). It must comply with EU Regulation 536/2014 (specifically Art. 29 and 30), *Good Clinical Practice Guidelines*, and the *Declaration of Helsinki*, while ensuring a risk↔benefit balance favoring the individual or public health.

[18] In Italy: L. 22 dicembre 2017, n. 219, in particular Art. 1.

19 For doubts regarding the freedom of human decisions, see references [39], [40], and [46].

Furthermore, consent must be unequivocally documented20—(for instance, *via* entries in medical records or outpatient charts, repeated information sessions, or any other means that serve the participant's interests 21). In all countries the underlying principle is everywhere the same (informed consent plus a prohibition against permanent or disproportionate harm), though with varying nuances. In the EU, the framework is harmonized by the aforementioned Regulation 536/2014 and the *Oviedo Convention*; informed consent is mandatory, and ethics committees play a central protective role. In the USA, where the *Common Rule* and *Institutional Review Boards* apply, there is a strong emphasis on individual autonomy and the assessment of minimal risk, alongside specific rules for vulnerable populations. In the United Kingdom, the *Human Tissue Act* and *Research Ethics Committees* mandate a rigorous approach to consent and risk proportionality. And so on. In summary, while the willingness to participate in research as a living subject is recognized across almost all Western legal systems, it is invariably contingent upon informed consent and the prohibition of causing permanent or disproportionate harm to physical integrity. In cases of doubt, a judge makes the decision based on the uncertain instrument of expert testimony [240,272].

As outlined above, drafting a research protocol that incorporates hypnosis is no small undertaking; it is best entrusted to expert researchers in the field, of whom there are few, who have already grappled with the inherent challenges of such work. The written informed consent form (which, while not exhaustive, is nonetheless mandatory) must be drafted to clearly demonstrate a commitment to participant protection and to emphasize the participant's voluntary decision to take part in the research solely for the purposes of cultural enrichment and the advancement of scientific knowledge.

Few people realize that even seemingly minor research projects, such as undergraduate, specialization, or diploma theses (including those at private institutions), must comply with the aforementioned obligations if they involve human experimentation; it is not the scale of the experiment that matters, but the protection of the participant.

The Research Staff and Subjects (Participants)

Hypnosis research must be conducted by a team possessing specialized training beyond what is required for clinical hypnosis practice. While researchers must obviously be expert hypnotists, that alone is not enough. Such research goes beyond merely inducing a neutral hypnotic state, delving into the specific mechanisms of applied hypnosis. Consequently, each task demands particular expertise. When investigating the effects of hypnosis described later in this paper, the authors already possessed years of academic and professional experience in fields such as internal medicine, neurology, psychiatry, neuroimaging, pharmacology, anesthesiology, cardiology, autonomic reflex studies, blood transfusion management, and echography, not necessarily all at once, but always available when required. Without this foundation, a study involving hypnosis is not only less safe but risks being futile. Furthermore, the team was always prepared and trained to address any psychological or physical issue by planning psychiatric, psychotherapeutic, and resuscitation

20 According to Art. 1 of the aforementioned L. 219/2017, *"time dedicated to communication between physician and patient constitutes time spent on care"*.

21 In Italy, compliance is also required with D.L. 211/2003 (implementing the former Directive 2001/20/EC) and Art. 2050 of the Italian Civil Code regarding liability for dangerous activities.

interventions. Building a comprehensive hypnosis research team requires years of selection, testing, and refinement. Each individual researcher bears *personal responsibility* for the success or failure of the experiment and is never merely a passive assistant; however, it is important to note that there is a lead investigator who bears *overall responsibility*, including legal and financial liability [63].

What is required of a participant in scientific research involving hypnosis is that they be capable of providing valid informed consent (and generally be of legal age, barring research in specific fields subject to special rules), possess sufficient intellectual and cultural depth to understand the nature of hypnosis (which also enhances hypnotizability), possess enough empathy to establish a rapport with the hypnotist, be willing to volunteer their time for the research solely in the interest of scientific knowledge, be free from psychological conditions that would make the induction and conduct of hypnosis difficult or risky, and be free from physical conditions or malformations that would make recording the effects of hypnosis impossible or even merely difficult. In cases where the use of certain brain imaging techniques is planned, it is also required that one be free from claustrophobia and willing to remain inside a narrow tube for several hours22.

Participants are often selected from among those who frequent the scientific laboratory, or from their friends or relatives. Given the great interest in hypnosis, it is never difficult to find volunteers even for studies on pain23. Alternatively, participants are recruited *via* notices posted near the laboratory or in university and hospital bulletins. The ideal participant is a healthy, curious individual aged 18 to 50, the age range when hypnotizability is at its peak and uncritical suggestibility is at its lowest.

In many respects, the requirements for participants do not differ significantly from those expected of the researcher.

One interesting topic is the participant's level of hypnotizability. When a paper undergoes peer review, reviewers almost invariably ask whether the subjects were evenly distributed between those who are *highs* and those who are *lows*, or they object if only *highs* were used. In reality, if the study aims to evaluate an effect of hypnosis, it is natural to select only *highs*, as the effect is more pronounced in them24. For physiological studies, *highs* are preferably recruited. The only instance requiring the study of both *highs* and *lows* (ideally matched for age and sex) would be a hypothetical *prevalence study* on population hypnotizability, a scenario that has never arisen and does not appear plausible25.

Mental Models Underlying Hypnosis

22 Those who are frightened by magnetic fields are not suitable candidates, even though, in another wing of the hospital, they pay to undergo magnetotherapy.

23 Except for studies involving dental pain [120,121,124,127]; in these cases, the number of volunteers drops drastically, partly due to the profound significance of interventions on or within the oral cavity [281].

24 Choosing *lows* in this case would be tantamount to studying swimming aptitude in subjects who do not know how to swim, a concept difficult to convey to those who are not researchers.

25 The authors of this paper who are also epidemiologists (E.C., V.T.) have conducted and published numerous population studies in other fields and would know how to organize a population-based survey on hypnosis; however, it is impossible to secure the funding required for such a highly expensive population-level project. Some studies use the term *population* incorrectly and misleadingly and are not actually population-based.

This chapter lies at the boundary between hypnosis understood in a descriptive sense and in an experimental sense. The scientific study of hypnosis cannot overlook a reflection on its epistemological dimension, which is inextricably intertwined with the ways in which human beings learn about, process, and interpret the surrounding reality [44-46]. Physical reality in and of itself is intrinsically inaccessible, since knowledge is inevitably mediated by receptors (§ 2.2) and the neurophysiological processes (§ 2.2 *et seq.*) triggered by them [35,42,73,161]. What is commonly defined as perceived reality is, in fact, the outcome of a unified subjective representation [137]. Hypnosis thus ceases to be viewed merely as a peripheral illusion or an artifact of simulation, emerging instead as a manifestation of the fundamental dynamics of the nervous system. Hypnosis experimentally demonstrates that the entire experience of the world is an internal process. By narrowing the focus of attention through plastic monoideism [72] (§ 2.5), hypnosis allows for profound alterations in perceptual, bodily, visceral, and temporal representations, endowing mental images with the same phenomenological, physiological, and biochemical status accorded to physical stimuli from the external world [44,75]. Since the neural matrix and representational reality are structured within a single representational space, hypnosis offers an ideal methodological tool for scientifically investigating how a focused idea can translate directly into receptor, immune, endocrine, and hemodynamic responses [64,73,137]. Building on these epistemological premises, some lines of research in modern cognitive neuroscience have progressively moved away from the model of the brain as a passive receiver of bottom-up information, proposing instead a view of the brain as probabilistic and the mind as a Bayesian predictor [80,252]. Perception is fundamentally a controlled hallucination [134,251]: the cerebral cortex does not passively await stimulation from sensory organs but constantly generates in a top-down manner an internal model that anticipates the external causes of incoming sensory data. Perceptual processing thus takes the form of a dynamic, ongoing process of probabilistic inference. The mind calculates the probability of the world's hidden causes (the posterior distribution) by combining prior beliefs – formed through past experience – with the likelihood of current sensory data [251]. What an individual consciously perceives at any given moment is not a direct measure of physical input, but rather the working hypothesis projected by the brain’s attentional spotlight26 [80] that minimizes the discrepancy with peripheral data. Under ordinary conditions, the brain continuously generates predictive conjectures about the world, and hallucination remains in check because the error signals conveyed by the bottom-up stream serve to constantly update the internal model. Within this context, the relational interaction (rapport) between hypnotist and subject becomes an integral part of the mind's predictive architecture, enabling the guided reconfiguration of perceptual and existential models [137]. In accordance with Karl Friston's free energy theory [213], to counteract the natural tendency toward entropy and maintain structural integrity, every biological system constantly minimizes so-called surprise or free energy, i.e. the discrepancy between expectations generated by the internal model and signals conveyed via the sensory veil [213]. Hypnosis appears to interfere with precision weighting, which represents the estimate of reliability or informational value assigned to a specific transmission channel. When a sensory channel is deemed uncertain, noisy, or irrelevant, the brain drastically lowers its precision, ignoring its input and allowing perception to be guided almost exclusively by the internal model's predictions. Hypnosis acts upon this precision weighting mechanism [159]. Through the

26 It is the *searchlight theory*.

induction process and the attainment of plastic monoideism (§ 2.5), the hypnotized subject narrows their attention to a single representation; this deep focus reduces the precision assigned to the array of external and peripheral sensory signals. In this state, verbal or symbolic suggestions provided by the hypnotist are adopted by the brain as a hyper-prior, a prediction of extremely high priority and certainty. From the perspective of neurofunctional connectivity, this entails a transient decoupling of the reality-monitoring function associated with the mPFC and dlPFC [173]. By deactivating analytical criticism, internal simulation is promoted to the status of perceived reality. PET and fMRI studies have shown that when a blind person explores Braille text with their fingertips, their primary visual cortex (V1) becomes intensely and structurally active [242]. V1 is not merely a passive screen designed solely to receive signals from the retina, but a processor of top-down spatial maps and representations. In line with this view, perceived reality is a flexible construct generated by the brain to minimize free energy, regardless of the sensory modality of origin27.

EXPERIMENTAL RESEARCH IN THE FIELD OF HYPNOSIS

What Is Known About Hypnosis and Its Deliberate Acceptance

In modern terms, hypnosis can be defined as a specific state of the organism [44-47,137] that arises whenever specific emotional and sensorimotor stimuli intervene; it is a physiological and dynamic modification of subjective consciousness 28 due to the establishment of a self- or hetero-induced plastic monoideism [72] (§ 2.5), allowing a privileged rapport between the operator and the subject [249] resulting from a connection formed by the combination of relationship and communication [74] between the person inducing and managing the hypnosis (the operator, hypnologist, or hypnotist) and the participant (the subject), and leading to significant behavioral and somatovisceral changes [42]. Alternatively, hypnosis is viewed as Logic remains present during hypnosis; the lowering (though not the total suspension) of critical judgment allows for the acceptance of the meaning conveyed by both verbal and non-verbal communication [74].

The study of hypnosis has been teaching us a great deal about the nature of the mind, and the Ego in particular [47]. Marked reductions in mPCC and DACC activation are observed during neutral hypnosis. Hypnotic attentional absorption is associated with reduced activity in the DMN and increased activity in the prefrontal system (§ 2.8). Bilateral dlPFC (executive control network) and the ipsilateral insula (salience network) are also implicated [97]. This is accompanied by reduced intrinsic connectivity within DMN regions, a factor contributing to alterations in the *sense of agency* and *consciousness* [39,152].

Although hypnosis, like the Ego [43], is likely not confined solely to the brain, current answers can only be derived from brain imaging techniques. Imaging results for neutral hypnosis are rather disappointing or contradictory; depending on the methodologies

27 It is the *theory of the extended mind* [81]: the boundaries of the cognitive system extend to encompass cultural artifacts, social rela-tionships, and linguistic interactions.

28 For the difference between *consciousness* and the *sensorium*, see Table 2. Throughout the paper, the term used is (egoic) *consciousness*, never (moral) *conscience*.

employed29, those that have addressed the question of where neutral hypnosis occurs have identified such a wide array of brain areas and regions as to suggest a nearly ubiquitous distribution, ultimately confirming the non-locality hypothesis [99,187,228,230,231]. Neutral hypnosis is not a good model, and the site30 of hypnotic activity can be identified only during a task, whatever that task may be. Under these circumstances, in *highs* in deep hypnosis, the prefrontal areas (specifically, though not exclusively, Brodmann areas 9, 25, 32, and 47), the precuneus, and parts of the cerebellum are activated (Figure 1). Any manual maintains that hypnotic *trance* differs from *suggestion*31 in that the former entails the critical acceptance of another person's ideas, whereas the latter calls for uncritical acceptance. But is this claim true? Or is it based merely on anecdotal evidence? [217]. Or is it, in fact, nothing more than a wish bordering on illusion? Experiments conducted at the University of Padua, the Venice Hospital, and the University of Trento have highlighted that the question of whether hypnosis is a matter of suggestion or of free acceptance is directly linked to the setting in which the hypnosis takes place. Evidence that hypnosis is deliberately accepted by the subject has recently come from neuroimaging. Indeed, during hypnosis, brain areas closely linked to what is popularly termed *conscious freedom*32 become hyper-activated (Figure 1), while other areas are rendered silent [68]. It must be noted that this demonstration is possible only during the performance of a task, not during neutral hypnosis. By identifying which areas are activated during a task under hypnosis, it has been observed that these correspond to the areas associated with *deliberate acceptance*; thus, the two concepts cannot be separated: hypnosis is a phenomenon free from coercion and is embraced voluntarily[30]. It is the task that, by activating the choice model, makes it possible to highlight the deliberate acceptance of the hypnotic command.

Table 3: Sensorium, consciousness and arousal [35,42].

Functions	Description
sensorium	the ability to perceive and integrate events through the use of attention and memory; it arises from the coordinated activity of diverse and varied nervous functions. Typical of animals and relevant to humans as animals
consciousness	the ability to respond to external stimuli while having a qualitative internal experience of existence. It is acquired over time through culture
arousal	a temporary state of heightened alertness evoked by a prompt reaction to a stimulus; a concept of exclusive interest to psychologists; in animals, it pertains only to the sensorium; in humans, it pertains to both the sensorium and consciousness, thus also taking on cognitive connotations

29 Various imaging studies have focused on hypnotizability rather than hypnosis itself, an approach that the authors of this paper do not endorse.

30 As previously mentioned, it is inappropriate to speak of a specific site or location, given that hypnosis is likely a dynamic and non-local function, much like the Ego [43].

31 Then, once the hypnotic state has been established, it is possible (and indeed useful in clinical, therapeutic, educational, or experimental settings) to administer suggestions often termed *commands*. These are, in fact, forms of conditioning [275] capable of operating even in the post-hypnotic phase. While the subject accepts these suggestions if they align with their principles and become an integral or even fundamental part of the hypnotic session, they do not constitute hypnosis itself.

32 Previously, in publications and lectures from years past, the authors of this paper maintained that hypnosis is *accepted consciously and voluntarily* [68]; today, they prefer to state that it is *accepted deliberately*, given that the concept of conscious freedom has been seriously challenged not only in hypnosis but in everyday life [39,40].

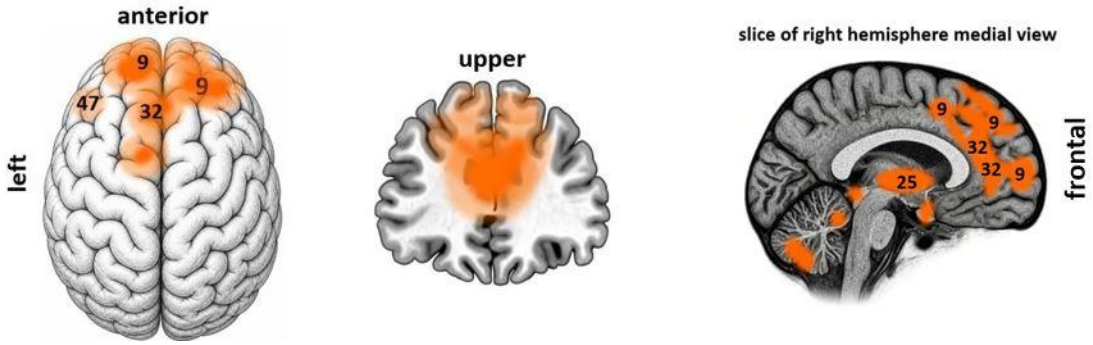


Figure 1: Some of the areas activated during hypnosis while performing a task, shown in brain sections *via* fMRI [73]. The areas affected by hypnosis are those considered to be involved in *conscious will* [68].

The Neuropharmacological Bases of Hypnosis

The authors of this paper are fully aware that any effect of hypnosis necessarily occurs through the action of ligands 33 on receptor structures 34 [75]. Schools of thought maintaining that hypnotic effects (especially psychological ones) are merely *as if* phenomena express a narrative opinion that cannot be proven; science cannot explain the *as if*, whereas it can attribute every known hypnotic phenomenon to the action of known ligands. In the case of hypnosis, where no pharmacological ligand is administered from outside the body, the ligands involved are the endogenous ones, i.e. those produced within the body in response to external stimuli (fear, anger, anxiety, calmness, arousal, meditation, introspection, etc.) or – as studied in the field of psycho-neuro-endocrino-pharmacology – to mental imagery [75,112]. Mental images are powerful stimuli that trigger biological consequences ranging from sensations and emotions to thoughts and physical changes. For instance, in daily life as well as in dreams [30], the mental image of a fanged beast raises heart rate and blood catecholamine levels, while an erotic mental image triggers an erection, and so on. This power of mental imagery holds true in all cases, but is vastly amplified when the mental image is generated or suggested under hypnosis. Each exogenous ligand elicits one or more specific effects, ranging from anxiolysis35 (§ 2.7, 2.10), to sedation (§ 2.7, 2.10), to analgesia (§ 2.8-2.10), to hypermnesia and revivification (§

33 Receptors are glycoproteic, nucleic, or lipid structures capable of specifically recognizing and binding a molecule known as a ligand; upon interacting with a ligand, they undergo a conformational change that triggers a biological or pharmacological response. Natural or synthetic ligands (which can act as agonists or antagonists) are molecules capable of binding to specific receptors and altering their structure, thereby producing specific effects [75]. This applies not only to higher animals but also to lower animals, plants, fungi, lichens, and molds. The presence in higher organisms, including *Homo sapiens*, of specific receptors that respond to animal and plant ligands [75] is attributable to the incorporation of receptors from lower organisms during the course of evolution.

34 Indeed, any state or change of state in an organism including those of thought is inevitably due to a receptor-mediated effect; no other mechanisms of action are known. This is obviously true for hypnotic effects as well, whether physical or psychological.

35 Prehistoric humans were more familiar with fear; modern humans are more familiar with anxiety. In the Paleo-Neolithic era, upon encountering a predator, the hominid felt under attack. Today, that prehistoric predator has not vanished; it still lurks within our emotional system: this is the underlying reason why we describe ourselves as anxious. Fear (the cascade of physiological phenomena triggered by an actual attack) has migrated into the unconscious, transforming into the *premonition of an event that might occur*. Anxiety is a state of anticipation regarding a potential future fear, keeping the defense system constantly on alert [281].

2.19), to amnesia (§ 2.10), to enhanced performance (§ 2.14), etc., but they do so in a somewhat chaotic manner, consistent with the traits selected by Darwinian evolution over millions of years. The same endogenous ligands likewise in a disorderly fashion occurs through the action of thought involving. In hypnosis, the endogenous ligands released either by the hypnotic state itself or by targeted commands produce the same effects, in a manner that is *more coordinated, purposeful, and focused*; this explains the high efficacy of hypnosis and especially of its commands (Figure 2). It is commonly said that the rapport resonates at a psychosomatic level [37,42], that is, it has physical effects, which is tantamount to acknowledging that thought activity (now demonstrable *via* neuroimaging) activates endogenous receptor systems. These biological concepts are of great interest to the researcher who investigates them to gain insight into the *what, where, how*, and *who* regarding hypnotic phenomenology [36,42]. The endogenous ligands plausibly implicated in the specific effects of hypnosis will be discussed below.

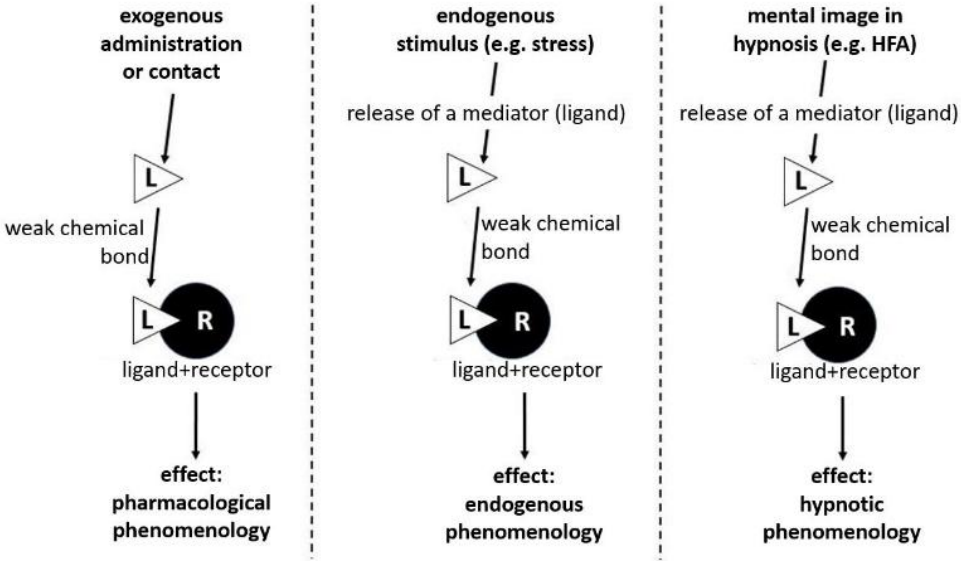


Figure 2: Receptor action. Left: an exogenous ligand (L) binds weakly to a specific site on its receptor (R) producing a conformational change that gives rise to pharmacological phenomenology. Middle: an endogenous stimulus (e.g., a mental image) triggers the release of an endogenous L which produces an endogenous phenomenology. Right: a hypnotic mental image triggers the release of an endogenous ligand, which gives rise to hypnotic phenomena, for example HFA (§ 2.8).

Hypnotic Induction

Any manual maintains that *hypnotic trance* differs from *suggestion*36 in that the former entails the critical acceptance of another person's ideas, whereas the latter calls for uncritical acceptance. But is this claim true?

36 Then, once the hypnotic state has been established, it is possible (and indeed useful in clinical, therapeutic, educational, or experimental settings) to administer suggestions often termed *commands*. These are, in fact, forms of conditioning [275] capable of operating even in the post-hypnotic phase. While the subject accepts these suggestions if they align with their principles and become an integral or even fundamental part of the hypnotic session, they do not constitute hypnosis itself.

Evidence that hypnosis is deliberately accepted by the subject has recently come from neuroimaging. Indeed, during hypnosis, brain areas closely linked to what is popularly termed *conscious freedom*37 become hyper-activated (Figure 5), while other areas are rendered silent [68]. It must be noted that this demonstration is possible only during the performance of a task (any task), not during neutral hypnosis: it is just the task that, by activating the choice model, makes it possible to highlight the deliberate acceptance of the suggestion (or hypnotic command).

The phase38 that, within a structured setting, deliberately initiates the emergence of plastic monoideism (§ 2.5) – that is, hypnosis – is termed *induction39* [273]. The term *techniques* refers to the measures sometimes implemented to achieve hypnotic induction within a structured setting40.

Induction can be slow or rapid. Slow induction (with relaxation) is characterized by increased activity in the right hemisphere compared to the left, whereas rapid induction (without relaxation) involves hyperactivity in both hemispheres (particularly the right) and the precuneus (Figure 3, left) [62]. The distinct phenomenological profile between the two types of induction (Figure 3, right) is also demonstrated by the fact that with the slow method (■) there is no increase in pulse rate (i.e., no stress), whereas with the rapid method (■) there is a transient rise in pulse rate (which is subsequently quickly overridden by the anxiolytic effect of hypnosis) [62]. In the past, only slow inductions (procedures that were lengthy and frankly tedious) were used. Today, the trend favors rapid, and sometimes ultra-rapid or instantaneous, inductions [235].

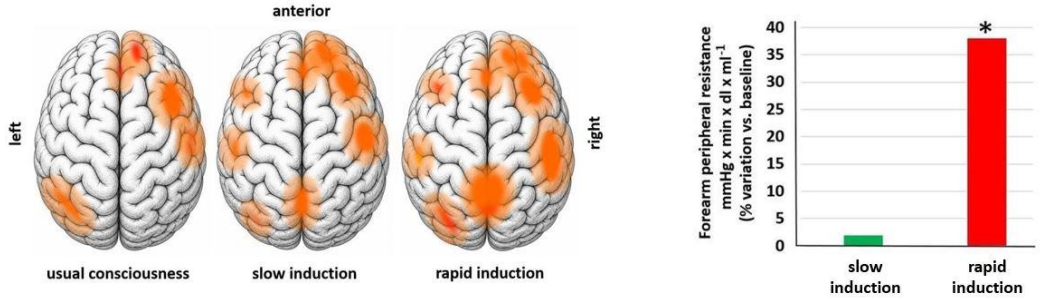


Figure 3: Left: brain imaging obtained during ordinary consciousness and during slow and rapid hypnotic induction using EEG-LORETA: during induction, particularly in *rapid*

37 Previously, in publications and lectures from years past, the authors of this paper maintained that hypnosis is *accepted consciously and voluntarily* [68]; today, they prefer to state that it is *accepted deliberately*, given that the concept of conscious freedom has been seriously challenged not only in hypnosis but in everyday life [39,40].

38 Which can also be carried out remotely [70].

39 Since the set of practices implemented in a structured setting to achieve hetero-hypnosis is referred to as *hypnotism*, it can be stated that induction is synonymous with hypnotism.

40 In reality, techniques are unnecessary except perhaps for novices or practitioners lacking empathy and often result in a waste of time that could be more productively spent managing the hypnosis itself. While treatises and manuals rightly emphasize that hypnosis is fundamentally a rapport, they often go on to devote dozens of pages to techniques; some even classify hypnosis itself as a technique [28], which is a clear contradiction. Induction does not occur in self-hypnosis [44] and is not strictly necessary even in a structured setting [31], although explicitly applying it can sometimes help save time [113-115].

***induction*, the right hemisphere and the precuneus show significant activation [62]. Right: during rapid induction, PR (an index of stress) increases significantly (* p<0.01) compared to baseline, whereas this does not occur during slow induction.**

Depth of Hypnosis

Some Schools of thought hold that the depth of hypnosis does not exist or cannot be measured, others maintain there is no need to do so [74]. Obviously, the concept of *depth* is merely a metaphor, here. Nevertheless, the use of certain methods employed in pharmacological general anesthesia to assess the depth of narcosis, such as BIS and CSI, has proven useful [162,216,295]. It must be borne in mind that working with hypnosis does not involve the *narcotized vs. awake* dichotomy, as a person under hypnosis is never asleep: their sensory system remains alert and their consciousness remains present (Table 3), albeit physiologically modified.

Plastic Monoideism and its Experimental Demonstration

The authors of this paper consider plastic (or ideoplastic) monoideism to be the trigger for hypnosis, if not hypnosis itself41.

For decades, plastic monoideism (§ 2.5) was merely hypothesized and treated as *dogma* by the Schools that adopted it, taken for granted (as implicit in the therapeutic relationship) by other schools, or deemed either unprovable or unnecessary to prove [74]. The ontological existence of plastic monoideism as a distinct phenomenon has recently been demonstrated by showing that, during a task, fMRI reveals the activation of brain areas characteristic of the hypnotic state (anterior regions, prefrontal cortex, precuneus, cerebellum) alongside the deactivation of any other areas previously involved in the task (Figure 4). The areas activated before hypnosis (■) and those activated during hypnosis (■) are completely different; they have no points in common, and the latter exclude the former. The plasticity of monoideism is evidenced by the fact that the hypnotic task is carried out exactly as programmed [72].

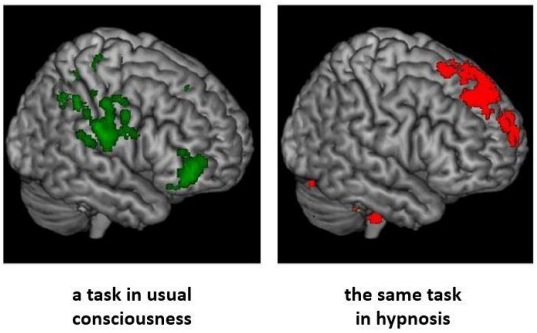


Figure 4: Demonstration of plastic monoideism using fMRI: ■ areas activated during a task out of hypnosis, ■ areas activated during the same task in hypnosis (prefrontal and posterior regions, precuneus, and cerebellum) in 20 highly hypnotizable

41 Various authors have gone to great lengths to describe and classify the unconscious in a multitude of ways, an undertaking that would be both impossible and pointless to summarize here. The reader is referred to the original sources [20,92,93,130,131,149,160].

volunteers. The areas do not overlap, because plastic monoideism excluded the areas not involved in the command [72].

Hypnotic Anxiolysis and Sedation

1) Pharmacological Background. Hypnosis, even neutral, is always accompanied by anxiolysis, which, through appropriate commands, can be intensified or progress to sedation. The anxiolysis and sedation accompanying hypnosis are entirely receptor-mediated phenomena and are due to different receptors[42]. Apart from ethanol[43], the first truly effective substances used as *anxiolytics, sedatives and narcotics*[44] were the *opioids*, which are primarily agonists of central μ (MOP) and δ (DOP) receptors [15,96,132,176,225,279]. Due to their tendency to induce tolerance, dependence, and fatal respiratory arrest, starting in 1903 opiates were partially replaced by $GABA_A$-receptor-agonists known as *barbiturates*[45] [17] which act by opening chloride channels [116]. In 1957, *chlordiazepoxide* [284] was introduced into clinical practice, and from 1963 onwards it paved the way for other much more convenient and safer $GABA_A$-ergic agonists (the *MBDZP*). The μ-receptor agonism is mainly sedative (GABA is the primary inhibitor of glutamate's excitatory effects). Agonism at μ, δ, and $GABA_A$ receptors produces fairly similar effects *in vivo*; consequently, the effect of opioids, barbiturates, and benzodiazepines shifts from anxiolytic to sedative to narcotic as the dose increases[41].

2) Hypnosis and Receptors. It is now evident that the endorphinergic, endopioid, and endozepine actions triggered by stimuli originating in the cerebral cortex entail measurable phenomena: in hypnosis, the anxiolytic and sedative effects of these endogenous systems are simply far more intense, thanks to the extremely high level of concentration on the mental image and the plastic monoideism[46] [96,127] (§ 2.5). The mental images that activate these endogenous systems and the associated ligand↔receptor interactions during hypnosis consist of simple suggestions such as *be relaxed*, *let go of your anxieties*, etc. Due to the combined agonism at μ, δ, and $GABA_A$ receptors, a significant degree of anxiolysis invariably occurs during any hypnosis session – even in the absence of chemical agonists – as a spontaneous effect that can be readily amplified through appropriate hypnotic and post-hypnotic suggestions [37].

3) Dynamics and Kinetics of Hypnotic Anxiolysis/Sedation. The anxiolytic nature of hypnosis stems from this agonism at the aforementioned receptors [36]; since no exogenous drugs are administered, this effect is attributable to the activation (well-documented in the

42 Receptor studies indicate that anxiolysis (a $GABA_{A\text{-}\alpha2}$ effect predominant in the hippocampus) [202] and sedation ($GABA_{A\text{-}\alpha1}$ agonism predominant in the thalamus and cerebellum), while often treated as synonyms by people, are both biochemical[42] and hypnotic distinct phenomena [18,129].

43 A large central depressor, the use of which dates back to at least 9000 BC.

44 Anxiolysis, sedation, and narcosis depend both on different receptors and on different doses of the same ligand, a fact that initially caused some confusion in the pharmacology of sensorium (Table 3).

45 Not exempt, although to a lesser extent, from the same drawbacks.

46 Although they never lead to sleep, which, after all, would interrupt the hypnotic trance.

literature) of endogenous opioid (endorphin / endopioid), $GABA_A$-ergic (endozepine), and adenosine systems [193,194,246]. Consequently, research into the anxiolytic and sedative properties of hypnosis will focus primarily on μ, $GABA_A$, and A_2 receptors and their corresponding endogenous agonists, although it is currently unknown which of these play the most significant role. Just as chemical receptor-mediated effects are governed by specific pharmacodynamics and pharmacokinetics [50], the same applies to the receptor-mediated effects of hypnosis; however, in the latter case, both the *pseudo-dynamics* and *pseudo-kinetics* of the effect are largely independent of the organism itself and are more amenable to control. Furthermore, just as there are specific antagonists for opioids and MBDZP (naloxone and flumazenil, respectively) that terminate the effects of those drugs, there exists the possibility – indeed, the certainty – of halting endorphin, endopioid, and endozepine effects at any time through hypnotic suggestions; this represents another receptor-mediated effect of hypnosis, with the distinction that naloxone and flumazenil have short kinetics (shorter than those of their agonists) and often require repeated administration, whereas hypnotic commands remain effective for the duration determined by the practitioner.

Local Analgesia Using the *be Analgesic* Command

1) The Mysterious Hypnotic Analgesia [71]. Hypnotic analgesia for acute pain is one of the most frequently discussed topics, particularly in the form of HFA. For anyone practicing clinical hypnosis at a high level, it has long been beyond doubt that HFA develops following a simple hypnotic command for analgesia. Until recently, it remained to be determined whether HFA was due to mere dissociation[47] or to an actual blockade of the pain signal's progression from the periphery to the brain. Both hypotheses were plausible in a narrative context, but in the scientific realm, the definitive answer could only come from brain imaging. The issue was recently resolved using fMRI [3,73]. Volunteers were subjected to a painful stimulus while inside the fMRI scanner both during ordinary consciousness and after receiving a hypnotic command not to feel pain using a Latin square design in which participants served as their own control. As shown in Figure 5 (left), the painful stimulus during ordinary consciousness triggers activation in the sensory areas (S1, S2, S3), as predicted by physiology; this demonstrates that the pain signal reaches the brain and is consequently perceived as pain. Conversely, when the painful stimulus is administered under HFA conditions (Figure 5, right), resulting in a reduction of subjective pain perception [51,52,53,56,58,59,63,120,121,124], the sensory areas remain silent. Instead, the brain activity pattern was dominated by the massive prefrontal hyper-activation characteristic of hypnosis during any given task [68]. The HFA hypnotic command persisting into the post-hypnotic state is therefore attributable not to dissociation, but to an actual blockade of the pain stimulus at some level of the centripetal sensory nervous system.

2) The Site of the Blockade of Painful Stimuli. Cardiovascular methods were used to determine whether this blockade was cortical or subcortical. The authors of this paper were well aware that systemic pain triggers an autonomic response characterized by increased central arteriolar resistance (calculated from cardiac output) and peripheral resistance

47 There is an Ego that feels pain and another Ego that, when asked, declares it does not feel it.

(calculated from segmental flow, e.g., in the forearm or leg) (Table 4) [36,51-54,58,59,63]. This reflex is involuntary and originates in lower subcortical structures [153]. By assessing peripheral resistance during painful stimulation in both the normal conscious state and under hypnotic analgesia (Figure 5, right), it is clear that the sympathetic cardiovascular response is greatly reduced, and in many cases abolished, when hypnotic analgesia is active (§ 2.8, 2.9, 2.10). The situation differs for trigeminal pain (specifically pain involving the maxillofacial complex: teeth, gums, jaws, nose, paranasal sinuses, palate, tongue, mucous membranes, and oral bones): trigeminal pain entails a reduction in peripheral resistance due to vagal activation, rather than an increase due to sympathetic activation. Controlled studies have demonstrated that the drop in peripheral resistance resulting from trigeminal pain is attenuated and, in many cases, abolished by the hypnotic analgesic command [120,121,125]. This further demonstrates that the sensory blockade abolished the autonomic response regardless of the nature of the pain and operated at a subcortical level. The reduction in the autonomic response to pain is real and prevents damage caused by increased PR in systemic pain (acute hypertension, cardiovascular damage, etc.) and by decreased PR in trigeminal pain (acute hypotension, lipothymia, syncope, etc.).

3) The Mechanisms of Hypnotic Analgesia. How is the blockade of the centripetal progression of the pain stimulus achieved in HFA? From a neurophysiological perspective, studies have highlighted the existence of *top-down* fibers with inhibitory activity originating in the pregenual cingulate, dorsolateral prefrontal, anterior insular, and anterior cingulate cortices, as well as in the hypothalamus and amygdala, capable of inhibiting nociceptive conduction in the spinal cord [193,194,212]. This explains the gap between sensory receptors and the cerebral cortex. Indeed, since these fibers originate in the brain, they respond to hypnotic suggestions just as they do to ongoing thoughts or distraction techniques; however, the response is far more effective under hypnosis. De Pascalis and De Benedittis [98] note that effects on SERP vary depending on the experimental paradigm, whereas EEG time-frequency analyses and studies on γ-band oscillations serve as markers capable of distinguishing hypnosis from distraction [98]. According to these authors, HFA involves distributed brain networks (ACC and MCC, thalamus, primary sensory cortex, dorsolateral prefrontal cortex, insula, and PAG). Functional connectivity analyses reveal enhanced interactions between the ACC, PAG, and insula during preparatory suggestion phases compared to a control condition. At the receptor level, HFA acts in every respect like local anesthetics, suggesting that it blocks sodium channels in the same way as lidocaine. This is not surprising, given that local anesthetics are known to act centrally as antagonists of nACh receptors, which are also implicated in analgesia induced by volatile anesthetics48. Cocaine49 [11,48] is also a potent local anesthetic and was, for a long time, the only one available. Cocaine acts primarily as a DAT/NET antagonist [36]. The analgesic μ-endorphin system is also spontaneously activated whenever necessary (for instance, in cases of intense acute pain), producing physiological effects identical to those of exogenous opioids used therapeutically. Experiments indicated that naloxone (a competitive antagonist of the μ-mediated effects of opioids) prevents or abolishes the morphine-like analgesic

48 Which was once erroneously considered non-specific, that is, non-receptor-mediated.

49 From this, lidocaine was obtained in 1943 and subsequently marketed in 1948. Subsequent anesthetic alkaloids, even though not of the tropane class, retained the suffix *-caine* by analogy [75].

effects of hypnosis50 [131,133,294]. Hypnosis-induced μ-receptor activation is far more effective and targeted than spontaneous activation [42,75].

4) Unfortunately, despite this incontrovertible scientific evidence, the dissociative theory, although wrong, remains the most widely cited and accepted, particularly among psychologists. Dissociation is certainly present in hypnosis [277], but it is not the cause of the analgesia.

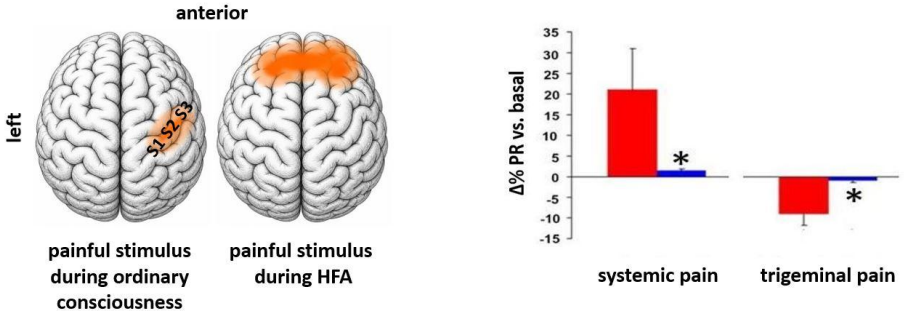


Figure 5: Left. Administration of a painful stimulus to the left hand in 20 highly hypnotizable volunteers. Under conditions of ordinary consciousness (without hypnosis), primary sensory areas are activated. If the same stimulus is administered to the same subjects during an HFA command, these areas are not activated, and the pattern is dominated by massive activation of the prefrontal areas [73]. Right. Forearm PR change relative to baseline during non-trigeminal systemic pain in the hand (induced by ice-water immersion) and during trigeminal dental pain (induced by trains of square-wave electrical pulses from a pulp tester). Non-trigeminal pain (■) produces a significant >20% increase in PR (index of stress) which is reduced to non-significant ~2% under HFA (■) [63,64,69,71]. Trigeminal pain (■) produces a significant ~9% reduction in PR, which decreases to non-significant ~1% during HFA (■) [120,121,125]. HFA thus prevents the autonomic PR response to pain regardless of the pain type, demonstrating that the blockade of the nociceptive stimulus occurs at a subcortical level [153]. *p<0.01 vs. ■.

Table 4: Effects of amines that can be also produced in hypnosis without using pharmacological agonists [48].

Agonist	recruited receptors	inotropism	chronotropism	arteriolar PR	BP	CO
adrenaline	β > α	↑↑	↑	↓↓↓	+	↑↑↑
noradrenaline	α > $β_1$	↑↑	↑	↑↑↑	↑↑↑	=
isoproterenol	$β_1$ + $β_2$	↑↑	↑↑↑↑	↓↓↓	↑	↑↑↑

50 This finding is not shared by some researchers who unsuccessfully attempted to reduce only hypnotic analgesia using naloxone (see below); according to Barber, this is because hypnotic pain control is more complex and widespread than commonly believed [15]. In particular, pharmacogenetic studies have shown that G-carrier subjects for the *Asn40Asp* polymorphism (A118G, rs1799971) of the OPRM1 gene (a splice variant of the μ-receptor gene encoding $μ_1$ opioid receptors) are less responsive to exogenous opiates/opioids and endogenous opioids [225], thereby defining a subpopulation that responds less effectively not only to endorphins but also to the opioid-mediated effects of hypnosis.

dopamine <5 μg x min^{-1} x kg^{-1}	DA_2	↑	↑	↓↓	=	↑↑
dopamine ≥12 μg x min^{-1} x kg^{-1}	DA_2 + β_1	↑	↑↑	↑↑↑	↑↑	=
dobutamine	β_2 > β_1 > α	↑	↑	↓	=	↑↑

↑ increase; ↓ riduction; = no effect; dopamine between 5 and 12 $\mu g \cdot min^{-1} \cdot kg^{-1}$ has variable effects

Local Analgesia Using Body Dysmorphism

Producing body dysmorphism51 is extremely easy during deep hypnosis, for instance using commands such as *your right hand is detached from your arm; I am taking it with me to the laboratory to work on it*. The same applies to trigeminal areas, though this requires great precision (e.g., *your mouth, tongue, palate, teeth, gums, etc., are detached from your body; I am taking them with me to the laboratory to work on them*). Consequently, any painful stimulus applied to these dysmorphic areas will fail to activate S1, S2, or S3; it will not be perceived as painful and will elicit no autonomic response (Figure 6) [69]. Dysmorphism has been employed to induce HFA under the general label of *depersonalization* [Röder et al., 2007], a much broader phenomenon that invariably accompanies hypnosis. The analgesic mechanism underlying depersonalization is identical to the one described here as *dysmorphism* to explain the lack of activation in sensory areas; however, Röder et al. link this condition to the neural mechanisms driving OBE [2,22,126], an interpretation that seems less than objective when applied to HFA and is, in any case, unnecessary to explain the phenomenon. The efficacy of dysmorphism-based analgesia is extremely high [69] (absolute in *highs*); for years, the authors of this paper have used this method exclusively in clinical and experimental settings, reserving HFA solely for educational contexts52.

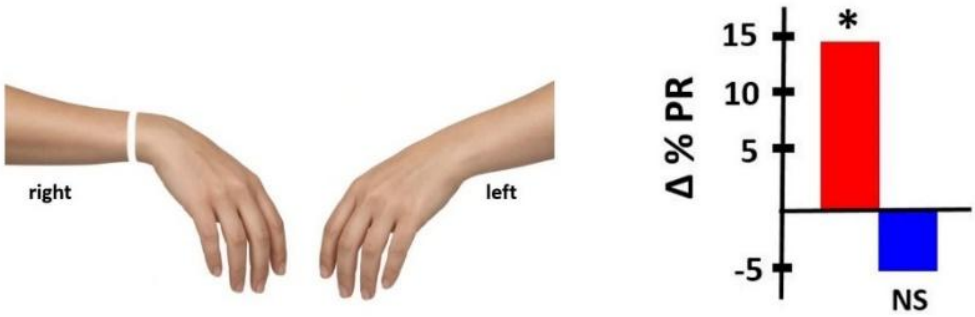


Figure 6: Body dysmorphism. Left. The participant perceives the hypnotic command that the right hand is detached from the body, so that a painful stimulus applied to the right hand cannot reach S1 S2 S3 areas. Right. In fact systemic pain (hand in melting

51 Dysmorphism has been employed to induce HFA under the general label of *depersonalization* [Röder et al., 2007], a much broader phenomenon that invariably accompanies hypnosis. The analgesic mechanism underlying depersonalization is identical to the one described here as *dysmorphism* to explain the lack of activation in sensory areas; however, Röder et al. link this condition to the neural mechanisms driving OBE [2,22,126], an interpretation that seems less than objective when applied to HFA and is, in any case, unnecessary to explain the phenomenon.

52 The technique known as *hypnopraxia* is not discussed here, as it is not of specific experimental interest [103].

ice at 0°C) produces PR increase under ordinary consciousness (■) but not during body dysmorphism (■). *p<0.01 vs. baseline values [69].

Hypnotic General Anesthesia and Paralysis

HGA53 can be easily obtained by extending HFA to the whole body (§ 2.8, 2.9), which can be done in one go, i.e. with a single command [64]. However, this is merely the first phase. In pharmacological general anesthesia for surgical purposes, the prevention of pain is only one of the required outcomes, and also necessary are pre-operative anxiolysis and sedation (using MBDZP), narcosis (using barbiturates), flaccid paralysis (using curare-like agents and necessitating intubation, the respiratory muscles being also paralyzed), and retrograde amnesia (using MBDZP) (§ 2.7). These measures aim not only to prevent surgical suffering but also to ensure immobility and protect target organs from physical and psychological stress.

HGA is achieved without drugs: anxiolysis stems from endogenous agonism at hippocampal $GABA_{A\alpha2}$ receptors, analgesia from extension of HFA (§ 2.10), flaccid paralysis *via* specific commands [49], pseudo-narcosis by creating a state of indifference that is sometimes erroneously termed *hypnotic sleep* 54 , and retrograde amnesia simply by suggesting it [64]55. The effects, including those on target organs, are exactly the same as those of pharmacological anesthesia (Figure 7, left) [16,64,237,238,241].

The mental imagery administered during the hypnotic *trance* in this instance follows the pattern *you will now fall into a very deep, pleasant sleep and will not emerge from it until I ask you to do so*. While there are no controlled comparative studies, it is generally assumed that poor chemical anesthesia – involving anxiety, pain, nightmares, premature or disturbed awakening, etc. – is more likely to occur (given the ever-present possibility of error) than poor hypnotic anesthesia.

Concerning flaccid paralysis, a key point of the HGA, any hypnotist knows it is very easy to induce it. Hypnotic paralysis was experimentally confirmed and measured (in μV) using bipolar concentric single-electrode electromyography, during hypnotic suggestions of paralysis of the striated muscles with commands such as *this part of your body is paralyzed and limp*. The resulting paralytic effect is, in most cases, total. Experimental demonstration of the procedure's efficacy was obtained by hypnotically paralyzing a muscle 56 and

53 HGA is always useful, but particularly so in burn therapy and in painful or uncomfortable diagnostic procedures, such as biopsies and endoscopies [85]. Furthermore, it offers the advantage of a conscious, communicative patient during the procedure, a highly beneficial factor when removing neoplasms from eloquent areas [88].

54 Obviously, the EEG is not that of sleep, and both sensorium and consciousnesss (Table 3) ae preferved. It may also be accompanied by profound sedation and an altered or absent perception of subjective time, and presents a physical phenomenology [282] entirely similar to the narcosis observed in pharmacology after administration of barbiturates or opiates (μ, $GABA_A$, and δ agonists) [75]. Some regard HGA as equivalent to *deep conscious sedation* (§ 2.7) [197] and limit it to minor procedures, usually performed on an outpatient basis54. Others, distrusting hypnosis, also administer drugs, though these are unnecessary.

55 Many individuals in a high-hypnotic state exhibit amnesia even without suggestion (they were once referred to as *somnambulistic*).

56 The corrugator muscle of the forehead is optimal for this experiment [49] for the simple reason that is flat and allows easy application of the electrodes, and furthermore is often chemically paralyzed with botulinum toxin in aesthetic medicine settings, and thus serves as a good point of comparison.

measuring its contractile capacity *via* electromyography under conditions of ordinary consciousness and during a hypnotic command of paralysis; the hypnotic paralysis proved as effective as the injection of 20 units of botulinum toxin (Figure 7, right) [49,154]. The generation of the mental image of hypnotic paralysis is attributable to the activation of the attentional control systems and of the precuneus [282] as well as to the hypoactivation of the ipsilateral ACC and frontal gyrus [29]. The mechanism underlying flaccid paralysis has been studied primarily in the context of *conversion disorder*57, which is considered analogous to hypnosis. Confirming this, Halligan et al. [148] demonstrated, following a hypnotic command for flaccid paralysis, selective activation of the ACC and ROFC without activation of rM1 [188]. From a receptor perspective, hypnotic flaccid paralysis is comparable to that induced pharmacologically by botulinum toxin (an SV_2 receptor agonist that blocks neuromuscular transmission), curare-like agents, and succinylcholine [100,301]; however, the mechanism potentially linking hypnotic and hysterical flaccid paralysis to these receptors has not yet been identified.

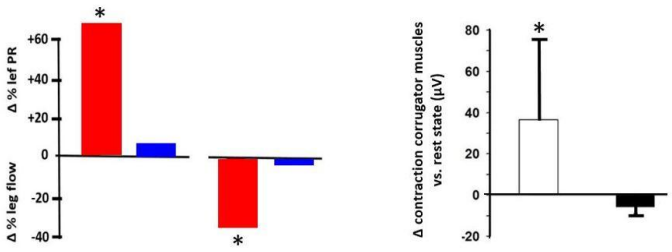


Figure 7: Left. Hemodynamic parameters recorded in usual consciousness without hypnosis (■) and during hypnotic general anesthesia (■); % variation during pain vs. basal conditions are shown [64]. Right. Effect of the injection of 20 IU of botulinum toxin per corrugator muscle (□) and of hypnotic suggestion of flaccid paralysis (■) on the tone of a striated muscle, measured via electromyography. Hypnotic suggestion proves more effective than the toxin; indeed, it is known to induce total paralysis, a phenome-non that, as demonstrated by the experiment described here, is objective rather than subjective [49].

Uncomfortable Procedures

This topic is only briefly touched upon here because this paper deals with experimental rather than clinical hypnosis58, and very few studies have addressed this subject with experimental rigor, for instance by strictly avoiding the confounding of hypnotic and pharmacological measures [122,127] and by refraining from treating hypnosis merely as a

57 fMRI studies have demonstrated that during left-hand paralysis there was no activation of the corresponding motor neurons [84] but rather an increased activity in the right hemisphere including the IFG and IPL, and an asymmetry in the connectivity of the rM1 compared to the lM1: the rM1 showed markedly higher connectivity with the precuneus and the vmPFC, a pattern not observed under ordinary conditions or during simulation [84]. It is interesting to note that in conversion paralysis the internal representation of motor intentions was not abolished (as occurs, for instance, in neglect (§ 2.17) or motor anosognosia [128,143,174]). In other words, participants engaged in preparing the movement of the left hand and recruited the rM1 during the programming phase, even though the initiation of the movement was blocked during the execution phase [84]. At a pathological level, conversion disorder is the closest imaginable equivalent to hypnosis (which is, conversely, a completely physiological state) [267].

58 Clinical hypnosis has been treated elsewhere [36,37,42].

complementary measure. Since they can readily produce anxiolysis, sedation (§ 2.7), HFA (§ 2.8, 2.9), and HGA (§ 2.10), appropriate hypnotic commands can be employed during painful or uncomfortable diagnostic or therapeutic procedures such as burn treatment [95], digestive endoscopies (including operative ones) (§ 2.16) [198-201], colonoscopies [107,198], biopsies [7,16,177,243,250], etc. in both inpatient settings (where they are far less costly than pharmacological methods) and outpatient settings (where they are better tolerated and allow for immediate return home by any means of transport, free from the residual effects of drugs on sensory perception and alertness) (Table 3). It has been demonstrated that surgical procedures both minor [122,127] and major [204,205,220-222] can be performed using only HFA or HGA + hypnotic anxiolysis/sedation. However, the hypnotists assisting surgeons or surgeon-hypnotists often prefer to supplement this with pharmacological sedation or low doses of anesthetic [291]. In the opinion of the authors of this paper based on experimental results (§ 2.8-2.10), this is not necessary, although in a clinical setting (where absolute research-level rigor is not required), hybrid procedures may sometimes make sense; for example, to save time and reassure the patient, and often the operator as well.

Chronic Pain

Although there is considerable literature regarding the use or potential use of hypnosis for chronic pain, this topic has received little experimental attention. The core issue is that it is extremely difficult to design pure, controlled experimental studies involving patients with chronic pain, as they often if not always present with co-occurring conditions that can confound the results. The experimental hypnosis discussed in this paper requires participants with specific characteristics (§ 1.4, 1.5) that are often difficult to identify in chronically ill patients. Some protocols have focused on hypnotizability rather than the effects of hypnosis itself, or have treated hypnosis as a complementary therapy; consequently, they are not relevant to this paper. A *state-of-the-art* review written by professional researchers examined perspectives supporting the use of hypnosis as a powerful technique for enhancing a patient's control over their mind and body [119]. In the context of chronic pain, hypnosis may be more effectively employed to manage the emotional resonance of pain and foster resilience, rather than attempting to control the pain itself. Such objectives are challenging to investigate experimentally with the level of rigor described here.

An exception is represented by migraine, as a recent review [33] examined controlled trials regarding migraine treatment using hypnosis (though not always as the sole approach). The review's methodological rigor is evidenced by the selection of only 9 studies out of the 1,082 identified *via* search engines, involving a total of 247 patients. Three studies showed no beneficial effects on migraine attack frequency, whereas others did, particularly in *highs*. Two studies observed a reduction in attack intensity, while one reported remission. Medication use sometimes decreased. These differences, along with others noted in the paper, may stem from the varying hypnotic suggestions employed; these ranged from enhancing internal resources, relaxation, conflict management, and ego strengthening to reducing anxiety and stress, boosting motivation, and – at times – direct symptom control. Although the interventions were highly heterogeneous in duration, number of sessions, and result, the review represents the most robust experimental evidence currently available.

The authors of the present paper have consistently achieved immediate resolution of all forms of migraine or headache in *highs* through direct suggestions of analgesia.

Hypnotic Hallucination with Enhanced Psychophysical Performance

Physical performance can be enhanced through appropriate hypnotic suggestions. Major sports teams and elite athletes typically employ a hypnotist to address this aspect. Here, *performance* encompasses muscle strength, resistance to fatigue and lactic acid accumulation, as well as precision and speed of execution.

Using hypnotic and post-hypnotic commands such as *you will be stronger* and *you will feel less fatigue* it is easy to achieve the results shown in Figure 8 and measure them in standard human physiological units. The suggestion involved the hallucinatory consumption of a highly energizing drink (which did not exist in physical reality but only in the participants' mental imagery). As shown, this resulted in an increase in both muscle strength (measured *via* dynamometer) and endurance, yielding a 71% boost in overall performance [269]. In separate experiments, the command *you will perform exceptionally well in your task* also led to a 20.5% increase in speed and precision when solving a jigsaw puzzle [18], an effect attributable to DAT-mediated dopaminergic agonism, NET-mediated noradrenergic agonism, σ_1-mediated opioid-neurosteroid agonism, and A_{2A}-mediated adenosine antagonism [75]. From a receptor-level perspective, these results resemble those obtained with cocaine [5,32,82,101,186,296], a DAT and NET antagonist with psychostimulant and energizing pharmacodynamic effects [10,32,101]. Dissociation was also observed59. The difference compared to cocaine lay in the absence of addiction and an elimination half-life of zero, rather than the several hours characteristic of chemical cocaine. Caffeine is also energizing, albeit less so than cocaine: its action relies on antagonism of the A_{2A} adenosine receptor and it functions as a central stimulant because A_{2A} receptor activation in the olfactory tubercle and striatum exerts depressant effects [155,196,239], effects that are nullified by caffeine's antagonism, thereby producing the energizing effect. Furthermore, through the inhibition of cardiac A_1 adenosine receptors, caffeine also exhibits – with lower intensity – the cardiac effects associated with cocaine [9,53,102]. Here, too, endogenous A-receptor antagonism can be observed in daily life in individuals who feel energized—either spontaneously or immediately60 after consuming coffee (an Italian-style espresso contains 80 mg [53]) or other caffeinated beverages. Clearly, endogenous A_{2A} mechanisms elicited by hypnosis are at play here. An endogenous adenosine system does indeed exist [246] and can be activated by cognitive stimuli during hypnosis; in fact, adenosine activity is often normally inhibited by the body in response to various stimuli through an A-receptor-mediated anti-adenosine effect, simply more intense during hypnosis61.

59 Cocaine also acts peripherally as a local anesthetic and centrally (especially in the mid-cingulate cortex) as a psychic dissociative agent [32].

60 This is pharmacologically impossible [70], given that the full effect of orally ingested caffeine, corresponding to the steady-state concentration, is not reached until after 3.3 half-lives, a period amounting to several hours.

61 In summary, the endogenous energizing effect with positive inotropism achieved during hypnosis may stem from: 1) hypnosis-induced inhibition of DAT and NET (a cocaine-like stimulant effect); 2) hypnosis-induced inhibition of cardiac A_1 receptors and cerebral/systemic A_{2A} receptors (a caffeine-like stimulant effect); 3) a positive inotropic effect resulting from the activation of cardiac dopaminergic DA_1 and adrenergic β_1

These clearly receptor-mediated effects of hypnosis on performance – while not pharmacodynamic, given that they rely solely on cortical action (i.e., a mental image) – are not surprising. Indeed, even outside of hypnosis, individuals facing unexpected demands can enhance their psychophysical capabilities without the use of exogenous substances, managing under emergency conditions to perform tasks that would otherwise seem impossible, such as lifting heavy weights or solving problems that exceed their usual aptitudes. These additional self-hypnotic abilities (which are far more intense in hetero-induced hypnosis) are achieved by recruiting, through a cortically initiated action, the activity of receptors that are normally unrecruited, inhibited, or underutilized; this leads to increased physical strength and psychomotor capacity, as well as a reduction in the sensation of fatigue, effectively eliminating the subjective limit [269] that manifests in daily life as thoughts such as *I can't go on* or *it's too much for me*.

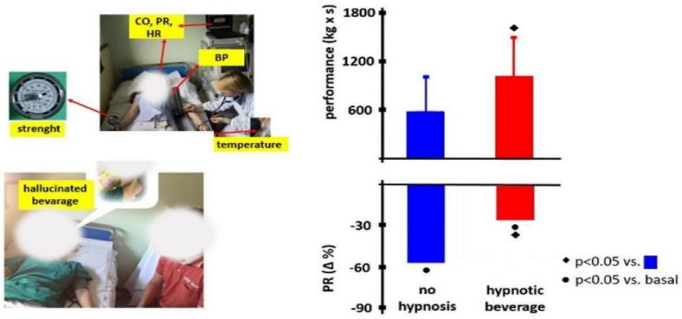


Figure 8: Isometric effort measured *via* dynamometer, involving the hallucination of consuming an energy drink. The increase in performance (in kg × s) is accompanied by an increase in heart rate (due to increased cardiac output) that is smaller than the increase observed during effort under normal waking conditions outside of hypnosis [269].

Hypnotic Hallucination of Heat and Effects on Vascular Smooth Muscle

A sensation of warmth is almost always perceived during neutral hypnosis and can be greatly intensified through appropriate commands to the point of becoming barely tolerable. It is interesting to determine whether this sensation of warmth is purely subjective (hallucinatory) or objective, that is, whether it is measurable and reproducible in an experimental setting. Unfortunately, attempting to measure temperature differences directly is unrealistic, given that they are extremely small, well below the method's margin of error 62 . The experimental challenge was overcome by measuring parameters proportional to temperature. The fundamental point of this research is that, in the absence of an external heat source, as is the case with hypnosis, the only way to raise the

receptors; and 4) an effect mediated by an endogenous digitalis-like system demonstrated by other authors [Bogrov et al., 2002] to act on digitalis glycoside receptors [23,48]. Distinguishing between these various effects requires specific, receptor-by-receptor studies, each necessitating approval from a different ethics committee; consequently, research in this area is likely to continue for years. Nevertheless, in light of the various effects observed, it can be stated that hypnotic recruitment engages specific receptors among those mentioned, depending on the type of suggestion administered [129].

62 It should be noted that the temperature defined as normal body temperature [139;293] varies within a very narrow range (between 36.93 and 37.73°C), and that skin temperature (35.01-36.93°C) is lower than core temperature (rectal 36.3-37.8, tympanic 35.8-37, urinary 35.6-37.6, oral 35.7-37.4), which decreases further in the elderly. Normothermia is defined as temperatures up to 36.8°C.

temperature of a specific body part is to increase arterial blood flow to that area. Therefore, if a subject under hypnosis perceives a rise in temperature in a specific body segment, whether spontaneously or in response to an appropriate suggestion, it is easy to determine whether that increase is physically real and measurable or merely subjective. It suffices to measure local arterial flow63 before and during the suggestion of heat: if it increases, the rise in temperature is real and measurable; if it does not, it is merely hallucinatory and subjective. Highly sensitive methods typical of cardiovascular physiology [51-56,58,59,140] make it possible to detect even minute thermal variations. A suitable experimental model involves administering a command to a group of highly hypnotizable volunteers, first that their forearm is immersed in hot water, and then that their entire body is immersed in hot water (Figure 9, left) [60]. This generates a hallucination of heat (initially local, then systemic), the effect of which can be measured in terms of arterial flow (ml x min^{-1}). When the forearm is hallucinatorily immersed in hot water, the subject perceives heat in the forearm; arteriolar resistance in the forearm decreases, while arterial flow increases correspondingly. When the heat hallucination involves the entire body, the subject perceives systemic heat; total resistance decreases while CO increases correspondingly, exactly as occurs during an actual hot bath [91] (Figure 9, middle). Since no external heat is applied, these cardiovascular effects stem entirely from the hallucination induced by the hypnotic command; the mind thus acts upon the body, much like when facial flushing occurs due to embarrassment. In this case, however, the vasodilatory effect is more intense and, crucially, can be modulated at the operator's discretion; it persists for the duration of the hypnotic phenomenon and then ceases. It is a targeted, purposeful, and controllable effect. Those familiar with vasomotor responses know that an increase in CO entails a compensatory increase in inotropism. Inotropism (Table 4), expressed by SV, indeed increases during whole-body heating (§ 2.20, 2.21), but not during isolated forearm heating, such as occurs during a hot bath [91]. Whole-body heating also affects the smooth muscle of visceral vessels (Figure 9, right). Imagining a hot water bath produces a 16% increase in mesenteric artery diameter and a 43% increase in flow velocity [270]. Conversely, portal vein diameter decreases by 25% in response to the mental imagery of body heating, counteracting64 arteriolar vasodilation and the systemic rise in CO. This may be due to the release of adenosine (§ 2.2) from the splanchnic region [155,156,157,196]. Ultimately, the result is the maintenance of pressure within the hepatic circulation (the so-called hepatic arterial buffer response) [106].

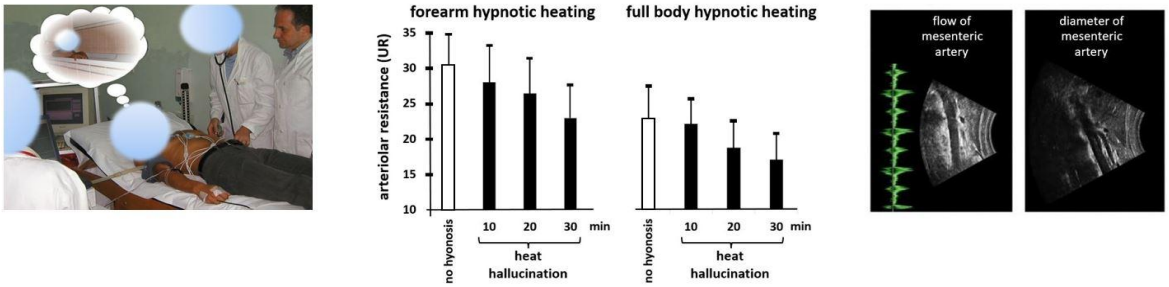


Figure 9: Left. Experimental setting for heat hallucination [60]. The participant is induced to hallucinate immersion in a tub of hot water, which is not physically present. Cardiovascular parameters are continuously monitored. Middle. PR in

63 The first measurement of this kind and for this purpose was conducted under hypnosis in the mid-1990s [55] using complex equipment (a venous-occlusion indium-gallium-in-silicone strain-gauge plethysmograph) [51-56,58,59,140]. The main challenge lies in the fact that one must already be familiar with such instruments, knowing how to use them and having employed them hundreds of times in a hemodynamics laboratory.

64 Crandall et al. [91] have indeed demonstrated a reduction in liver volume during actual (non-hypnotic) body heating.

ordinary consciousness (no hypnosis) and after 10, 20, and 30 minutes of hallucinated immersion of the forearm and the entire body in warm water. UR: units of resistance (mmHg x ml^{-1} x min x dl_{tissue}). Right. Mesenteric artery flow and diameter of a participant in the hypnotic body-warming experiment [270].

Hypnotic Effects on Visceral Smooth Muscle

Endoscopists practicing hypnosis had long observed that patients in a hypnotic *trance* appeared capable of controlling gastroduodenal peristalsis [147] and that during the procedure gastric peristalsis appeared reduced, an effect logically attributed, at the time, to hypnotic relaxation of the smooth muscle. After all, as previously noted, hypnotic suggestions can act powerfully and readily upon voluntary striated muscle (§ 2.14), involuntary striated muscles (§ 2.15), striated muscles subject to unconscious nocturnal contraction (§ 2.13), and the smooth muscles of blood vessels (§ 2.15); why not on visceral muscles? The first experimental demonstration took place at an international conference, where specific hypnotic command delivered in real-time experimentally demonstrated that it was possible to both induce and resolve antro-pyloric spasms through targeted instructions65 [198-201].

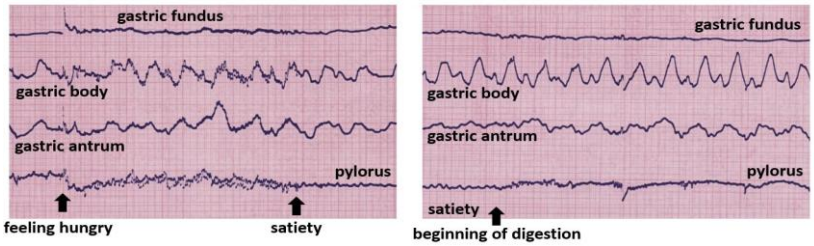
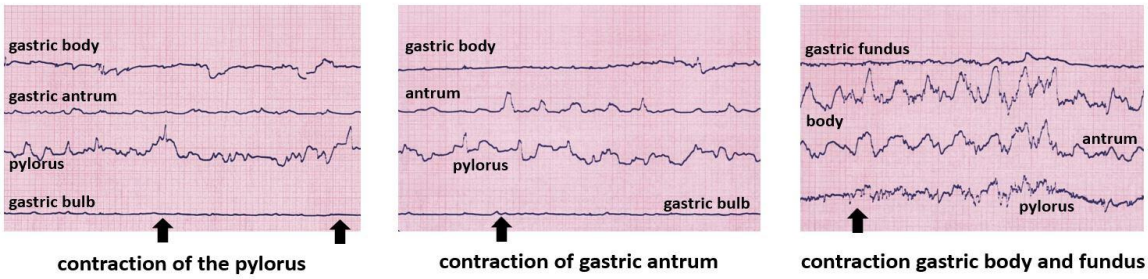


Figure 10: Left: endoscopic manometry with hypnotic simulation of fasting in 20 participants (phase II: 1-2 cycles/min with unsynchronized antral movements and pyloric contractions) and simulation of satiety (antral phase III: 3 cycles/min with synchronized mixing waves). Right: simulation of digestion showing the classic downward-directed peaks. Arrows indicate hypnotic commands [201].



65 The mental image employed, which is now known not to be strictly necessary, as a direct command can be used instead, was that of the petals of a flower opening in the morning. Since the volunteer had previously undergone a digestive endoscopy, the technique of revivification (§ 2.19) regarding the conscious sedation and local anesthesia (§ 2.10) was also used to reduce the discomfort associated with the procedure.

Figure 11: Peristaltic pulses following contraction commands at the level of the pylorus, extending to the gastric antrum, the body, and finally the fundus of the stomach. The arrows indicate the hypnotic commands [201].

The gastrointestinal tract possesses its own nervous system that regulates the basic motor and secretory functions of the stomach and intestine. The sympathetic and parasympathetic systems act merely to modulate the enteric nervous system (the former in an inhibitory manner and the latter in a stimulatory one). Under normal conscious conditions (outside of hypnosis), visceral afferents transmit information from mechano-ceptors, chemo-ceptors, and noci-ceptors to the central nervous system, where they elicit perception or trigger autonomic reflexes. The primary neurotransmitters released by enteric nerve endings include acetylcholine (which has excitatory effects, such as membrane potential depolarization leading to increased excitability), adrenaline and noradrenaline (which have inhibitory effects on intestinal smooth muscle), serotonin, dopamine, the vasoactive intestinal polypeptide, somatostatin, leuenkephalin, metenkephalin, and bombesin. The receptor mechanisms associated with these transmitters have already been outlined (§ 2.2); it is now known that the ligand↔receptor interaction responds to cortical stimuli [75], thereby providing the basis for the response to hypnotic commands. In a controlled study on the effects of hypnosis on gastroduodenal motility [201], participants (who were also given suggestions regarding fasting and satiety) placed their hands on their abdomens; the instruction was: *your hand, guided by your brain, is capable of making you perceive your intestinal movements...* This was followed by: *"Your stomach is like a fist that contracts and closes pleasantly, and then your stomach relaxes, expands, and opens like the petals of a flower"*. Continuous manometric monitoring demonstrated that, under hypnosis, the patient can perfectly simulate fasting, satiety, and digestion, and contract and expand the stomach with an almost immediate response. When asked to contract the stomach, peristalsis begins at the antro-pyloric level, approximately 5–6 cm from the pylorus (where the peristaltic impulse physiologically originates), and propagates in an oro-aboral direction (Figure 10). Separately, it has also been observed that gastric motility can be modified *via* hypnotic commands, targeting specific regions such as the *fundus*, body, *antrum*, and *pylorus* which the patient in hypnosis is able to control (Figure 11). Experimental results thus confirm that gastroduodenal motility can be modified and controlled when the subject is in a hypnotic state. PET studies have demonstrated that the prefrontal cortex and the ACC serve as the anatomical source of specific visceral symptoms arising from ideas or mental images [234]. The prefrontal cortex acts as a personal memory repository, combining the meaning and emotional weight of events with personal experience, while the ACC responds to emotionally charged ideas, memories, and various stimuli by generating a visceral response. Hypnosis acts on the ACC without altering somatosensory cortex activity [229]; this explains how a suggestion administered during hypnosis can, through mental imagery, elicit an immediate and precise visceral motility response. Today, hypnosis involving specific commands is frequently used in digestive endoscopy, either alone or in combination with mild sedation [203].

Hypnotic Neglects

All hypnotists with some experience are capable of producing[66] what are loosely referred to in the field as *negative hallucinations* [37,42,65], i.e. situations in which an element of the world goes unperceived (a body part, an object, one or more people – even selectively, such as for instance only those dressed in red – or an entire sector of the visual field). The same applies to auditory stimuli. These phenomena are, in reality, instances of *selective neglect*. Demonstrating their objective existence experimentally is no easy task.

A particularly striking example of negative hallucination is *spatial hemineglect* [21,65], in which one side of the physical world (such as *everything to the left of the nose*) ceases to be of interest to the subject[67]; it is obviously perceived visually, yet it does not enter consciousness. If asked, the subject will state in perfect good faith that they do not see it. The premise is that spatial attention can be directed by specific endogenous cues [223,224]. By inducing, for instance, left-sided neglect, the hypnotist can *appear and disappear* from the participant's field of attention simply by changing sides in what is known as the *now you see me, now you don't* experiment (the participant sees the hypnotist, of course, but takes no interest in them). To demonstrate hemineglect, one can use a system consisting of a screen where an algorithm causes a light point to appear at unpredictable intervals to the right or left of a central cross; a button available to the participant (who keeps their gaze fixed on the central cross) is used to signal perception in the right or left periphery[68]. If, for instance, a command such as *the left side of the world does not interest you*[69] is given during hypnosis or in a post-hypnotic state, light points originating from the left are perceived a few ms later than those from the right; this indicates that directing visuospatial attention toward the neglected side results in a slower reaction [226]. The same phenomenon occurs in reverse with right-sided hemineglect. Hemineglect can thus be experimentally demonstrated and measured in terms of reaction-time delays (145 vs. 79 ms, $p<0.02$) (Figure 18). In cases of complete hemineglect (easily induced in *highs*), the failure to perceive one side of the world is absolute – as if that side did not exist – because the lack of interest driving the neglect is total. This confirms that participants allocate their visuospatial attention along a gradient [164]. It is essential that these results, obtained at the University of Padua's Laboratory of Experimental Hypnosis, be replicated using neuroimaging techniques, something that, to date, has not occurred. Consequently, to the best of the present paper authors' knowledge, the mechanisms underlying hypnotic hemineglect remain unknown. An experiment from the late 1980s involving carotid injection of barbiturates (the Wada test [283] conducted, moreover, on epileptic patients) appears to point toward an extinction-type response [192], but in reality, nothing more is known.

Another interesting form of neglect is *hypnotic alexia*, concerning written language. These experiments, designed to demonstrate and measure the neglect for written language may seem simple when described here, they are actually highly complex and require a large, trained team. Even creating the conceptual model is challenging; Figure 12 shows the experimental model for alexia as an example. Furthermore, reaction time measurements

66 And they usually do so in an educational or demonstrative context.

67 This is a well-known condition in neurology, usually caused by a neoplasm, ischemia, or physical damage to the brain—typically the right hemisphere, resulting in left hemineglect [189].

68 The protocol is somewhat more complex; for details, please refer to the original source [226].

69 Left hemineglect faithfully reproduces the pathological condition described above, but the same procedure can be repeated with similar results to induce right hemineglect.

require specialized equipment – often custom-built – are difficult and prone to error, and must be repeated several times. The Stroop effect70 has been used to demonstrate this neglect. Under the hypnotic command *you have lost the metaphor of language*, words are stripped of their linguistic meaning and appear as non-verbal symbols; consequently, they produce little to no word-color incongruity. The existence of a neglect for the written word (now known as) is demonstrated by a reduction in the Stroop effect, measured as the change (Δ) in response time (in ms) to the visual stimulus (-34%, p=0.03) [61] (Figure 13).

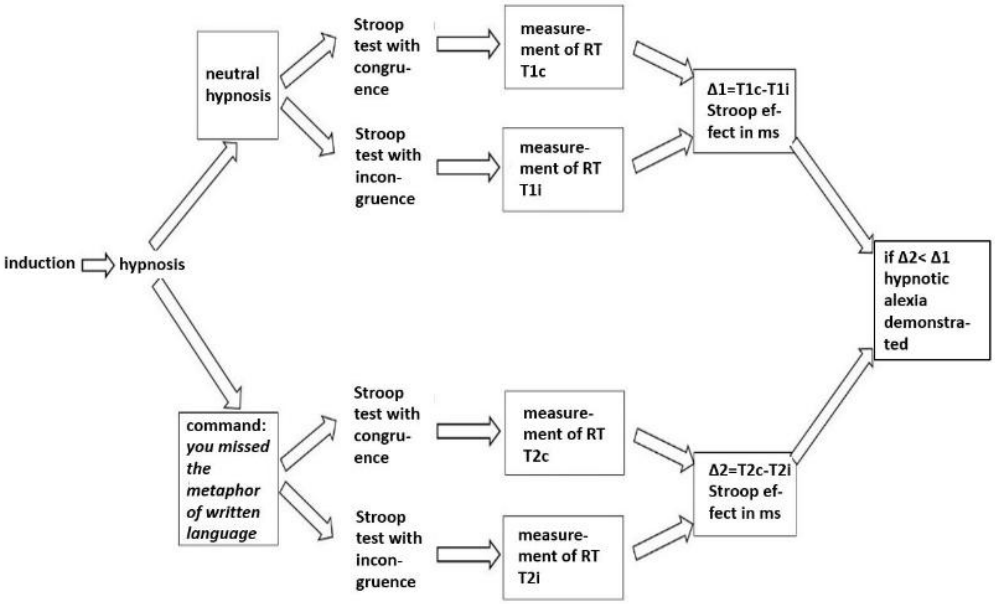


Figure 12: Mental model of the experiment demonstrating the neglect known as *hypnotic alexia*.

Using a similar procedure and the command *you have lost your sense of rhythm*, researchers demonstrated a form of neglect known as *hypnotic amusia*71 [125]. In this experiment, the participant hears a series of *beeps* through headphones; when a different signal (a prolonged *beeeeep*) is introduced, their EEG records a discrepancy known as *mismatch negativity* (an auditory event-related potential widely distributed across the scalp, with greater amplitude in the right frontal areas [4,209]), measured as a change (Δ) in signal amplitude (in μV). Mismatch negativity decreases on average from −8.2 ± 2.2 μV to −5.4 ± 1.1 μV (−20%, $p<0.05$) when the sense of rhythm has been abolished by the hypnotic command.

70 In the Stroop test, colored words denoting colors (RED, GREEN, YELLOW, BLUE) are presented to the participant, who must select the button corresponding to the color; if the word is written in its own color (e.g., RED), it is termed *congruent*, whereas if it is written in a different color (e.g., GREEN), it is termed *incongruent*. The time (measured in ms) required to select the color is longer in cases of incongruence, and the difference compared to the congruent condition is known as the *Stroop effect*.

71 A pathological form of amusia, commonly known as *temporal amusia* or popularly referred to as *beat deafness*, does indeed exist and affects 1.5% of people to varying degrees of severity [214,215].

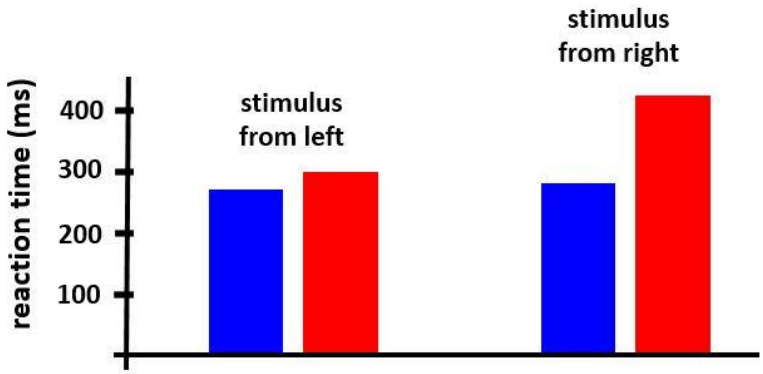


Figure 13: Right-sided hemineglect induced by hypnotic suggestion. When a visual stimulus originates from the right, its perception is slower under hypnosis (■) compared to usual consciousness (■). When the stimulus originates from the left, there is no difference between the two conditions [226].

Phantom Limb

This topic would have been of purely narrative interest and would not have found a place in this paper on Experimental Hypnosis, but a recent review [244] re-examined it by introducing an analysis of experimental methods. The authors state that the therapeutic modality most frequently used to treat phantom limb pain is *mirror* therapy72 [232], followed by *virtual reality* and *augmented reality*. Auditory feedback, neurofeedback, thermal biofeedback, and illusory touch have also proven useful; these are procedures closely linked to medical technology that border on hypnosis.

The authors conclude that phantom limb pain *"is a complex condition involving physiological, psychological, and social factors"* in addition to pharmacological ones. It is plausible that a hypnotic hallucination would render Ramachandran's mirror box setup [232] useless, even though such an experiment has never been attempted.

Hypnotic Regression and Revivification

It has long been known that *age revivification* is possible [141,256,257], whether spontaneously [135] or within a therapeutic context [289]. In an educational or demonstrative setting, it is relatively easy to lead a participant to relive events, experiences, thoughts, and sensations from their personal life, even from the distant past [287]. In short, it is possible to induce age revivification during deep hypnosis and directly observe the associated phenomena (for instance, if regressed to childhood, the subject adopts childlike facial expressions, asks for milk, looks for their mother, cries, etc.). This applies to the narrative level.

72 A method that employs a mirror device capable of making the patient believe that their amputated limb still exists and can be moved. The technique is based on the theory that phantom limb pain stems from an altered body schema and the futile attempt to contract muscles that are no longer present. The *mirror device* creates the illusion that the patient can contract these muscles, whereupon the pain caused by the impossible contraction disappears [232]. Although this has never been attempted, the mirror device could be replaced by a hypnotic hallucination (§ 2.14, 2.15, 2.20) or by a simple body dysmorphism (§ 2.9).

However, demonstrating that this actually occurs – that the revivification is real (rather than a mere subjective experience) and that the subject feels and actually *is there and then*, rather than *here and now* – is a different matter.

In age regression, a subject is led through hypnotic suggestion to relive moments from their autobiographical memory, as well as moments that had been removed from consciousness and relegated to the Unconscious73 [160]. Regression and revivification are sometimes confused. While hypnotic revivification (age assumption adopting the experiences, behaviors, and personality of the past) does indeed involve age regression (recalling the past while retaining one's present personality), it also requires hypermnesia [236] with enhanced powers of recall and memory fixation, an increased, fluid, and orderly flow of recalled experiences, and a certain degree (potentially an intense one) of dissociation [42,277]. For instance, a person undergoing hypnotic revivification of his/her childhood thinks and behaves like a child, while also being convinced (in a state of dissociation) that he/she *is a child* [142]. The very complex protocol used for demonstrating hypnotic revivification is shown in Figure 14.

A child's personality differs from an adult's, and projective tests yield different responses depending on the subject's age: adults tend to provide more *global responses*, whereas children provide more *detail responses*. Consequently, a projective test can serve as a valid objective measure in age-revivification studies [195], provided that the frequency of global vs. detail responses is compared using an intra-subject Latin square design and quantified by measuring both response types. Under these conditions, the test can be used with subjects unfamiliar with the instrument to assess baseline personality outside of hypnosis (based on chronological age) and to observe whether during age revivification (e.g., to age 6) there is a shift toward more frequent detail responses and less frequent global responses (Figure 15, left panels). If this shift occurs, it demonstrates that adult subjects undergoing childhood revivification exhibit a child-like personality, thereby confirming the reality of the revivification process.

Following pioneering experimental attempts [13,14,135,136,168,263], this approach was implemented in a study conducted at the University of Padua; participants undergoing revivification actually showed an increase in detail responses and a decrease in global responses, i.e. a pattern consistent with childhood (Figure 21, left panels) [142,245].

Further confirmation came from intelligence tests. Under identical conditions – and conditions are identical when each participant serves as their own control – a child revivifying participant possesses lower intelligence than an adult. Measuring intelligence *via* the Raven test for adults at both the chronological age and the revivified age revealed lower intelligence during revivification (Figure 15, right panels). The adult subjects undergoing revivification were thus *truly children* in this respect as well [142], thereby confirming the reality of the revivification74 [142].

73 In this paper the reference is not to any particular Unconscious among those theorized by the many psychoanalysts who have addressed the subject but simply the part of the mind inaccessible to consciousness [20,71,113,160] (§ 2.21).

74 Revivification can serve for instance to rapidly retrieve repressed memories and traumas. Demonstrating that it is a genuine, measurable phenomenon grounded in science has paved the way for its application in other areas, such as experimental research, forensic practice (with all the associated complexities [272]), and

Furthermore, when taking Raven's Progressive Matrices test for adults, subjects in an ordinary state of consciousness corresponding to their chronological age exhibited a stress response (PR +6.4%, $p<0.05$) that was not present (-1%, non-significant variation) under conditions of revivification. In fact, subjects in a state of revivification experienced the Raven's test as a game, and this playful aspect is incompatible with stress.

Even the alleged reliving of past lives (now more accurately termed *regression to an unreal time*) has been the subject of some experimental study. Curiously, the two studies that came closest to meeting scientific standards were conducted on behalf of national television broadcasters (one Korean, one Italian), and video recordings of them exist. It goes without saying that these rigorously conducted investigations led to the conclusion that it is easy to manipulate a participant into adopting a past personality [171]; indeed, often no specific prompting is required, as the subject is capable of spontaneously constructing a past identity (usually one of some distinction). Gonella [144] notes that during hypnotic *trance* the imagination can break free and give rise to the most extraordinary fantasies; consequently, a subject's creativity may shift into a retrograde or anterograde *unreal time* [288], even extending to alleged memories of encounters with extraterrestrials [144]. Unfortunately, the internet is rife with accounts of such unreal regressions, which people tend to believe, and the topic is often treated superficially; for instance, it is rarely specified whether these memories are articulated during a state of *waking trance* or a so-called s*omnambulistic trance*75. The formation of false memories and false beliefs under hypnosis is well documented [208] and is clearly mediated by the k-opioid receptor. Indeed, experiences of revivification occur (albeit in a far less coordinated and much more bizarre manner than in hypnosis) even outside of a hypnotic context following the administration of KOP agonists, typically psychedelics such as salvinorin A or ibogaine76 [94,183].

Hypnotic age revivification (real or unreal) is therefore a KOP phenomenon suggesting the existence of a cortically controlled endoKOPergic system, one that has never been experimentally demonstrated given the practical impossibility of conducting research with psychedelics due to current legal restrictions [75].

criminal investigation [41]; it also offers a practical method for recovering memories that have slipped into the Unconscious [87] or locating lost objects whose whereabouts have been forgotten.

75 An individual entering a "waking trance" maintains a strong connection to the here and now; consequently, any fantasizing occurs while retaining awareness of the narrative, even when accompanied by vivid mental imagery, and the person remembers the events and contexts they memorized, imagined, or interpreted after emerging from the trance. In contrast, a subject in a so-called "somnambulistic" hypnotic state drifts in a condition detached from time and space, where critical judgment is moderated and serves the new context emerging within their mental representation. In an ordinary state of consciousness, the somnambulistic subject is invariably unable to recall the hypnotic experience they underwent. The amnesia associated with somnambulistic hypnosis is always a failure of recall rather than of encoding; thus, all the stored memory material would be available and retrievable if the patient were returned to a somnambulistic hypnotic trance [144].

76 The k-stimulation also elicits a combination of ego expansion [81], OBE (including autoscopic ones) and a sense of divination; these experiences can be induced at will by the operator during hypnosis, whereas with the chemical ligand, they occur unpredictably, depending on the context and the subject's personality [36].

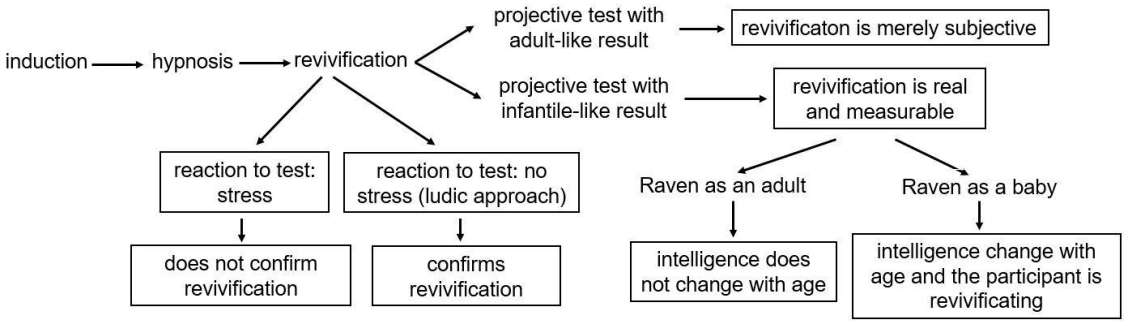


Figure 14: Study protocol implemented for the experimental demonstration of hypnotic revivification [213]. The childhood personality was assessed using a projective test and Raven's matrices. The cardiovascular reflex response to the Raven test, acting as a stressor, was also investigated [142].

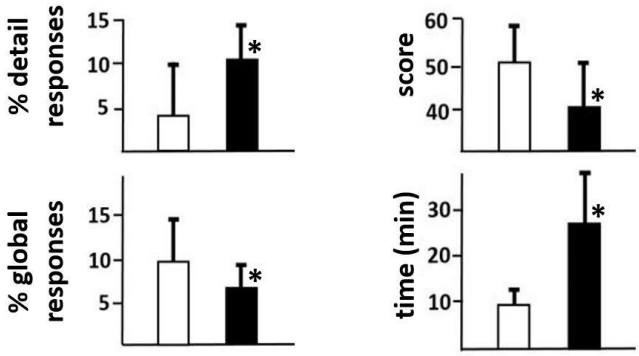


Figure 15: Left. Demonstration and measurement of hypnotic revivification [142]. Compared to ordinary consciousness (□), the subject undergoing hypnotic revivification (■) shows a higher frequency of detail responses and a lower frequency of global responses on the projective test, indicative of a childlike personality. Right. On the Raven's Progressive Matrices test for adults (right panels), the subject achieves a lower score and takes longer to solve the problems, confirming lower intelligence typical of childlike personality. *p<0.01 vs. □.

The Experimental Demonstration of Hallucinations

Hypnotists know how easy it is to produce hypnotic hallucinations (§ 2.4) that, for the subject, possess the quality of absolute reality. It is more difficult to demonstrate that these hallucinations are real – that they are not merely subjective experiences – and that they have consequences at an experimental level and are measurable [42]. Evidence that hallucinations are real is already implicit in several preceding sections of this paper. The hypnotic sensation of heat (§ 2.15), enhanced psychophysical performance (§ 2.14), dysmorphism (§ 2.9), the digestion of a non-existent meal (§ 2.16), and revivification (§ 2.19) are hallucinations that not only hold the quality of reality for the participant but also produce physical effects that can be demonstrated and measured in units typical of human physiology. To round out this topic, a more complex situational hypnotic hallucination of paradigmatic significance is presented here. In one experiment, a bloodletting procedure was hallucinated [55,57] to determine whether the hemodynamic changes observed during blood donation (which serves as an experimental model of acute hemorrhage) should be

attributed to the actual physical withdrawal of blood or to the experience of the donation itself77. Can a hallucination be used to resolve an outstanding question in physiology? When subjects lose 300 ml of blood, they exhibit a reflex sympathetic reaction (specifically tachycardia and vasoconstriction) that overrides the drop in blood pressure that would otherwise result from the blood loss. For decades, the question remained whether this sympathetic *alarm response* stemmed purely from hemodynamic factors (the loss of blood itself) or from the experience of the blood draw (which is inherently stressful).

Individuals who had never donated blood first underwent an actual 300 ml blood draw as a voluntary donation (Figure 16, left). On a separate occasion, the same individuals underwent a hallucinated blood draw under hypnosis, during which they experienced the sensation of donating blood, but suffered no actual blood loss. In reality, there was no needle, collection set, or blood bag, except in the subjects' minds (Figure 22, right). Hemodynamic parameters were continuously monitored. Thus, actual *bloodletting involving blood loss* and the *hallucinatory version without blood loss* elicited the same hemodynamic response, with a reflex vasoconstriction that was virtually identical in both experimental settings (Figure 16, right). These results align with the observation that when a normal subject moves from a lying to a standing position there is no increase in peripheral resistance (even though 300-500 ml of blood shifts abruptly due to gravity from the central circulation to the peripheral capacitance vessels) because the experience of changing posture involves no stress. Consequently, this answers a long-standing question among physiologists: the response to blood loss is neither physical (hydraulic) nor chemical, but entirely psychological, so much so that it can be triggered by a mere hallucination in the absence of any actual reduction in circulating blood volume. At the same time, the hallucination of a complex situation was demonstrated to be real and measurable.

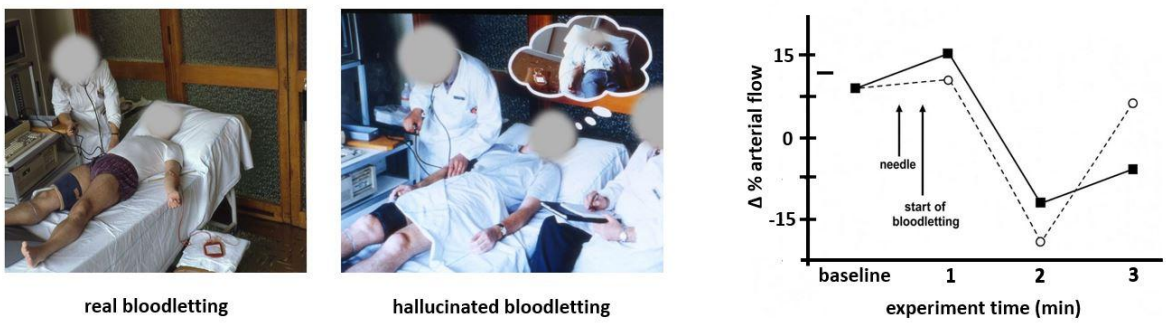


Figure 16: Left. Experimental setting for demonstrating the hypnotic hallucination of bloodletting. On the left, the subject undergoes the withdrawal of 300 ml of blood; on the right, the subject hallucinates the bloodletting while under deep hypnosis. Hemodynamic changes are monitored in both conditions. The minimum critical mass for this experiment is three researchers [55,57]. Right. Hemodynamic effects of actual bloodletting (■) and a hallucination of bloodletting (○), which produce equal vasoconstriction in the leg.

77 This physiological question remained unresolved until the experiment described here, and, frankly, it is difficult to see how it could have been clarified other than through experimental hypnosis.

The Experimental Demonstration of the Unconscious

An Unconscious (i.e., a part of the mind inaccessible to consciousness) was first vaguely hypothesized by Arthur Schopenhauer (1788-1860), subsequently formalized by psychoanalysis [130,131,160], and later summarized in various historical reviews [109,266]. However, no one had ever proven its existence. The Unconscious as an ontological reality [61,66] has recently been experimentally demonstrated at the University of Padua using indirect methods (that is, through its effects) employing hypnosis as a tool [55,63]. The chapters discussed above have highlighted various responses that can only be described as unconscious.

During hypnotic body warming induced by hallucinating a hot tub bathing (§ 2.15), the participant is unaware that physical warming [91] increases SV (+28%); even if they were aware of this, they would be unable to increase it voluntarily and consciously. The increase in SV during actual warming (Figure 17) is an autonomic event driven by the temperature effect; conversely, the increase observed during hallucinatory warming in the absence of external heat application (§ 2.15) [60] is a phenomenon driven solely by the mental image [44-47] of warming and is, therefore, a completely unconscious phenomenon. The existence of the Unconscious is thus demonstrated [66].

Also in the context of body warming simulating a warm tub bathing [91], a 59% increase in the diameter of the visceral arteries was observed, along with a mirroring trend in the portal vein (§ 2.15) [270]. The setup is that outlined in Figure 25. Once again, the participants are unaware that physical warming causes dilation of the mesenteric artery; even if they were aware of this, they would be unable to induce it voluntarily and consciously, whereas a mental image can achieve it. The existence of the Unconscious is thus demonstrated once more [66]. Furthermore, the drop in portal vein blood flow during warming is a phenomenon virtually unknown even to physiologists, yet the hallucinatory mental image of heat succeeded in producing it; it is, therefore, a completely unconscious phenomenon. Not only that, but, being independent of the consciousness of both the participant and the experimenter, it constitutes a sort of *double-blind unconscious experiment* [270].

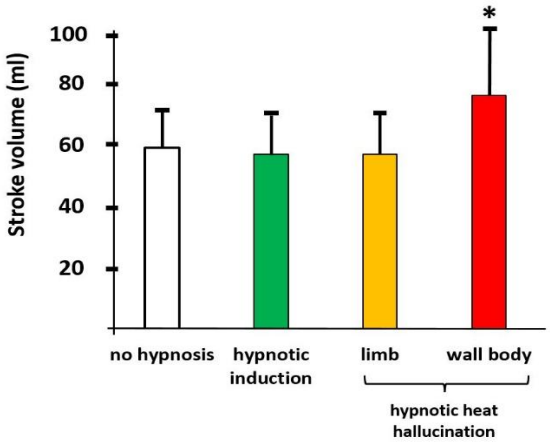


Figure 17: SV under baseline conditions without hypnosis (□), during hypnotic induction (■), and during hypnotic suggestion of a limb in warm water (■) and the

whole body in warm water (■). *p<0.01 vs. no hypnosis. Other differences are not significant [60]. The increase in SV due to body warming is an unconscious event [66].

Through bloodletting – an experimental model of acute hemorrhage feasible in the laboratory (§ 2.15) – it has been demonstrated that an acute loss of blood that is merely hallucinated (though real to the subject within their subjective world) is also real in the physical world, insofar as it produces reflex vasoconstriction resulting from the formation of a mental image from the plasticity of a monoideism.

In another experiment cited above, the one involving hypnotic alexia (§ 2.17), the existence of the Unconscious was demonstrated using RT to visual stimuli as an indicator [61]. As will be recalled, the sequence of experimental events was: hypnotic induction → suggestion of alexia → mental visualization of the alexia becoming *plastic* → Stroop task → measurement and comparison of any variations in RT. The theoretical premise of this model was that 1) cognitive processes can be controlled either unconsciously or voluntarily, that 2) involuntarily activated processes (triggered unconsciously) cannot easily be interrupted, and that 3) words are processed at an unconscious level [184]. The principle postulated by Stroop is that reading color names unconsciously interferes with the color in which the word is written, thereby reducing responsiveness and slowing down word identification in incongruent conditions. Indeed, in cases of incongruence, RT were 120 ms longer than in the congruent condition (i.e., the Stroop effect was 120 ms); however, following the suggestion of hypnotic alexia, the Stroop effect was halved [61]. The detection of a significant interaction between suggestion, congruence, and hypnotizability ($p<0.04$) confirmed that hypnosis was indeed the cause of the hypnotic alexia. Since no conscious or voluntary control is possible within this RT interval, once hypnotic alexia characterized by the loss of word meaning was achieved, an unconscious component must have come into play: the mental image of hypnotic alexia evidently generated an unconscious neglect of written language, leading to greater unconscious congruency in cases where colors conflicted with the words denoting those very colors. This once again demonstrated the existence of the Unconscious [66].

A similar situation arose in the experiment [125] concerning hypnotic amusia (§ 2.17). Briefly, after inducing neglect for rhythm following the sequence of hypnotic induction → suggestion of amusia → mental visualization of the amusia taking effect → presentation of deviant stimuli → measurement of any variations in the mismatch response, the amplitude of the mismatch negativity (the response typically following an anomalous signal within a series of identical ones) decreased. Clearly, this response to the mental image of hypnotic amusia must be unconscious in nature, as there is no way to consciously or voluntarily control EEG traces (particularly within the ~100 ms stimulus time window, which is well below the threshold of conscious perception). This once again demonstrates the existence of the Unconscious [66].

In the experiment [226] regarding hemineglect (§ 2.17), the sequence of experimental events was: hypnotic induction → suggestion of hemineglect → formation of a mental image of hemineglect → presentation of lateral visual stimuli → measurement of any variations in RT. Once again, this response could only be unconscious in nature, given that it is impossible to control RT consciously or voluntarily within this timeframe. Naturally, this was a subliminal response (falling within the realm of psychodynamics) rather than an

automatic response resulting from a brain lesion (a matter for clinical neurology), as there was no organic lesion in the experimental context based on hypnotic suggestion of neglect. Consistent with observations reported by other authors in pathological conditions, this phenomenon stems from an unconscious spatial attraction that draws attention away from the ipsilateral side and strongly attracts it toward the contralateral side [164,185]. Neglect is, therefore, simply an unconscious shift of attention *from left to right* or *from right to left* [226]. All the aforementioned results confirm the existence of the Unconscious [66].

As highlighted above (§ 2.9), achieving analgesia and even surgical anesthesia (§ 2.10) is surprisingly simple with hypnosis. The best method involves suggesting direct mental imagery (§ 2.8) or dysmorphism (§ 2.9) that leads to insensitivity to pain-inducing stimuli. The sequence is as follows: hypnotic induction → suggestion of HFA or dysmorphism → mental imagery of HFA (which can be extended to the entire body, causing it to take on a plastic-like consistency) → administration of a painful stimulus → imaging of sensory brain areas + measurement of pain perception, pain tolerance, and any hemodynamic reflex response. Non-trigeminal (peripheral) pain is associated with increased sympathetic discharge and a rise in PR, whereas trigeminal pain is associated with a reduction in PR [63,118,119]. Knowledge of this hemodynamic response is not part of the general public's understanding, being instead the province of a select group of physiologists, anesthesiologists, and cardiologists. Nevertheless, when HFA was suggested, the cardiovascular response to pain was consistently inhibited, resulting in a smaller PR increase following non-trigeminal pain and a smaller PR reduction following trigeminal pain (§ 2.8). Since the participants were unaware of the difference between the cardiovascular consequences of the two types of pain, this differential response to the mental imagery of HFA and HGA can only be unconscious in nature, thereby demonstrating the existence of the Unconscious [66].

Hypnotic age revivification (§ 2.19) [142] following the model hypnotic induction → revivification suggestion → transformation of the mental image into a *plastic* form → quantification of any variations in projective tests (for age-specific personality) and Raven tests (for age-specific intelligence) proved illuminating even at the protocol stage. Indeed, the projective test administered during the revivified age revealed a childlike personality; the Raven score for adults decreased, while the time required to complete the test increased. Ordinary individuals are unable to control their responses to projective or intelligence tests while simulating a younger age (a skill that might perhaps belong to an expert psychologist). However, what truly demonstrates the existence of the Unconscious is the cardiovascular response to the Raven test, viewed as a stressor. Under baseline conditions, the administration of Raven's matrices was accompanied as expected by a significant increase in PR and a reduction in SV due to a reflex drop in afterload; yet, when the test was administered during hypnotic childhood revivification, no variation in these cardiovascular parameters was observed. This was because the playful approach typical of childhood stripped the Raven test of its stress-inducing effect, thereby reducing its impact on sympathetic outflow. These objective variations in cardiovascular response, which are obviously involuntary and cannot be simulated, confirm the Unconscious exists [66] as has long been stated; furthermore, its effects are physical and measurable in the units of human physiology. The Unconscious revealed by experimental data eludes all conscious or voluntary control, it is blind and totipotent, can manifest with all the characteristics of a physiological agent (as seen in psychosomatic disorders), and can be demonstrated experimentally using

instruments and devices typical of Galilean sciences, such as physiology and cardiology. Most importantly, it must not be confused with an automatic neurovegetative response, as it is evoked by a mental image (rather than a simple reflex) and operates through the higher function of plastic monoideism.

CONCLUSIONS

Approaching problems through a narrative framework is often effective; indeed, from an anthropological perspective, this is precisely what *Homo sapiens* does in every daily activity: an approach no one questions. It is therefore not surprising that the various narratives surrounding hypnosis have consistently been accepted as valid, even when they contradicted one another, or were later proven demonstrably incorrect. At a certain point in history, however, a segment of society (namely, the scientific community) determined it was necessary to bring clarity by distinguishing through science subjective narratives from objective reality.

Science arrived late to the field of hypnosis, so it is only natural that it has struggled to establish itself as the *definitive truth*. Over the decades, a multitude of overlapping interpretations have accumulated; stripping away these layers can be difficult, and at times unsettling. The only way forward is through experimentation, relying on results that have been rigorously confirmed and reconfirmed, as Galileo taught, and ensuring these findings permeate both the professional sphere and the general public. This process strengthens certain concepts while refuting others, ultimately leading to greater clarity. To achieve this, everything must be open to questioning.

The contributors to this paper have dedicated significant portions of their lives to this scientific research, and a part of their key findings are summarized here. Today, it can be affirmed that many of the insights held by the masters of the past, passed down through tradition, have proven to be accurate. For instance, hypnosis is a real phenomenon, is a distinct state, can be intentionally induced, relies on the emergence of plastic monoideism, requires the subject's deliberate acceptance, and manifests in varying degrees of depth. Furthermore, it is confirmed that hypnosis, when properly conducted, can produce both psychological effects (such as anxiolysis, sedation, age revivification, hallucinations, neglect, etc.) and physical effects (analgesia, anesthesia, paralysis, the control of blood vessels and visceral muscles, etc.). All of this is now scientifically established, whereas other aspects, such as whether hypnosis constitutes a modified state of consciousness or the existence and nature of the rapport, still await confirmation.

Moreover, the use of hypnosis as a research tool has enabled the experimental demonstration of the Unconscious, thereby shifting it from the realm of narrative-based disciplines to that of empirical science.

Much remains to be confirmed or refuted, and it is highly desirable that more scholars engage in experimental research in this field: a challenging prospect, given that, while hypnosis itself is a niche discipline, experimental hypnosis is even more so.

Table 1: Acronyms Used in the Text.

ACC	anterior cingulate cortex
APA	American Psychological Association
ART	Artigianelli Echosystem Institute
BIS	bispectral index
BP	arterial blood pressure
c.c.	Codice Civile Italiano
CO	cardiac output
CSI	cerebral state index
D.L.	Decreto Legge
DA	dopaminergic
DACC	dorsal anterior cingulate cortex
DAT	dopamine active transporter
dlPFC	dorso-lateral prefrontal cortex
DMN	default mode network
DOP	central δ opioid receptor(s)
EC	European Community
ECG	electrocardiogram(s), electrocardiographic
EEG	electroencephalogram(s), electroencephalographic
EU	European Union
fMRI	functional magnetic resonance imaging
GABA	γ-gamma-hydroxybutyric acid
GDPR	General Data Protection Regulation
HF	high-frequency
HFA	hypnotic focused anesthesia
HGA	hypnotic general anesthesia
highs	subjects highly susceptible to hypnosis
HRV	heart rate variability
IASP	International Association for the Study of Pain
IFG	inferior frontal gyrus
IPL	inferior parietal lobule
L	ligand
L.	Legge
LF	low-frequency
lM1	left motor cortex
LORETA	low-resolution brain electromagnetic tomography
lows	subjects not very susceptible to hypnosis
MBZDP	modern benzodiazepine(s)
MCC	medial cingulate cortex
M.D.	medical doctor
MOP	central μ opioid receptor(s)
mPCC	medial prefrontal cingulate cortex
mPFC	medial prefrontal cortex
NET	norepinephrine transporter
PAG	periaqueductal gray

PET	positron-emission tomography
Ph.D.	post-doctoral Doctor of Philosophy
RC	responsabilità civile
rM1	right motor cortex
ROFC	right orbito-frontal cortex
R-R	interval between two peaks of the rapid ventricular complex on the ECG
SERP	somatosensory evoked potentials
USA	United States of America

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