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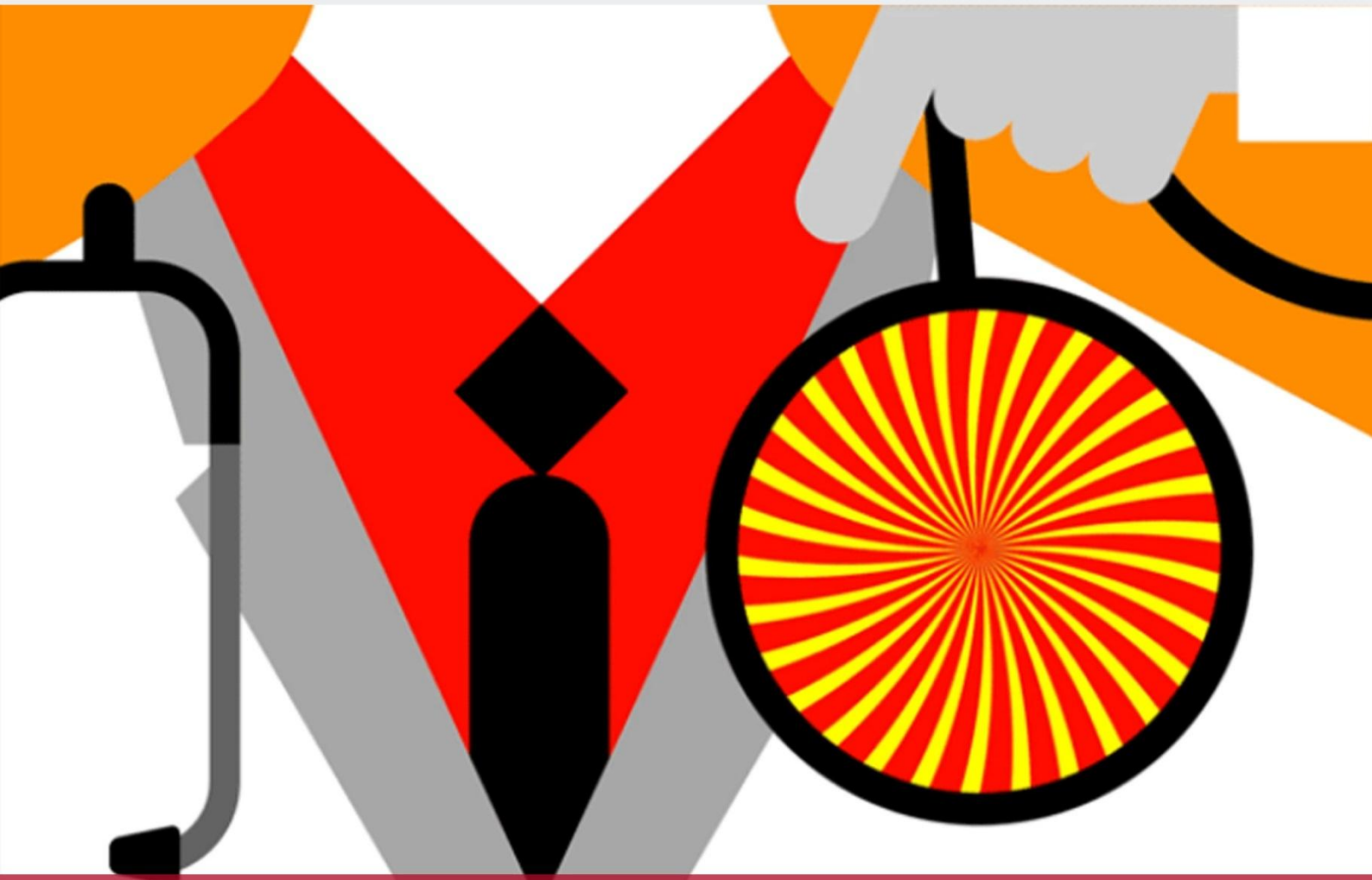

Hypnosis: from Neural Mechanisms to Clinical Practice

Edited by

Giuseppe De Benedittis

Printed Edition of the Special Issue Published in

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Special Issue Editor

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About the Special Issue Editor

Giuseppe De Benedittis, is Associate Professor of Neurosurgery at the University of Milan (Italy). He founded and directed the Interdepartmental Center for the Study and Treatment of Pain at the University of Milan, the first multidisciplinary pain center established in Italy. He is internationally recognized as one of the leading experts in pain therapy, particularly in the field of primary chronic headaches, orofacial pain, pain in the spine (e.g., neck pain, low back pain), neuropathic pain (e.g., shingles), fibromyalgia, and cancer pain. His long clinical experience and his experimental studies have focused on the measurement of pain, quality of life, the psychological aspects of chronic pain, and the use of innovative pharmacological, anesthesiological, and psychophysiological techniques for pain control in a multidisciplinary approach, which takes into account all of the most relevant components of chronic pain. Professor De Benedittis has also been a recognized pioneer in the clinical and experimental use of hypnosis for pain control, contributing to the elucidation of the complex neurophysiological mechanisms of hypnotic analgesia. He is Vice President of the Italian Society of Hypnosis and is a Member of the Board of the International Society of Hypnosis. He is also the Chairman of the International Task Force for “Hypnosis for Pain Relief” recognition by WHO. He received the Ernest R. Hilgard Award for Scientific Excellence from the International Society for Hypnosis in 2009.

He has written over 220 articles in peer-reviewed journals and has authored, co-authored and edited over 10 books on pain and hypnosis topics.

Professional Areas of Expertise:

- Chronic Pain Management (e.g. headaches, back pain, neuropathic pain, fibromyalgia and cancer pain)
- Innovative pharmacological, anesthesiological and psychophysiological techniques for pain control
- A Multi-Modal Approach to Chronic Pain
- Neurophysiological Mechanisms of Hypnosis and Meditation
- Neurophysiological Mechanisms of Hypnotic and Meditation Analgesia
- Ericksonian hypnotic techniques for pain management
- Quantum-like Hypnosis

Preface to “Hypnosis: from Neural Mechanisms to Clinical Practice”

Hypnosis is the oldest of all psychotherapies and one of most practiced methods for the control of pain and other stress-related chronic disorders. This enviable history denotes and reflects its unsurpassed adaptive power, which enabled hypnosis to survive even to itself.

As an area of scientific inquiry and clinical practice, hypnosis dates back over 240 years. Although interest in hypnosis has waxed and waned over centuries, it remains fairly strong today. The aim of scientific hypnosis is to go beyond popular perceptions and misperceptions to reveal the real essence of hypnosis and the value of its applications.

However, hypnosis has long been an elusive concept for science, mainly due to the lack of objective neurobiological markers of the state of trance. But the relentless advances of neuroscience in the last decades have opened up a "bridge of knowledge" between the classic neurophysiological studies and psychophysiological studies of cognitive, emotional and sensory systems. Nowadays, hypnosis is increasingly being recognized by the international scientific community as a valid and flexible physiological tool to explore the central and peripheral nervous system. This seems to be a real Copernican revolution in the field (De Benedittis, 2015).

Hypnosis has been defined as “a state of consciousness involving focused attention and reduced peripheral awareness characterized by an enhanced capacity for response to suggestion” (Elkins, et al., 2015).

In recent years, interest in hypnosis has grown exponentially in health care and education. However, its role has not been fully explored and the mechanisms of action are not well understood.

This Special Issue addresses some of the crucial questions and challenges relating not only to the neural mechanisms of hypnosis but also to a wide variety of clinical applications and practices. Leading researchers and clinicians from all over the world have contributed their perspectives, research, and recommendations for future work. The articles offer critical analysis, cutting edge research, clinical perspectives, and directions for future research and clinical practice. The Book is devoted to experimental research, but also addresses itself to clinicians, filling the gap between basic research and clinical practice. It stands as a provisional summary of where hypnosis had been, where it stands today, and where it is heading tomorrow.

The editor hopes that bringing together these papers on current research efforts and clinical researchers will be stimulated to search out and examine facts about hypnosis so far ignored, ask questions not yet posed and test ideas as yet tested. Furthermore these papers raise more questions than answers, stimulating critical thinking, research at the leading edge of the fascinating and intriguing domain of hypnosis.

It is an honour to be academic editor for this Special Issue and a great pleasure to review many insightful manuscripts first-hand. I wish to thank the publisher for this excellent opportunity to serve the community of researchers and clinicians. I am also grateful for the hard work and support provided by the editorial office to make this project a success. To all the authors, thank you for your contributions. To the readers, thank you for your interest. A plethora of quality works from the latest hypnosis research may provide many useful insights in these fascinating fields.

The future of hypnosis depends greatly on the capacity of hypnosis researchers and clinicians to integrate hypnosis research and practice in broader areas of medicine, psychology and psychotherapy.

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Comment

Clinical, Theoretical and Conceptual Issues in Chronic Pain and Their Application in a Hypnosis Practice

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Hypnosis interventions consistently produce significant decreases in pain associated with a variety of chronic-pain problems [1], while neurophysiological studies have shown that specific hypnotic suggestions have clear effects on the brain and spinal cord functioning [2, 3]. Thus, it is useful for clinicians who practise hypnotherapy to understand pain paradigms.

1. Theories and Conceptual Models of Pain

Pain is a complex phenomenon and several authorities have proposed theories to help explain how pain is experienced. Many of these theories of pain were initially based on biomedical conceptualisations of pain. Moayedi and Davis [4] identified several of the influential biomedical models in the literature, such as Specificity Theory, Intensity Theory and Pattern Theory. In their paper, Moayedi and Davis [4] described each of the theories, working from the current definition of pain outlined by the International Association for the Study of Pain (IASP) which describes pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of tissue damage, or both." The authors cautioned that while each

of the theoretical frameworks contributes to the understanding of the physiological basis of pain, none yet accounts for a full explanation of pain perception.

2. Biomedical Models of Pain

The Specificity Theory suggests there is a specific pathway in the nervous system to communicate messages about pain and that these pathways carry signals via specific pain receptors in the periphery and spinal cord to the sensory region of the brain [5]. However, several researchers have pointed out that this model assumes a direct link between tissue damage and pain experience, yet the experience of pain does not provide a reliable indication of the presence of tissue damage. Phantom limb pain is an example of this – pain can be perceived as being within the missing limb, yet the limb is no longer present. Indeed, it is not uncommon for people reporting pain not to have evidence of there being damage to that part of the body. Similarly, the presence of tissue damage is not always associated with the presence of pain.

Another biomedical theory described by Moayedi and Davis is the Intensity Theory of Pain [4]. This theory evolved from experiments which involved tactile stimulation, below the threshold for tactile perception, being repeated between 60 and 600 times in patients who quickly reported the pain as being unbearable. These findings led a conclusion that some type of summation of stimuli must be occurring for subthreshold stimuli to become very painful and that pain was an emotion which occurred when a stimulus was stronger than normal, as opposed to pain being a unique sensory experience [4]. The Intensity Theory as it is understood today, developed from these earlier theories that weak stimuli produce non-painful sensations while strong stimuli trigger a greater activation of nerve fibres resulting in pain. No differentiation of variations in response to different stimuli was made by the proponents of this theory, thus, all stimuli were considered to have the same effect on neural activity. This theory considered stimulus intensity and central summation to be the critical determinants of pain [6]. The Intensity model, like the specificity model was concerned with acute pain and did not address persistent pain or chronification of pain, which may as Moayedi and Davis explained [4], be due to the belief at this time that the nervous system was ‘hard wired’. Furthermore, when different patterns of neural activity were identified in response to different stimulus modalities, for example, mechanical, chemical and thermal the Intensity Theory lost support [7]. At the very beginning of the 20th century it was determined that there were two classes of somatic sensory pathways subserving discriminating sensations such as touch and pressure and crude sensations such as pain and the Pattern Theory emerged [7].

The Pattern Theory was based on the belief that signals travelling along large diameter nerve fibres may inhibit signals being carried by thinner pain fibres and thereby were able to modify pain intensity. However, the theory assumed the presence of tissue damage and as Chen pointed out [7], the Pattern Theory has been found to be ‘a great simplification for the central nervous system or even plainly wrong for the organization of the peripheral input to the spinal cord’ (p.347). Other aspects of the theory such as the dorsal horn organisation of presynaptic links between A and C fibres have also been shown to be incorrect [7].

These early biomedical theories of pain suggested that pain arose specifically from a physiological anomaly or pathology. However, modern conceptualisations of pain recognise that pain experience is more complex and is influenced by psychological (affective, cognitive, behavioural) and social factors, leading to the adoption of biopsychosocial models of pain.

3. The Biopsychosocial Model of Pain

The current IASP definition of pain can be considered to reflect a biopsychosocial model. This conceptualisation of pain has implications for how pain is treated, meaning that due consideration in treatment be given to addressing the psychological and social factors in addition to addressing the physiological factors.

The earliest biopsychosocial theory of pain was the Gate Control Theory by Melzack and Wall [8]. The GCT proposed that there is a 'gate' in the dorsal horn of the spinal cord which closes and opens in response to different factors. When the gate is 'open' pain messages are permitted to travel to the brain while when the gate is 'closed' pain messages are inhibited from reaching the brain. The concept includes the notion that there is a flow of information both to and from the brain so that the brain also has the ability to 'open' and 'close' the gating mechanism. Three types of sensory nerves have been identified as being involved in transmission of noxious stimuli, namely a-Beta fibres, a-Delta fibres and C fibres. Of interest from a psychological perspective, the Gate Control Theory suggested that mood and thoughts had an impact on whether the 'gate' remained open or closed. It incorporated the notion of sensory-discriminative, motivational-affective and cognitive-evaluative factors [8].

While the GCT is one of the more comprehensive models of pain perception, it has been shown to have limitations, for example, no actual 'gating mechanism' has yet been identified [9]. The GCT reflects the current IASP conceptualisation of pain by as having an emotional component and referring to both 'actual' and 'potential' tissue damage.

Moseley [10] argued that clinical approaches to the treatment of pain require consideration of somatic, psychological and social factors. Moseley pointed out that (1) the presence of pain does not provide an assessment of the state of the tissues (2) that biological, somatic, psychological, and social factors modulate pain (3) that when pain is persistent, the relationship between the perception of pain and the condition of the tissues becomes less clear and (4) that pain can partially be interpreted as being dependent on the degree to which there is a perception of threat to the body tissues. Moseley explained that attention, anxiety and expectation of pain seem to be underpinned by a shared context, that is, the meaning of pain. This, he stated, has been demonstrated by studies investigating pain catastrophizing (a particular way of thinking about pain). He noted that higher catastrophic interpretations of pain were associated with higher pain ratings.

If we then apply the biopsychosocial model of pain to the application of hypnosis in the treatment of pain, hypnotherapists can develop a more systematic approach. Virtually all of the brain areas involved in the processing of pain have been shown to be impacted by hypnosis and hypnotic analgesia [11]. Jensen et al. outlined four key areas which an experienced therapist who wishes to obtain optimal results with their pain patients/clients should include in their treatment approach [11]. These include managing outcome expectencies and inspiring a level of hope, developing a positive rapport, encouraging motivation and creating a 'hypnotic environment' for the treatment.

Given the complexity of pain, before using hypnosis with pain patients/clients it is essential to first develop a detailed understanding of the way in which pain affects their life socially, personally, professionally and physically. Words and suggestions delivered in an hypnotic state are more powerful in alleviating pain than those delivered in the normal waking state as illustrated in a

study by Nusbaum et al. [12]. The researchers examined the parts of the brain that were activated by analgesic suggestions in trance and in a state of normal alertness. The cognitive network was activated in those who were not hypnotized while the emotional network was activated in those who were in a state of trance. In this same study, it was observed that in a state of trance, both direct and indirect suggestions are effective in alleviating pain. An example of a direct analgesic suggestion would be 'your shoulder feels numb'. Metaphors are good examples of indirect suggestions. Similarly, simple phrases which refer to a benefit which occurs as the result of an increased level of comfort, for example, 'You find it easier now to do more work every day'. In a randomized controlled trial [13], examined the efficacy of hypnosis delivered online for migraine sufferers and used a combination of direct and indirect suggestions in the mp3s. There was a 48% decrease in headache disability and a 60% decrease in pain catastrophizing in the treatment group who listened to the mp3s three times a week over a period of ten weeks.

Given that all areas of the brain involved in the processing of pain have been shown to be influenced by hypnotic suggestions, and that there is copious evidence to support the efficacy of hypnosis in the treatment of a variety of chronic and acute pain conditions, there is scope to introduce hypnosis as a mainstream treatment option for pain patients.

Biopsychosocial models emphasise the important contribution of psychological processes in the physical experience of pain. Arising from a greater understanding of how psychological processes influence pain perception, theoretical models have emerged that aim to explain how pain-related disability develops and indicating potential targets for psychological intervention. One such model that has received a good deal of attention is the Fear-Avoidance Model [14].

4. Fear Avoidance (FA) Model of Pain

The FA model of pain is a cognitive behavioural account of how patients develop chronic musculoskeletal pain as a consequence of avoiding activity [15]. The FA model explains how avoidant behaviour is useful when a patient injury is still healing but becomes counter productive in the context of a chronic pain condition because reduced physical activity leads to physical deconditioning and this in turn leads to more pain when activity is undertaken. Increased pain leads to hypervigilance and increased fear of movement and activity, leading to worsening disability. The FA model has been used to explain the transition of acute pain to chronic pain.

A meta-analysis conducted by Zale, Lange, Fields and Ditre synthesised the findings of 41 studies and found a positive relation between pain-related fear and disability which was moderate to large in magnitude [16]. The authors suggested the findings indicate that pain-related fear may be considered an important risk factor for pain-related disability with related implications for the treatments designed to treat pain.

While the fear avoidance model literature has focused on musculoskeletal pain, the key constructs of catastrophizing and pain-related fear which underlie the contemporary fear avoidance model have also been investigated in the migraine literature [17]. One study by Black, Fulwiler and Smitherman [18], which examined fear of pain (FOP) in headache patients looked at how FOP differed between headache sufferers and those who do not suffer with headaches. They defined FOP as the fear of physical movement because of it's assumed threat of pain. Like FA, FOP, they affirmed, has the ability to restrict physical ability and can lead to over-prediction of pain. Black et al. examined FOP differences across headache categories, the degree to which FOP could

predict headache severity, frequency and disability and also whether FOP had an effect on the relationship between pain severity and headache disability [18]. They found that FOP was higher in migraineurs than in individuals with tension type headache (TTH) and that FOP partially mediated the relationship between pain severity and disability. They concluded by stating that knowledge of FOP and its various associations could have a therapeutic benefit in decreasing disability and improving functioning.

While the pain paradigm continues to evolve, hypnotherapists can benefit from a current comprehension of how pain models have developed more recently to include psychological and social factors. An understanding of these theories will empower clinicians practicing hypnotherapy to tailor suggestions specifically to their pain patients so that optimal results are achievable.

Author Contributions

Niamh Flynn is the author of this paper.

Competing Interests

The authors have declared that no competing interests exist.

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Research Article

Imagined and Actual Movements with and without Suggestions for anesthesia in Subjects with Different Hypnotizability

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Abstract

***Background*:** Hypnotizability is a psychophysiological trait associated with several differences including the level of functional equivalence (FE) between imagery and perception, i.e., the similarity of the cortical activations and network configurations associated with each of them. FE is stronger in high hypnotizability individuals (*highs*) than low hypnotizable participants (*lows*). In this framework, this study investigates the correlation between electroencephalogram (EEG) of imagined arm/hand movements (MI) and of actual movements performed in the absence of suggestions (M) and in the presence of suggestions of arm/hand anesthesia (MA) in *highs* and *lows*.

***Methods*:** The EEG alpha (8–12 Hz) and beta (13–25 Hz) absolute power, classically associated with movement preparation and execution, were studied in 18 *highs* and 17 *lows* classified according to the Stanford Hypnotic Susceptibility Scale, form A. EEG was recorded during M, MI, and MA. The subjective reports of imagery and the duration of movements were also studied.

***Results*:** The duration of movements did not differ between *highs* and *lows. Highs* reported better imagery during MI, greater perceived influence of the suggestion of anesthesia during

MA, and lower cognitive efforts than *lows* for both tasks. In line with earlier studies, the spectral analysis did not reveal significant restructuring of the cortical activity during tasks in *highs*, whereas *lows* showed cortical changes during MI and MA indicating that they were able to mentally simulate movements and to accept suggestions for anesthesia during voluntary movement, despite their low hypnotizability scores.

***Conclusions*:** The present study indicates that unusual psychophysiological characteristics can differ in the response of individuals to suggestions.

Keywords

Imagery; hypnotizability; motor control; suggestions; functional equivalence; anesthesia

1. Introduction

Hypnotizability is a psychophysiological trait that is measured by scales predicting the proneness to modify perception, memory, and behavior according to specific instructions named "suggestions" [1]. Several cognitive, emotional, and physiological differences have been described between the subjects with high *(highs*) and low hypnotizability (*lows*) out of hypnosis and in the absence of specific suggestions [2].

1.1 Hypnotizability as a Psychophysiological Trait

The EEG studies based on spectral analysis conducted in resting conditions out of hypnosis and in the absence of specific suggestions failed to separate the effects of hypnotizability from those of relaxation [3]. The study also did not recognize any variable which could discriminate *highs* from *lows* and medium hypnotizable participants (*mediums*). Recurrence quantification analysis of the EEG plot [4] revealed that the plot determinism discriminates *highs* from *lows* at midline parietal sites [5, 6]. Additionally, the topological analysis of EEG signals has shown a qualitatively different cortical activity during both sensorimotor and cognitive tasks. *Highs* exhibit a widely distributed mode of information processing whereas *lows* show localized changes [7]. In *highs,* earlier reports showed greater left activation than right anterior activation and hemispheric differences in information processing for electrodermal responses, brightness, haptic discrimination, tones evoked cortical potentials [8], temporal judgment of visual stimuli [9], and line bisection [10].

The earliest neuroimaging study of hypnotizability-related morphological characteristics revealed larger anterior *corpus callosum* [11] in *highs*, which may account for the better interhemispheric transfer of information. Successively, smaller grey matter volume in the entire brain [12] or in regions belonging to the salience and executive circuits has been described [13]. From a functional point of view, *highs* exhibit a stronger connection between the cingulate cortex and the dorsolateral prefrontal and parietal cortices possibly leading to increased likelihood to modulate the information selection and processing [13]. In addition, *highs* show reduced grey matter volume of the cerebellar left IV-VI lobules [14], suggesting a role of the cerebellum in the observed hypnotizability-related differences in sensorimotor integration, cerebellar control of pain and a few cognitive-emotional traits. In the absence of suggestions and out of hypnosis, *highs*

show less strict postural control and less accurate visuomotor performance. The *highs* do not exhibit learning effects due to task repetition in both postural and visuomotor tasks [2]. In contrast to the general population, reports showed increased pain perception associated with increased amplitude of cortically evoked nociceptive potentials during transcranial anodal cerebellar stimulation in *highs* [15]. The structural variations in the salience network, particularly in the insula, may be responsible for higher emotional intensity during imagery [16], recall of emotional events [17], and perception of the inner world and sensitivity/empathy in *highs* than that in *lows* [18]. The same structural brain irregularities could influence heart rate, which is para-sympathetically controlled in *highs* during long-lasting relaxation in the awake state [19]. The nociceptive stimulation in *highs* releases nitric oxide (NO) from the endothelial cells of the brachial artery. This condition is not influenced by mental stress and is less profound in *lows* [20, 21]. The high concentration of NO at the cerebral level may have a role in the *highs'* brain morphofunctional peculiarities. This is because excessive or uncontrolled diffusion of endothelial NO to the cerebral tissue may be responsible for neurotoxicity [2].

1.2 Suggestions and Imagery

Suggestions are requested to imagine a sensorimotor, cognitive or emotional condition different from the actual one that is effective in both the awake and hypnotic state [22]. Many studies have analyzed hypnotizability-related differences by standard imagery questionnaires which, however, have often provided negative results concerning the vividness of imagery [23]. In contrast, semistructured interviews related to the mental images experienced during specific experimental conditions have shown greater vividness and lower effort in *highs* than that in *lows* [24], which may be due to the kinaesthetic modality of imagery [25–29].

More importantly, hypnotizability-related differences have been found in the functional equivalence (FE) between imagery and perception/action [29, 30]. FE is generally described in terms of similar activations observable during actual and imagined perception [31–33] or action [34–37]. FE is found stronger in *highs,* which means that they experience the suggested mental images at both subjective and physiological levels more than that in *lows* [24, 28–30, 38].

Greater cerebral cortical excitability (Spina, personal communication) could be responsible for stronger FE possibly due to greater cortical activation by ascending systems [39, 40] or lower cerebellar inhibition of cortical sensorimotor areas [14]. Among activating systems, the dopaminergic pathway plays the best role [41–45]. The cholinergic contribution may be roughly excluded on the basis of tests of visual and verbal memory [46], which did not detect any difference between *highs, mediums,* and *lows* [47]. The noradrenergic contribution from the *Locus Coeruleus* (LC) is also excluded from the primary findings because of the similar pupil diameter [48, 49] as observed in *highs, mediums,* and *lows*.

1.3 Hypnotizability and Motor Imagery

Actual and imagined actions have been compared in *highs* and *lows* through neuroimaging and EEG studies. The former revealed the activation of a parietal-cerebellar circuit during ideomotor movements induced by suggestions. This is experienced by *highs* as an involuntary action. According to the feed-forward model of motor control, it was proposed that the inhibition of the peripheral reafference may be responsible for the perception of involuntariness [50]. As observed

in postural imagery, the latter showed different activation modes in *highs,* in contrast to *lows* who do not exhibit local cortical changes with respect to baseline [7, 28- 30].

The main physiological difference between actual and imagined action consists of the presence or absence of the peripheral reafference. In the general population, fMRI studies have shown activation of a distributed frontoparietal occipital network during motor planning, imagery, and execution [35, 36, 51]. EEG source analysis has shown that physical suppression of the kinaesthetic reafference reduces the source activity at pre and postcentral sites and that the same occurs during imagined movements in which the sensory reafference is absent [52]. In *highs,* the lack of sensory information could be replaced by its mental image owing to their stronger functional equivalence between imagery and action [27, 29]. This may lead to the suppression of the difference between actual and imagined action. On the other hand, during actual movement, the *highs*' stronger FE should induce greater effects of suggestions of anesthesia than that in *lows.*

1.4 Aim of the Study

The aim of the present study was to investigate the correlation of EEG between actual and imagined arm/hand movement and of an actual movement performed during the administration of suggestions of arm/hand anesthesia in *highs* and *lows*. We expect that a) *highs* report better vividness of imagery and greater movement difficulty for the actual movement performed during suggestions of analgesia and that b) in contrast to subjective experience, the EEG changes associated with tasks are more pronounced in *lows* than in *highs* [28- 30]

The EEG midline alpha power (8-12 Hz), indicating cognitive engagement, and hemispheric alpha and beta (13-25 Hz) absolute power, classically associated with movement preparation and execution [53], were studied.

2. Methods

The research was approved by the Bioethical Committee of the University of Pisa (n.4/2018, January 25, 2019) and conducted ethically according to the Declaration of Helsinki.

2.1 Subjects

Thirty-five students of the University of Pisa participated in the study who were drug free, healthy (according to neurological, psychiatric, and medical anamnesis), and right-handed (Edinburgh Handedness Inventory score $\geq$ 16). Their hypnotic susceptibility was assessed through the Italian version of the Stanford Hypnotic Susceptibility Scale, form A [54]. Seventeen low hypnotizable (*lows*, 9 females; (mean, SD): age 22 $\pm$1.21; SHSS score 1.19 $\pm$ 1.38) and 18 high hypnotizable individuals (*highs*, 7 females; (mean, SD): age 21 $\pm$0.92; SHSS score 10.06 $\pm$1.39) were sorted from a database which included *highs* and *lows*. No medium hypnotizable individuals *(mediums)* accepted to join the experimental session.

2.2 Experimental Procedure

Experimental sessions were conducted between 11 a.m. and 2 p.m. Upon arrival, the participants read and signed the informed consent. Throughout the experimental session, participants were comfortably seated in a semi-reclined arm-chair in a sound and light-attenuated

room. The experimental procedure consisted of three eyes-closed trials which were divided into basal and task conditions (actual movement, M; motor imagery of it, MI; actual movement during suggestions for anesthesia, MA). In the basal condition preceding each task (b_M, b_{MI}, and b_{MA}), the participants were asked to relax. M consisted of the execution of a complex flexor-extensor movement of the right arm, i.e., opening and closing of hand repeated five times consecutively. MI consisted of the motor imagery of M, and MA consisted of M associated with suggestions for anesthesia. Tasks were presented to all subjects in the described sequence. The instructions for M ("...*please perform a flexor-extensor movement of your right arm, close your hand into a fist and then re-open it, repeat it five times and then put your arm and hand in their initial position...*"), MI ("…*please, now try to imagine the described movement looking at it from your own eyes..from inside your body*…") and MA ("…*please, now imagine you do not perceive any sensation from your arm and hand….*"). Instructions and suggestions were given immediately before the respective task which was triggered by verbal commands. For M and MA, the delay between the verbal command ("*please, now move"*) and the movement of onset, as well as the movement duration (that is the time interval between the verbal command and the observed end of the movement), were measured. MI duration was calculated by measuring the time interval from the verbal command (*please now listen to me and imagine*…..) to the "STOP" command. The participants were invited to say at the end of their imaginative experience. After MI, the subjects scored the vividness and easiness of their imagery and the ability to maintain their mental image through the requested modality of imagery (range: 0–10). After MA, the subjects were asked to score the influence of the suggestion on movement easiness on a scale of 0–10.

Arm/hand movement monitoring during M and MA was performed through the marker-less infrared sensors Xbox 360 Kinect Sensor System that tracks body joints in real-time without requiring markers attached to the body [55].

Electroencephalogram (EEG) was recorded by means of a 32-channels DC-coupled monopolar amplifier (Scan LT, Neuroscan). Scalp EEG signals were filtered with a notch filter centered at 50 Hz and a bandpass one (0.5–45 Hz) and acquired with a 1000 Hz sampling rate by means of electrodes with contact impedance below 10 kΩ. It was referenced to FCz. Off-line signals were re-referred to A1/A2 and FCz was restored. Eye (right medial/lateral; left medial/lateral) and ECG electrodes (standard DI lead) were also used. No participant had more than 1 bad channel per condition and this was calculated using the spherical interpolation method (EEGLAB pop_interp function). The signal components were obtained by running independent component analysis decomposition (infomax ICA algorithm, EEG LAB function runica) and were visually inspected to remove artifacts. The signal was divided into 20 s epochs (20.000 samples). According to the exclusion criteria (amplitudes ≥100 μV or median amplitude > 6SD of the remaining channels), a maximum of 1 epoch per condition was deleted per subject.

Variables and statistical analysis

SPSS15 was used for all statistical analysis. Self-reports were analyzed by means of non-parametric tests (Mann-Whitney or Wilcoxon). *Highs'* and *lows'* delay in movement initiation in MA was analyzed through univariate ANOVA. The movement durations in M and MA were analyzed through repeated measures ANOVA (2 Hypnotizability × 2 Task). The kinematics of the arm/hand movement could not be analyzed because most signals were too noisy and a part of them was lost.

Repeated measures ANOVA was applied to EEG log-transformed absolute beta power (F3-F4, C3-C4, P3-P4) according to a 2 Hypnotizability (*highs, lows*) × 2 Hemisphere × 3 Trial (b_M-M, b_{MI}-MI, b_{MA}-MA) × 2 Condition (basal, task). The analysis of midline fronto-central alpha power (μ rhythm, Fz, and Cz) was performed through 2 Hypnotizability (*highs, lows*) × 3 Trial × 2 Condition design.

In addition, the changes occurring during tasks with respect to basal conditions (Task Related Power (TRP) changes: Δ_M, Δ_{MI}, Δ_{MA}) were computed in order to compare Δ_M with Δ_{MI} and Δ_{MA} (2 Hypnotizability × 3 Tasks design). The possible basal differences may have prevented the detection of significant interactions between trials and conditions by the former analysis. Negative TRP values indicate desynchronization, while positive TRP values indicate synchronization. The Greenhouse-Geisser ε correction for non-sphericity was used when necessary. Post-hoc comparisons between conditions (Δ_M vs. Δ_{MI}; Δ_M vs. $\Delta_{MA)}$ were carried on through contrast analysis. The level of significance was set at p = 0.05. The number of participants included in the various comparisons was not the same owing to the exclusion of a different number of outliers from each condition.

3. Results

3.1 Self-Reports and Movement Duration

During MI, *highs* reported higher vividness (Z= –2.41, p< .017) and longer maintenance of the kinaesthetic modality of imagery than *lows* (Z= –2.01, p< .010), whereas no significant difference between *highs* and *lows* was observed for the easiness of MI (FIG 1A).

Highs exhibited a greater influence of the anesthesia suggesting their movement during MA with respect to *lows* (Z= –2.07, p< .007). A few *highs* reported the experience of "weak arm" or "absence of joint localization". One of the subjects was not able to move his arm at all. However, the mean delay in the movement initiation during MA with respect to M was not significantly different between *highs* and *lows* (Fig. 1B).

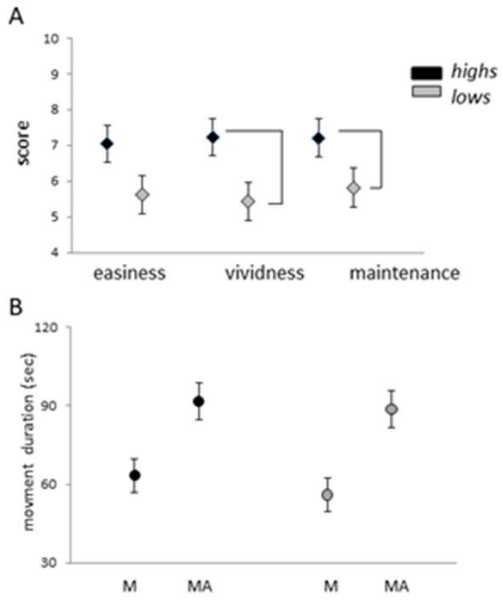

Figure 1 Motor imagery. a) Easiness and vividness of mental imagery, maintenance of the requested kinaesthetic imagery. b) movement duration in the absence (M) and in

the presence (MA) of suggestions for anaesthesia in highs (black dot) and lows (grey dots). Error bars represent standard errors.

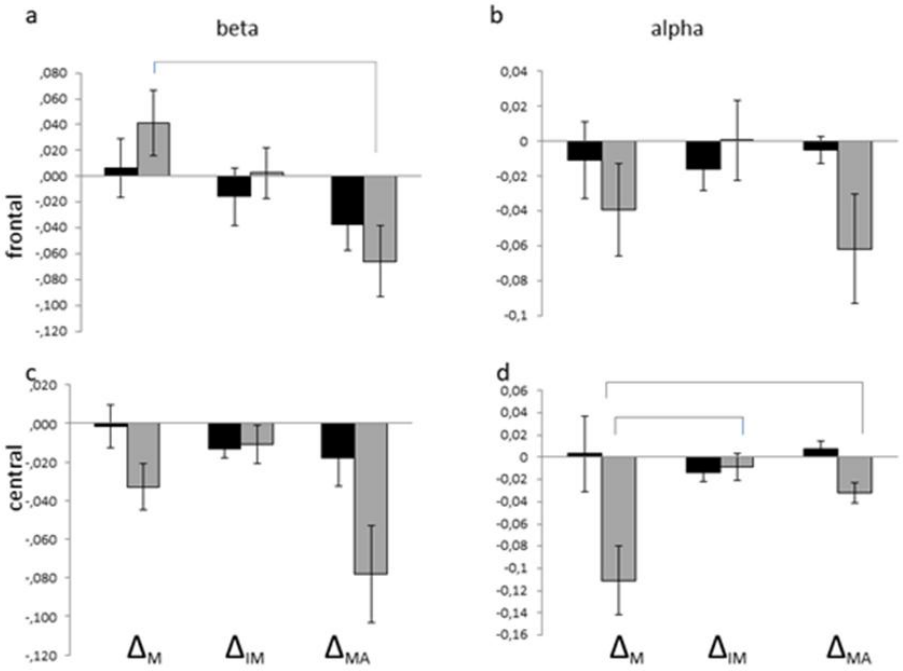

Figure 2 Task Related Power (TRP) changes. Upper panels: frontal beta and alpha; lower panels: central beta and alpha. Black columns, highs; grey columns, lows. ΔM, actual movement; ΔIM, movement imagery; ΔMA, movement with suggestions for anaesthesia. Error bars represent standard errors.

3.2 EEG

The cortical correlates of the three experimental conditions showed significant hypnotizability-related differences which are reported in Table 1.

Table 1 Summary of result.

Site	Effect	Beta				Alpha			
F3-F4		F	p	η^2		F	p	η^2	
	condition	7,898	.009	.233	b>task	6,009	.021	.177	b>task
	hypnotizability	10,270	.004	.283	highs< lows	11,503	.002	.291	highs< lows
	cond x hypn	7,354	.012	.220	highs, ns lows, b>task F(1,13)=11.374, p<.005				
C3-C4	condition					13,583	.001	.335	b>task
	hypnotizability	16,977	.0001	.369	highs< lows				
P3-P4	hemisphere	4,378	.045	.131	left < right	5.94	.021	.165	left< right

condition	5,302	.029	.155	b>task	4,585	.040	.133	b > task
hypnotizability					4.61	.040	.133	highs<lows

At frontal sites *highs* exhibited lower beta power than *lows* (Hypnotizability effect) and a significant Hypnotizability × Condition interaction revealed that only *lows* changed their beta power during tasks. In this group (Fig. 2) Δ_M, $\Delta_{MI,}$ and Δ_{MA} were significantly different between each other (Task effect, F (2, 32)=7.526, p<.002, μ^2=.320) as beta power increased in M and decreased in MA with respect to basal conditions (Δ_M vs. Δ_{MA}, F (1,16)=11.035, p<.004), whereas Δ_M and Δ_{MI} did not differ between each other (Fig. 2A).

Alpha absolute power (Table 1) was always lower in *highs* than in *lows* (Hypnotizability effect) and decreased during all tasks with respect to basal conditions (Condition effect). Alpha TRP changes during M, MI, and MA did not exhibit significant differences between each other (Fig. 2).

At central sites (C3, C4), beta power was lower in *highs* than in *lows* independently from the experimental conditions (Hypnotizability effect**).**

Alpha changes showed a significant condition effect (basal > task) and the comparisons of alpha TRP changes (Fig. 2) revealed a significant Task effect (F (2, 26)=8.641, p<.006, μ^2=.399) sustained by differences between Δ_M and Δ_{MI} (F (1,13)=10.063, p<.007) and between Δ_M and Δ_{MA} (F (1,13)=8.339, p<.013).

At parietal sites, alpha power was significantly lowered in *highs* than in *lows* (Table 1) (Hypnotizability effect). Both beta and alpha power were significantly lowered on left sites independently from hypnotizability, trial, and tasks (Hemisphere effect) and decreased during all tasks with respect to basal conditions (Condition effect). No significant Task effect was observed for Δ_M, Δ_{MI}, and Δ_{MA}.

Midline alpha (μ rhythm) exhibited significantly lower power in *highs* than in *lows* at both Fz (1,28)=9.950, p<.004, μ^2= .269) and Cz (F (1,28)=6.203, p<.019, μ^2= .181).

4. Discussion

The study confirms earlier reports of greater vividness of motor imagery and the ability to maintain the requested kinaesthetic modality of imagery in *highs* than that in *lows.* [30]. The similar easiness of mental imagery experienced by the two groups, unlike earlier studies [28, 29] can be accounted for by the experimental paradigm. In the present study, actual movement preceded its mental imagery allowing learning effects in *lows*. Also, the subjective effects of the suggestion of anesthesia were greater in *highs* than in *lows,* despite the absence of significant differences in the movement duration. This finding, however, should be considered together with nonstructured subjective reports indicating greater difficulty in initiating and/or control the movement by *highs*. The most relevant outcome of the study, however, is that, in line with studies of postural and motor imagery [28- 30] *highs* did not exhibit significant EEG changes during actual and imagined tasks, in contrast to *lows*.

The μ rhythm is modulated by both sensorimotor tasks [56-58] and cognitive states and traits [59- 62]. In the present study, the *highs*' lower power of μ rhythm with respect to *lows* in both basal and task conditions indicates that they were more activated than *lows* in basal conditions and performed the tasks with lower effort.

In both groups, alpha power did not exhibit hemispheric differences, as often observed during various lateralized motor tasks [53]. The *lows*' smaller alpha decreases during MI and MA with respect to M observed at central sites seem to reflect their lower embodiment of the mental images of movement and anesthesia, generally worse cognitive performance with respect to *highs*. The lack of local EEG modulation in *highs* is consistent with the findings obtained during sensorimotor and cognitive tasks [7, 29, 30]. It can be accounted for a largely distributed information processing likely sustained by activating systems [39, 40] which cannot be revealed by spectral analysis but is detected by topological methods [7, 29].

The different beta changes observed in *lows* during the various tasks with respect to basal conditions suggest that *lows* were able to similarly represent actual and imagined motor planning ($\Delta_M=\Delta_{MI}$ at frontal sites) and execution ($\Delta_M=\Delta_{MI}$ at central sites). They were also able to prepare their movement differentially in the imagined absence and in the presence of sensory reafference (Δ_{MA} different from Δ_M).

At post-central sites low beta power was observed in the left hemisphere. At this level, highs and *lows* exhibited similar beta reduction with respect to basal conditions independently from the specific task, suggesting that the different experience of normal, imagined and imaginatively anesthetized arm/hand movement was sustained by central commands [63- 65] rather than by the sensory reafference.

Although the basal EEG differences between *highs* and *lows* were not the objective of the present study, it was noticed that *highs* exhibited lower beta absolute power than *lows* at hemispheric levels. Lower alpha absolute power indicates different styles of resting cortical activity. This is in line with the findings of different activities of the Default Mode Network [13]. It was also observed that long-lasting relaxation is a cognitive task associated with increasing and decreasing gamma activity in *highs* and *lows*, respectively [66].

5. Limitations and Conclusion

An important limitation of the study is the absence of movement monitoring, which is due to instrumentation failure occurred in the initial phase of the study. The paradoxical increase in beta power observed at frontal sites during actual movement, although insignificant, could possibly due to the movement, which was continuous and repetitive. The beta changes usually associated with movement preparation and execution may have been masked by the beta rebound associated with the termination of each movement within the sequence of five movements. Moreover, a better interpretation of the results could be provided by including medium hypnotizable participants (*mediums*) who were a better representative of the general population [67]. Preliminary findings however, indicate that the *mediums*' motor cortex excitability is intermediate between that of *highs* and *lows* (Spina, personal communication). From this point of view, it may be conferred that their functional equivalence may also be intermediate.

The present findings confirmed hypnotizability-related subjective differences in the ability of motor imagery [30] and in the efficacy of suggested anesthesia [27]. It replicates earlier findings of hypnotizability related sensory-cognitive information processing [7, 28, 29]. It indicated that *lows* performing motor imagery and imagery of anesthesia do exhibit EEG cortical modulation. The findings suggested that both groups were able to embody mental images, through different cortical activity [28] which were more in *highs* more than *lows* [24, 28].

In the present study, it can be concluded on the basis of experimental findings that a re-approachment of the experimental hypnosis based on the classification of individual on standard scales (the Ericksonian model) – any person can be considered as hypnotizable – is quite near. In particular, it can be proposed that various "hypnotizabilities" exist [68] and individual psychophysiological characteristics may enable different subjects to respond to different suggestions.

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Author Contributions

All authors designed the study, analysed results, wrote and approved the manuscript. SR conducted the experiments and analysed EEG signals.

Competing Interests

The authors have declared that no competing interests exist

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Review

Hypnosis for Clinical Pain Management: A Scoping Review of Systematic Reviews

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Abstract

There is a growing body of research evaluating the effects of hypnosis for the management of clinical pain. A summary of the recent systematic review would help understand the quality of evidence regarding the efficacy of hypnosis, and provide directions for future research. We conducted a scoping review of systematic reviews and meta-analyses on the efficacy of hypnosis for management of clinical pain conditions published after 2013. We searched four databases and two reviewers independently screened studies. We extracted information regarding efficacy of hypnosis, quality of trials reviewed, and author's conclusions from the included reviews. We included 13 systematic reviews or meta-analyses that synthesized results from 77 unique clinical trials published from 1841 to 2017. There

was a large degree of heterogeneity in the hypnosis interventions evaluated in the trials. Overall, the authors concluded that there was low-quality evidence for beneficial effects of hypnosis in the management of procedural pain, headache and pain associated with breast cancer care. All 13 reviews concluded that higher-quality trials were needed. Hypnosis may be an effective treatment for a variety of clinical pain conditions. However, the efficacy of hypnotic treatment for clinical pain is yet to be verified in high-quality trials. Researchers should follow recommended guidelines, checklists, and tools to avoid the common methodological shortcomings of previously published trials.

Keywords
Hypnosis; hypnotic analgesia; review; pain management

1. Introduction

Both acute and chronic pain remain significant problems worldwide and contribute to suffering and disability. Pain and anxiety are common with many invasive medical procedures [1], and greater exposure to procedural and surgery-related pain can lead to negative long-term outcomes [2, 3]. Chronic pain is also common, with a prevalence rate of 37% to 41% [4]. Given the problems associated with biomedical approaches to pain treatment including limited efficacy and adverse events [5-7], and given the increasing understanding that pain is the end result of multiple biological, psychologic, and social factors, there has been a growing interest in the use of psychosocial interventions for pain treatment [8-10].

One psychological treatment that has the potential to benefit many individuals with both acute and chronic pain is hypnosis. Hypnosis has been defined as “A state of consciousness involving focused attention and reduced peripheral awareness characterized by an enhanced capacity for response to suggestion.” (page 6, [11]). It usually involves several specific components [12-14]. First is a “hypnotic induction” during which the patient or hypnotic subject is invited to focus his or her awareness on a specific object or experience, such as the therapist’s voice, a spot on a wall, or their own breathing. This is sometimes, but not always, followed by suggestions for “deepening” the hypnotic experience. The deepening suggestions, when included as a part of the hypnosis intervention, may involve inviting the subject to experience themselves as riding in an elevator or on an escalator that takes them “down” to “deeper and deeper levels of comfort and awareness.” The induction and deepening are then usually followed by suggestions that target the symptom or presenting problem. These usually invite the subject or patient to experience changes in their emotions (e.g., to experience a sense of calm or joy), sensations (e.g., to experience physical comfort), or behaviors (e.g., to engage in behaviors associated improved health, such as regular exercise). The clinical suggestions can, and often do, also include “post-hypnotic” suggestions that the changes in emotions, sensations, or behaviour will last beyond the session. For example, they might include suggestions for experiencing comfort and relaxation during an upcoming planned medical procedure. Or they might include suggestions for experiencing greater comfort (i.e., less pain) throughout the day outside of the hypnotic sessions. The clinicians might also make an audio

recording of the session and offer the subject or patient to listen to the recording between treatment sessions (e.g., once or twice every day).

A large and growing number of clinical trials have been conducted to evaluate the efficacy of hypnosis for pain management. Moreover, reviews of these trials – including both systematic reviews and meta-analyses (which are considered as providing the highest level of evidence) – have also been published [15-18]. A useful next step would be to perform a review of these reviews in order to summarize the current state of the evidence regarding the overall efficacy of hypnosis for clinical pain, which in turn could potentially inform future research and the clinical application of hypnosis and hypnotic procedures. A good place to start for such a review is a scoping review. Scoping reviews are an ideal form of review to provide an initial summary of the types of available evidence, understand knowledge gaps, and clarify concepts that would all be useful as a precursor to a systematic review [19].

Given these issues, the primary aim of this scoping review of reviews was to better understand: (1) the type of evidence available, (2) the overall quality of that evidence as reported in the reviews, (3) identify critical knowledge gaps with respect to research in this area, and (4) and provide recommendations for future clinical trials and reviews of those trials regarding the effects of hypnosis on clinical pain.

2. Materials and Methods

2.1 Overview

We conducted a scoping review of the literature to identify reviews synthesizing trials on the effectiveness of hypnosis for pain management. Although the study protocol was determined a priori, the review was not pre-registered online. This scoping review was conducted in line with Joanna Brigg's Institute's guidelines for scoping reviews [20] and reported based on the PRISMA Extension for scoping reviews [21]. An initial search of four databases for recent reviews of research evaluating the efficacy of hypnotic treatments for pain was conducted on August 21, 2019. A second (final) search was conducted on December 31, 2019, to identify any reviews that met the review inclusion criteria that were published after August 21, 2019. Here we elected to limit the published reviews to include only those published recently (since January 1, 2014).

2.2 Inclusion Criteria

In this review of reviews, we included systematic reviews or meta-analyses that focused on evaluating the efficacy of hypnosis for any clinical pain condition (i.e., procedural, acute or chronic pain) if they were written in English (based on the author's language proficiencies) and were published on January 1, 2014, or later. Only studies published on or after January 1, 2014, were included in order to ensure that the most recent evidence are captured. We included systematic reviews and/or meta-analyses of both randomized controlled trials (RCTs) and non-randomized studies of effects hypnotic interventions primarily on pain. To be included, the reviews needed to have reported findings on at least one of the following pain outcomes: pain intensity, pain interference, pain affect, use of pain medication, or satisfaction with pain relief.

2.3 Exclusion Criteria

We excluded: (1) reviews that were published on or before December 31, 2013; (2) reviews of the effects of hypnosis on experimental pain; and (3) overviews or umbrella reviews.

2.4 Procedures

Search Strategy: We conducted a systematic search of four databases PsycINFO (via Ovid), PubMed, Cochrane Review database and SCOPUS using a combination of "hypnosis" (or "hypnot*") AND "pain" AND "reviews or meta-analysis". The initial search was performed in August 21, 2019 and an updated search was conducted on December 31, 2019, to capture any reviews published between August and December 2019. For example, the search term used in PubMed was (((Hypnosis [Title]) OR (Hypnot*[Title])) AND (Pain [Title/Abstract])) AND (review [Title/Abstract] OR meta-analysis [Title/Abstract]). The search filter was then used to limit studies published on or after January 1, 2014. The search terms and filters were adapted as appropriate for the different databases. We also screened the reference list of included reviews to identify any additional relevant reviews that might not have been captured by the database searches.

Data extraction and analysis: The lead author independently performed all data charting. The review authors created and approved a data extraction form based on the Joanna Briggs Institute recommendations for reviews [20, 22]. The data extraction form included: author names, publication date, description of the populations studied in the trials that were reviewed, number of studies reviewed, sample size (total number of subjects in all of the trials reviewed combined, as well as the median and range of the number of subjects in the individual trials), quality of the included trials as reported by the review author, the number of studies included in the meta-analysis (for meta-analyses), the key findings of the reviews including information on study heterogeneity, and the authors' primary conclusions. If there were missing data, we recorded it as such and did not consult the authors or the primary studies or review authors, since the aim of this paper is to provide an overview of the reviews and not of primary sources or clinical trials. We then performed a narrative synthesis of the reviews to describe types of hypnosis used, types of comparator groups, quality of trials within the reviews, and effectiveness of hypnosis for pain management. As this was a scoping review of literature, we did not assess the quality of included reviews [19].

3. Results

3.1 Scope of Current Literature

3.1.1 Search Results

We retrieved a total of 70 papers from the four databases on August 21, 2019, and then removed 24 duplicates. AP and MJ independently screened the remaining 47 articles – only 18 of these were systematic reviews or meta-analyses. Five of these were excluded from the current scoping review of reviews because they were not written in English (n = 2) [23-25] or did not primarily examine the effects of hypnosis on one of the pain outcomes (e.g., pain intensity, analgesic medication use, etc.; n=2) [26, 27]. We did not identify any new articles with our second search performed on December 31, 2019.

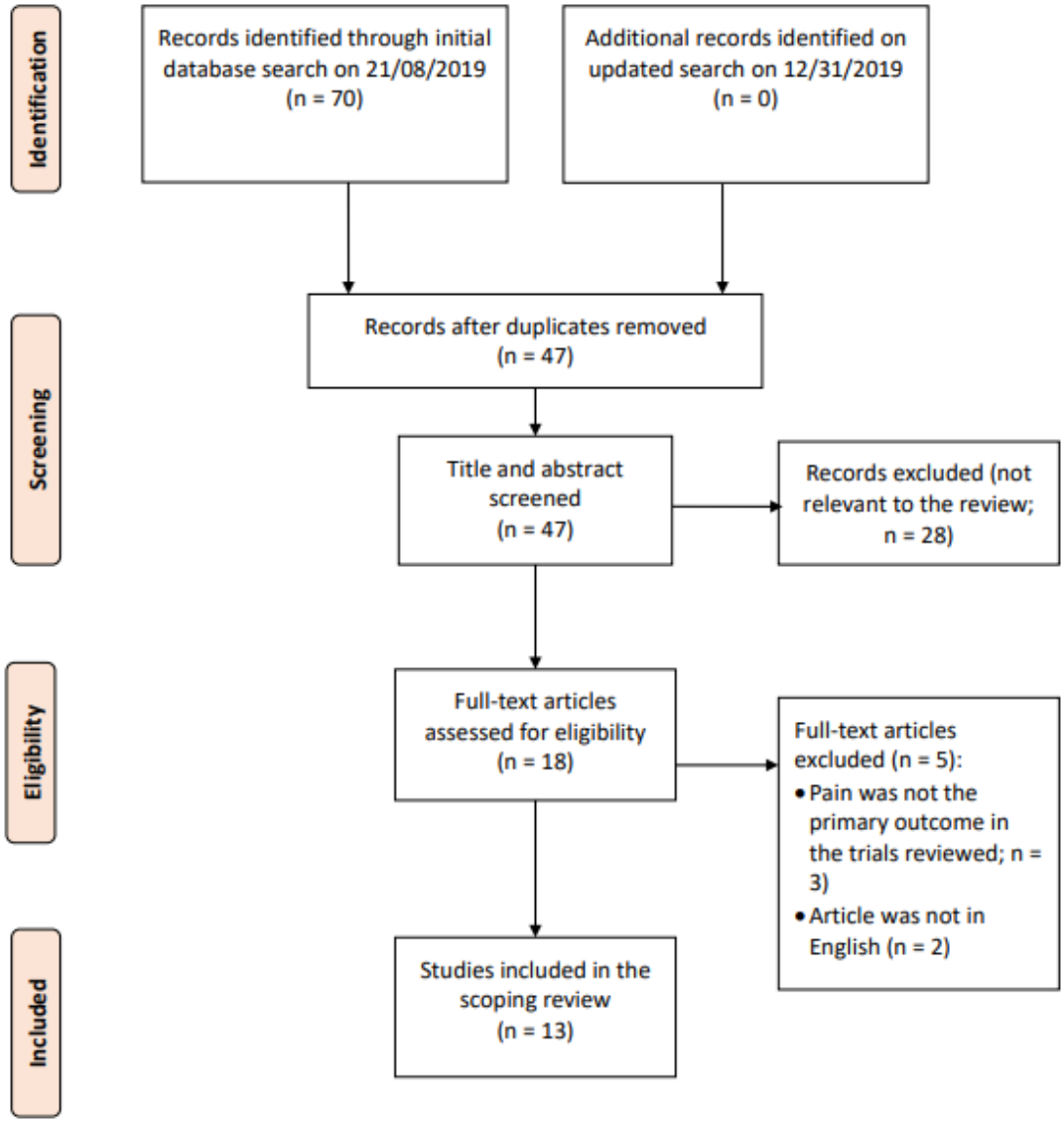

Figure 1 PRISMA Flow diagram.

Thus, we included a total of 13 systematic reviews or meta-analyses that synthesized results from 99 RCTs or non-randomized clinical trials published from 1841 to 2017 that evaluated the effects of hypnosis on pain [15-18, 28-36]. There were overlapping trials between reviews: overall, there were 77 unique trials that included data from more than 6,882 participants (one review did not report sample sizes [33]). A large proportion of these RCTs were published before January 2009 (70%, n=69) and 38% (n=37) were published before January 2000.

Five of the reviews summarized in this paper reviewed the effects of hypnosis on procedural pain [18, 28, 29, 34, 35], four reviewed studies examining the effects of hypnosis on chronic pain [16, 32, 33, 36], and four reviewed trials that examined the effects of hypnosis on other pain conditions [15, 17, 30, 31]. However, the authors of one of the reviews that sought to evaluate the effects of hypnosis on end-of-life cancer pain were unable to find any trials to review that met their inclusion criteria [31].

3.1.2 Hypnosis Interventions and Comparators

There was a great deal of missing information regarding the details of the hypnosis treatments evaluated in the clinical trials reviewed, as well as the comparators used. However, based on the limited information that was provided by the review authors, it was clear that there was a large variation in how hypnosis treatment was provided in the trials reviewed, as well as the comparators used in the 72 trials (see Supplementary Table S1).

Based on the information provided in the thirteen reviews, thirty-eight trials examined the effects of self-hypnosis using audio recordings, most often (but not always) after one or more face-to-face hypnosis sessions [15-17, 28, 29, 33, 35, 36]. Five unique trials included in three reviews used audio recordings to teach hypnosis without any face-to-face sessions [17, 18, 35]. Although most trials provided hypnosis treatment to individual patients, the reviewers also reported on some trials that used group therapy for teaching hypnosis [15, 29, 36]. Seven trials included in two reviews used hypnosis combined with visual or thermal imagery [28, 33]. Many of the trials reported on the findings from studies that used hypnosis to provide suggestions for analgesia, although others included non-analgesic hypnotic suggestions [28, 33].

As noted previously, the reviews provided minimal information regarding the details of the hypnosis interventions studied in the clinical trials that were reviewed, perhaps in part because the original trials provided minimal or inadequate information. The review authors used terms such as “live hypnosis” [17, 18, 29], “direct hypnosis” or “indirect hypnosis” [33], “tailored hypnosis”[15, 32], and “standard hypnosis”[15, 29] to describe the hypnosis treatments being studied. The most common hypnotic technique studied in the trials reviewed in the 13 reviews was an adapted version of Rapid Induction Analgesia (also called Barber’s technique; [18, 34, 37]). Other techniques included what the authors referred to as “Ericksonian” hypnosis [18, 28, 32], Jacobson’s hypnosis [16], Gardner’s Technique [18, 28], Enquivist’s technique, Elmal’s technique, and Olness’s technique [18].

There were also large differences in the dose (e.g., number and length of sessions) of hypnosis and who provided the hypnotic interventions. Three reviews did not provide any information regarding the dose used in the trials reviewed [28, 30, 33], and only seven reviewers provided some information regarding who provided the hypnosis treatment, including the level of expertise of the clinicians [15, 28-30, 34-36]. Only one review reported on the training and experience of the treatment deliverer [35]. This review noted whether or not the treatment providers were trained. The frequency of hypnosis sessions ranged from just one session (most often in studies evaluating the effects of hypnosis for medical procedure-related pain; [17, 18, 34-36] to as many as fourteen sessions for treatment of chronic conditions such as fibromyalgia [32] and forty-eight sessions for ongoing breast cancer care [29]. A similar variation was also seen in the duration of individual sessions, which varied from 10 minutes [18, 35] to 2 hours [32]. Hypnosis interventions were delivered in the trials by psychologists, hypnotherapists, nurses, medical students, physicians, research assistants and psychotherapists. When hypnosis treatment was offered to treat pain associated with medical procedures, some trials provided hypnosis treatment before the painful procedure, while others provided hypnosis during the procedure [18, 28, 29, 34, 35].

Hypnosis treatment was compared against both active control conditions and standard care in the trials reviewed. Twenty-five trials compared hypnosis to usual care [15-17, 28, 35], nine to relaxation [15-17, 33, 36], six to attention control conditions [28-30], and five each to autogenic

training [16, 32, 33] and to biofeedback [16, 17, 33]. Eleven trials compared hypnosis to no treatment or waiting list [15, 16, 30, 36]. Flynn [33] reported the use of "placebo" in four trials. However, these authors did not describe what the placebo intervention referred to (i.e., whether it was a medication placebo or some other placebo or sham intervention). Trials also studied the effects of hypnosis when combined with other active treatments, such as CBT (versus CBT alone; [32]) or lorazepam (versus lorazepam only) [34].

3.1.3 Quality of Evidence

All included reviews, except the one that was unable to identify any trials to include in the review [31] and a recent review by Eason [17], assessed the quality of included trials using a validated tool. Six studies used the Cochrane Risk of Bias tool [15, 28-30, 32, 34], and one each used the PEDro Scale [33], critical appraisal instrument from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) [35] and Jadad Score [18], Downs and Black's Quality Index [36] and Yates scale [16]. The authors that assessed study quality reported that all or almost all of the trials included in their reviews were of low or moderate quality. Only two reviews rated some clinical trials as being of high quality – the studies reported by Madden and colleagues and Cramer and colleagues [15, 29]. Overall, the clinical trials reviewed in these reviews were viewed as having inadequate reporting of randomization procedures, allocation concealment and blinding of outcome assessor [15, 16, 18, 28-30, 32-36]. The review authors also indicated that they had difficulties with assessing selective outcome reporting due to a lack of trial registration [15, 16, 28, 29, 32-34]. Adachi and colleagues [16] noted the methodological quality of clinical hypnotic intervention studies had remained poor even for the most recently published studies, although there has been a trend for trials to use larger sample sizes. There were also concerns expressed by the reviewers about the potential lack of experience in delivering hypnosis in the study clinicians, potential problems with patient adherence to procedures, and inadequate reporting of missing data [15, 18, 30].

3.2 Current Evidence Regarding the Efficacy of Hypnosis

3.2.1 Efficacy of Hypnosis for Procedural Pain

Five reviews including a total of 3172 participants synthesized the effects of hypnosis on procedural pain (see Table 1) [18, 28, 29, 34, 35]. Noergaard and colleagues [35] conducted a systematic review of nine randomized controlled trials and one quasi-experimental study that assessed the effectiveness of hypnosis in adults undergoing minimally invasive medical procedures. The authors were unable to conduct a meta-analysis on effects on pain intensity and use of medication due to large heterogeneity in the outcomes studied. In eight of the studies, there were no significant differences between hypnosis and the control condition in patient-rated pain intensity. However, based on five trials that reported on use of pain medication, the authors of the review concluded that there was a decrease in pain medication consumption by 21% to 86% in the hypnosis groups compared to usual care alone.

Table 1 Summary of included reviews on hypnosis and pain.

Author, Year	Clinical population	No. Of studies	Total sample size (Range, Median)	Meta-analysis (no. of studies)	Key findings
Noergaard, 2019 [35]	Adults undergoing minimally invasive	10	1364 (26 to 350, 105)	Yes, but not for outcomes procedures of interest	• Hypnosis = Usual care [pain intensity] (n= 8) • Less pain medicine consumption in hypnosis group (n=5)
Eason et al., 2018 [17]	Adults with mixed clinical pain conditions	11	2656 (15 to 1,222, 60)	Yes, but not pain-specific	• Self-hypnosis > Other active controls* (n=6) • Self-hypnosis > Standard care (n=2) • Self-hypnosis not useful for labor pain (n=3)
Flynn, 2018 [33]	Adults with migraine	8	Not Reported	No	• Hypnosis > Autogenic training (n=2) • Hypnosis > Biofeedback (n =1) • Hypnosis = Non-hypnotic imagery (n =1)
Provencal et al., 2018 [34]	Burn patients receiving wound care	6	234 (26 to 61, 31)	Yes (5)	• Hypnosis > Attention control and medication conditions [(MD = −8.90, (95% CI −16.28 to −1.52)]**
Montgomery et al., 2017 [31]	Cancer patients	0	-	-	• No studies met inclusion criteria
Zech et al., 2017 [32]	Adults with fibromyalgia	5	229 (32 to 63, 40)	Yes (9)	• Hypnosis = CBT (n=2) • Hypnosis > Physiotherapy and no treatment at 3 months [NNT for 30% decrease in pain= 5 (95%CI, 3 to 50)]
Madden et al., 2016 [15]	Women in labor	9	2954 (38 to 1,222, 65)	Yes (9)	• Hypnosis > Usual care and supportive therapy [RR to use pain relief = 0.73 (95% CI 0.57 to 0.94)] (n=8)

Cramer et al., 2015 [29]	Women diagnosed with or suspected of having breast cancer	5	671 (20 to 240, 125)	No	• Pre-operative hypnosis > Attention (n=1) • Pre-operative hypnosis > Usual care (n=2) • Hypnosis + exercise > Self-education (n=1) • Hypnosis + support group > Usual care and support group only (n=1)
Zhang et al., 2015 [30]	Adults with temporo-mandibular disorders	2	64 (25-39, 32)	Yes (2)	• Hypnosis > No treatment and attention control [MD= -28.33; (95% CI: -44.67 to -11.99)]**
Adachi et al., 2014 [16]	Adults with chronic pain	12	669 (22 to 157, 42)	Yes (12)	• Hypnosis > Standard care [g =.60, (95% CI 0.03 to 1.17)] (n=4) • Hypnosis = Other psychological interventions† (n=11)
Birnie et al.,2014 [28]	Children undergoing needle punctures	7	225 (25 to 60, 30)	Yes (5)	• Hypnosis > Play, CBT, attention control, and local anesthesia [SMD=1.40 (95% CI 2.32 to 0.48)]
Bowker et al, 2014 [36]	Adults with chronic disability	10	365 (20 to 66, 34)	Yes (10)	• Hypnosis > Waiting list [pain intensity] [ES= 0.53 (90% CI 0.28 to 0.84)] • Hypnosis = CBT, other behavior treatment
Cheseaux et al., 2014 [18]	Adults and children undergoing medical procedures	13	678 (20 to 200, 36)	No	• Hypnosis > Psychological treatments‡ (n=4) • Hypnosis > No treatment (n=3) • Hypnosis = No treatment and other psychological treatments (n= 5)

*Biofeedback, pain education, attention control, empathy, sedatives.

**Based on a meta-analysis.

†Autogenic Training (n=4), Relaxation and Visualization (n=2), Progressive muscle relaxation (n=2), CBT (n=1), Supportive Psychotherapy (n=1) and Biofeedback (n=1).

‡ Psychological Interventions used in individual studies not reported by authors.

Note: Only RCTs within reviews that examined the effects of hypnosis on pain are reported. ES= Effect Size, CI= Confidence Interval, MD= Mean Difference, CBT= Cognitive Behavior Therapy, NNB= Number needed to Benefit, RR= Risk Ratio, SMD= Standard Mean Difference.

Provencal and colleagues conducted a systematic review of 6 RCTs published from 1980 to 2017 that compared the use of hypnosis in wound care in adult burn patients [34]. The meta-analysis of 5 trials showed a statistically significant effect of hypnosis on subjective pain intensity among adults undergoing treatment of burns (MD = −8.90 on a 100mm scale, 95% CI −16.28, −1.52) but no effects of hypnosis on the use of analgesic medications. However, due to a small number of studies included in the meta-synthesis, of which four were from the same research group, the authors conclude that results, while promising, need to be interpreted with caution.

Cramer and colleagues [29] also narratively synthesized results of 5 RCTs that examined the effects of hypnosis on pain during breast cancer care (including during a diagnostic biopsy). Of these, three RCTs reported decreases in post-procedural pain compared to standard care, and one of the two RCTs showed significantly lesser pain compared to attention control. The authors recommended that more research is needed to confirm these promising initial findings.

Another review published in 2014 [28] synthesized the findings from nine RCTs examining the effects of hypnosis for decreasing pain and distress during needle procedures in children aged 2-19 years. Five RCTs including 176 participants showed significant effects of hypnosis on self-reported pain intensity (SMD= 1.40 [2.32, 0.48], Z=2.97, p<.01, I2=85%) compared to play therapy, attention control, CBT and local anaesthesia. However, based on GRADE ratings, the quality of the evidence from the trials reviewed was deemed to be very low.

Finally, Cheseaux and colleagues [18] reviewed the results of 18 RCTs published before 2012 that evaluated the effects of hypnosis provided before diagnostic or therapeutic medical procedures, such as EMG, surgery, and lumbar punctures among both children and adults. Among 13 trials that reported pain outcomes, eight trials did not find significant effects on pain intensity for hypnosis compared to control conditions, while five reported a significant decrease in pain. However, as with other reviews, the author reported problems with heterogeneity in hypnotic interventions and comparators, as well as a general low methodological quality of the trials they reviewed.

3.2.2 Efficacy of Hypnosis for Chronic Pain

We identified four reviews that studied the efficacy of hypnosis in adults with chronic pain [16], disability [36], and fibromyalgia [32] and chronic headache [33]. In the first of these, Adachi and colleagues [16] reviewed results of 12 clinical trials, 6 of which were RCTs and concluded that hypnosis had a moderate effect (Hedges' g =.60, 95% CI: 0.03–1.17, p< .05) on treatment efficacy compared to standard care, but were not significantly more effective than other psychological pain interventions (g= .04, 95% CI: –0.22–0.30, ns). However, there was moderate to large heterogeneity for both the results. The authors also recommended that authors need to improve methodological quality in future studies.

A review in 2017 by Zech and colleagues [32] synthesized findings from five RCTs that evaluated the effects of hypnosis on pain in adults with fibromyalgia published between 2010 and 2016. The trials reported no difference in results between CBT combined with hypnosis compared to CBT alone (Risk Difference 0.08 (95% CI -0.05, 0.21)). In addition, no significant differences were found in the efficacy of either guided imagery or hypnosis when compared to a control condition for a greater than 50% decrease in pain. However, low-quality evidence with large heterogeneity

suggested that hypnosis was superior to controls when the outcome was a 30% decrease in pain intensity (NNTB= 5, (95% CI 3–50)), suggesting some benefit of hypnosis.

Flynn [33] conducted a systematic review of 8 RCTs evaluating the effects of hypnosis in adults with migraine or chronic headache disorders. Of these, four studies used hypnosis in conjunction with visual imagery and five studies used self-hypnosis techniques. Of the 8 studies included, five out of six studies reported significant decreases in headache activity in participants who received hypnosis compared to those who received other psychological interventions. Four studies found no significant differences between hypnosis treatment when compared to "placebo" (specific placebos used not specified in the review) treatment.

Bowker and colleagues [36] conducted a meta-analysis of studies examining the effectiveness of hypnosis for chronic pain in adults with long-term disabling conditions such as fibromyalgia, osteoarthritis or spinal cord injury. The authors found evidence in favour of hypnosis, with a medium weighted effect size of 0.53 (CI = 0.28–0.84) in comparison to no-treatment or education-only control conditions (n = 6 studies). They also found, however, that hypnosis treatment was not significant more effective than cognitive or behavioral pain interventions (n=6). Five studies also showed greater reductions in pain medication use among the participants who received hypnosis at 3 to 6 months, compared to control conditions which included no treatment, relaxation, or physical therapy.

3.2.3 Efficacy of Hypnosis for Other Pain Conditions

A recent systematic review by Eason and colleagues [17] reviewed 22 RCTs to assess the clinical uses of self-hypnosis. Only eight of the included RCTs assessed efficacy of self-hypnosis in the management of painful conditions which included chronic pain (n=3, one of which also included in [16]), labor pain (n=3, all studies also included in [15]) and procedural pain (n= 2, one of which also included in [29]). In all the eight studies reviewed, training in hypnosis followed by self-hypnosis was more effective for reducing pain than control conditions such as biofeedback, structured attention, relaxation, empathy, sedatives, and standard care.

Montgomery and colleagues [31] conducted a systematic search of five databases for RCTs published before November, 2016 that reported data regarding the effects of hypnosis for treating patients with cancer at the end-of-life. Specifically, they looked for outcomes related to pain, fatigue, dyspnoea, appetite loss or sleep disturbance. However, the authors were unable to find any relevant studies and concluded that hypnosis had not yet been rigorously tested in end-of-life cancer patients.

A Cochrane review performed in 2016 synthesized findings from 9 RCTs including 2954 patients that evaluated the effects of hypnosis for labor pain [15]. In eight of the studies, hypnosis training was provided during the antenatal period. In one study, the hypnosis intervention was provided during labor. The authors found that women in hypnosis group were less likely to use pharmacological pain relief or analgesia than those in the control groups, (average risk ratio (RR) 0.73, 95% CI 0.57 to 0.94, eight studies, 2916 women; very low-quality evidence; random-effects model; substantial statistical heterogeneity), but there was no effect on epidural use. There were no significant differences between the hypnosis group and control groups for satisfaction with pain relief either.

Finally, Zhang and colleagues [30] reviewed two RCTs that evaluated the efficacy of hypnosis compared to no treatment and attention control in patients with temporomandibular disorders. Based on data from the trials, there was very low-quality evidence that hypnosis was comparable to the control groups for reduction in overall pain (MD= -9.16 mm on 100 mm scale; 95% CI: -23.47 to 5.14; P = .21) but may have some benefit for reduction in maximal pain (mean difference on 100 mm scale = -28.33; 95% CI: -44.67 to -11.99; P =.007).

4. Discussion

The results of this scoping review provide important summary information regarding our current knowledge about the efficacy of hypnosis for clinical pain, as well as the current state of the quality of research in this area. The findings may be useful to clinicians who are considering using hypnosis in their practice, as well as to future researchers. In this section, we discuss the implications of the findings with respect to three specific areas: issues related to the heterogeneity of "hypnosis", recommendations for improving the quality of research, and conclusions regarding treatment efficacy.

4.1 The Heterogeneity of "Hypnosis"

The review findings made clear that hypnosis treatments can vary a great deal across a large number of characteristics. Hypnosis treatment can vary with respect "dose" (number and length of face-to-face sessions), frequency of hypnosis treatments, the training and experience of the clinicians providing the treatment, whether or not and the extent to which participants practice hypnosis on their own between sessions (with or without audio recordings to assist them with home practice), and the specific content of the hypnotic inductions and suggestions. Moreover, there is a great deal of heterogeneity with respect to the types of pain conditions examined in this literature [38]. For example, acute pain differs in many important ways from chronic pain, and different chronic pain conditions can differ to a great extent with respect to both type and etiology [39].

Researchers would do well to keep the heterogeneity of hypnosis in mind when designing and conducting hypnosis trials. First, they should carefully consider each component of the hypnosis intervention they plan to test (i.e., dose, treatment frequency, use of experienced clinicians, participant practice, use of audio recordings, and content of the suggestions), perhaps balancing feasibility against the need to maximize efficacy. If the trial authors do not make efforts to maximize efficacy by, for example, providing a minimal number of treatment sessions, encouraging and facilitating between-session practice, and using clinicians with adequate training and experience, it could be difficult to conclude if a null finding is due to a lack of efficacy of hypnosis in general or because of problems with the way that hypnosis treatment was delivered. Also of great importance, researchers should carefully and clearly describe each of these components of the hypnosis treatment tested. This could be done either in the text of the paper that presents the findings, or as supplementary materials (e.g., as a study treatment manual used by the study clinicians and that could be provided to readers who request it). Checklists such as the Template for Intervention Description and Replication (TiDieR) can be useful resources for describing the hypnotic treatments evaluated in the trials [40].

By providing this level of detail, future investigators who perform reviews of the literature could then classify each clinical trial with respect to each of these domains, and then evaluate the level of efficacy (e.g., pain reduction) as a function of each factor. They may learn, for example, and that for certain pain conditions, maximum benefit occurs with at least four 60 minute sessions of hypnosis provided by clinicians supervised by very experienced clinicians and that includes suggestions both for pain reduction and for changing the meaning of sensations, but that regular practice at home does not provide any additional benefits. Providing detail regarding the hypnotic treatment being evaluated would also be very important for reviewers to be able to understand when (and for whom) hypnosis has no, minimal or large benefits.

In addition, some research suggests that trait hypnotizability – that is, the tendency of an individual to respond to hypnotic suggestions – might potentially moderate the efficacy of hypnosis for pain management [41-43]. These moderation effects appear to be more pronounced in laboratory-based settings than studies of patients with clinical pain [44]. However, this issue was rarely addressed in the reviews we summarized in the current study, perhaps in part because researchers tend to not evaluate these effects in clinical trials. We recommend that not only should trials evaluate whenever possible, using one of the several measures of hypnotizability that are available [45], but that future reviews should include a section discussing this issue, specifically.

Another important issue to consider is whether review authors should perform meta-analysis when significant heterogeneity is found in the clinical trials being reviewed. When there is a variety of different treatments (i.e., in this case, different types of hypnosis treatments) and different comparators, it is recommended that the meta-analysis should consider each combination separately [46]. Moreover, meta-analyses should also exclude studies with high risk of bias [46]. Each of the seven meta-analyses included in the current scoping review reported a high level of heterogeneity in the trials reviewed, and some reported additional publication bias. Each of these factors suggests that it may be too early to use a meta-analytic approach to summarize the findings from hypnosis studies. A greater number of high-quality clinical trials that evaluate similar hypnotic approaches and compare them to similar control conditions will be needed before a meta-analyses of this literature will likely be useful.

4.2 The Low Quality of the Existing Evidence

Despite the large and growing body of research evidence on the efficacy of hypnosis for clinical pain, all of the reviewers noted that the quality of the clinical trials that have been published is low. Moreover, one review [16] noted that although more recent studies include larger sample sizes, the quality of the evidence has not tended to improve over the years.

In order for the conclusions regarding the efficacy of hypnosis treatments to be more definitive, improving the quality of the research evidence should be given a high priority. Researchers could use any one of a number of research quality rating tools (e.g., [47-49]) as a guide to help ensure that their trials meet the highest possible quality standards. As noted in the results section of this scoping review, the problems noted most often by the reviewers of the hypnosis literature include a lack of detail regarding randomization procedures, a lack of treatment allocation concealment, a lack of blinding of the individual(s) performing the outcomes assessments, and a lack of registration of the trial prior to study enrollment.

However, although it is possible (and important) to blind the research staff who perform the outcomes assessment to treatment condition, it is extremely challenging to blind treatment providers and study participants to treatment allocation when evaluating the efficacy of behavioral interventions [50, 51], including hypnosis. Requiring this level of blinding of clinical trials in this area for a study to be viewed as being of high quality would by definition mean that a high-quality hypnosis clinical trial is next to impossible. Given this, special design features for behavioral clinical trials are needed. These include, for example, the use of multiple (active treatment) comparison conditions, use of "dual-blind" designs in which participants are blind with respect to the treatment condition that is the focus of the trial, and the development of special treatment conditions that control for the non-specific effects of the behavioral intervention, but do not include the components of the treatment thought to have specific effects [52, 53].

Moreover, it may make sense to use tools for rating research quality that do not require that the study participant be blind to treatment conditions in order to deem a study as being of high quality. One example of such a tool was introduced in 2005 [54]. This tool focuses on 13 design features that are specific and unique to trials of psychological interventions for pain management. Thus, it emphases the importance of design features important and necessary for such trials (e.g., clinician experience and training, strategies to engage participants in treatment), while placing less emphasis on design features that are of less importance to the design and conduct of studies evaluating the efficacy of psychological interventions (e.g., allocation blinding). It is also more comprehensive than many of the other existing tools. Trialists would do well to consider using this tool as a guide when designing hypnosis trials, and reviewers should consider using this tool (or others that might also be developed specifically for evaluating psychological interventions) when rating the quality of hypnosis clinical trials.

4.3 The Efficacy of Hypnosis for Pain Management

The conclusions made by the authors of the 13 reviews we identified regarding the efficacy of hypnosis as a treatment for pain here were inconsistent. Hypnotic treatments were found beneficial in some studies for pain associated with medical procedures such as burn wound care, cancer treatments, and needle puncture. The findings also suggest the possibility that hypnotic treatments can be effective for chronic headache conditions and labor pain. In contrast, other systematic reviews [16, 35, 36] reported hypnosis was as good as usual care or other psychological interventions for treatment of procedural pain and chronic pain. However, in no case was hypnosis found to be worse than any control condition. In short, the evidence indicates that hypnosis as a treatment for clinical pain remains promising, but not yet proven effective. Strong recommendations for or against the use of medical hypnosis cannot, therefore, be made at this time.

5. Conclusions

Hypnosis may be an effective treatment for a large variety of clinical pain conditions, but the efficacy is yet to be verified in high-quality trials. Hypnosis appears to be promising as an intervention compared to no treatment for the pain associated with burn wound management, cancer treatments, needle injections, and a variety of chronic pain conditions. Hypnosis also appears to be as effective as other psychological pain treatments. There is a consensus from the

systematic reviews that the quality of the trials on efficacy of hypnosis for pain management remains low. Trialists performing research in this field should use recommended guidelines and checklist(s) while planning and reporting their trials. This will allow other researchers to replicate their findings and also allow reviewers to use this information when determining the factors that impact the effects of hypnosis in future studies.

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Author Contributions

AP, MJ and SS were all involved in designing the protocol of the review. AP and MJ conducted the screening independently, AP conducted the data extraction and all AP, MJ and SS were involved in drafting and editing the manuscript.

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Competing Interests

One of the team members, Mark P. Jensen, PhD, has published books on hypnosis, and receives royalties for the sales of these books.

Additional Materials (if any)

The following additional materials are uploaded on the page of this paper.

1. Table S1 Description of the hypnosis interventions evaluated in the trials reviewed (as reported by trial authors).

First author, year	Hypnosis Intervention	Comparator(s)	Hypnosis dose	Delivered by
Noergaard et al., 2019 (Review of trials evaluating the efficacy of hypnosis for minimally invasive procedures) [35]				
Hilzi, 2015	"Hypnosis"	Usual care	NR	Physician
Norgaard, 2013	Guided self-hypnotic relaxation + attentive behaviour + usual care	1) Usual care	NR	Nurse
Shenefelt, 2013	Hypnotic induction + self-guided imagery during procedure + usual care	1)Usual care 2) Recorded hypnotic induction (group not included in review)	1 (10 min) session	Physician
Slack, 2009	Self-hypnosis using audio recording only	Usual care + audio recording of patient education booklet	1 (20 min) session	N/A (recordings)
Marc, 2008	Hypnotic relaxation + usual care	Usual care	1 (20 min) session	Hypno-therapist
Lang, 2008	Self-hypnotic relaxation with empathic attentive behavior + usual care	1)Usual care 2) Empathic attentive behaviour (group not included in review)	NR	Research assistant
Marc, 2007	Hypnotic relaxation + usual care	Usual care	1 (20 min) session	Hypnotist practitioner

Lang, 2006	Self-hypnotic relaxation with empathic attentive behaviour + usual care	1)Usual care 2) Empathic attentive behaviour (group not included in review)	NR	Research assistant
Lang, 2000	Self-hypnotic relaxation with empathic attentive behavior + usual care	1)Usual care 2) Empathic attentive behaviour (group not included in review)	NR	"Additional person"
Lang, 1996	Hypnosis using relaxation and guided imagery + usual care	Usual care	NR	"Dedicated practitioner"
Eason et al., 2018 (Review of trials evaluating the effects of self-hypnosis)[17]				
Downe, 2015	Live + self-hypnosis using audio recordings	Usual care	2 (90-min) sessions, 3 weeks apart	NR
Tan, 2015	Live hypnosis with or without self-hypnosis + self-practice	Biofeedback	8 sessions (time NR) w/ or w/o practice or 2 sessions	NR
Werner, 2013	Self-hypnosis using only audio recordings	1)Mindfulness, body awareness training and relaxation 2) Usual care	3 (time NR) sessions	NR
Jensen, 2011	Live + self-hypnosis using audio recordings	1)Cognitive restructuring 2) Education	4 (time NR) sessions	NR

Jensen, 2009b	Live + self-hypnosis using audio recordings	EMG biofeedback	10 (time NR) sessions	NR
Liossi, 2006	Live + self-hypnosis + EMLA	1)EMLA + attention 2) EMLA only	3 (time NR) sessions	NR
Lang, 2006	Live-hypnosis before procedures	1)Empathy 2) Usual Care	1 (time NR) session	NR
Lang, 2000	Live-hypnosis before Procedures	Conscious sedation	1 (time NR) session	NR
Lang, 1996	Live-hypnosis before Procedures	Conscious sedation	1 (time NR) session	NR
Harmon, 1990	Live + self-hypnosis Once/day	Audio-recordings with active engagement	6 (time NR) sessions	NR
Olness, 1987	Live + self-hypnosis twice/day	Propranolol	5 (time NR) sessions	NR
Flynn, 2018 (Review of trials evaluating the efficacy of hypnosis for chronic headache)[33]				
Nolan, 1995	Hypnosis + visual imagery + self-hypnosis	1)Non-hypnotic imagery 2) “Placebo”	NR	NR
ter Kuile, 1994	Live + self-hypnosis	Autogenic training	NR	NR
Spanos, 1993	Hypnosis + visual imagery	“Placebo”	NR	NR

Spinhoven, 1992	Hypnosis + visual imagery + self-hypnosis	Autogenic training	NR	NR
Melis, 1991	Hypnosis + visual imagery + self-hypnosis	NR	NR	NR
Levinthal, 1987	Direct + indirect hypnosis	Relaxation training	NR	NR
Friedman, 1984	Hypnosis + Thermal Imagery	1)Biofeedback 2) Relaxation	NR	NR
De Fazzano,1980	Self-hypnosis	"Placebo"	NR	NR
Provencal et al, 2018 (Review of trials evaluating the efficacy of hypnosis for pain associated with burn injury wound care)[34]				
Askay, 2007	Adapted RIA+audio recordings	Attention control	NR	NR
Frenay, 2001	"Permissive suggestion"	Stress reduction strategy	NR	NR
Wright, 2000	Adapted RIA	Usual care	1 (15 min) session	NR
Patterson, 1997	Adapted RIA	Attention Control+education	1 (25 min) session	NR
Everett, 1993	Adapted RIA	1)Attention control 2)Lorazepam + hypnosis 3) Lorazepam only	1 (25 min) session	NR
Patterson, 1992	Adapted RIA	1)No treatment 2) Attention control +	1 (25 min) session	Psychologist

		education		
Zech et al, 2017 (Review of trials evaluating the efficacy of hypnosis for fibromyalgia)[32]				
Picard, 2013	Tailored Hypnosis	Waiting list	5 (60 min) sessions	NR
Castel, 2012	"Traditional" hypnosis +CBT	CBT	14 (120 min) sessions, 1 session/week	NR
Castel, 2009	"Traditional" hypnosis + CBT	CBT	12 (90 min) sessions, 1 session/week	"Therapist"
Rucco, 1995	"Ericksonian" hypnosis	Autogenic Training	"Variable"	NR
Haanen, 1991	"Traditional" hypnosis	Physiotherapy	8 (60 min) sessions	NR
Bowker et al, 2016 (Meta-analysis of trials evaluating the efficacy of hypnotherapy for disability-related pain)[36]				
Picard, 2013	Individual hypnosis + daily self-hypnosis	Waiting list	5 (60 min) sessions over 9 weeks	Psychologist
Jensen, 2011	Individual hypnosis and Cognitive restructuring +Daily self-hypnosis	1)Education 2) Cognitive restructuring alone	4 (30 min) sessions	Clinicians
Jensen, 2009a	Individual hypnosis+daily self-hypnosis	Progressive muscle relaxation	10 (time NR) sessions	Clinicians
Jensen, 2009b	Individual hypnosis + daily self-hypnosis	EMG biofeedback relaxation	10 (40 min) sessions	Clinicians

Castel, 2007	Individual hypnosis	Progressive Muscle relaxation	1 (20 min) session	Researcher
Jensen, 2005	Individual hypnosis	No treatment	10 (time NR) sessions	Clinicians
Rickard, 2004	Individual hypnosis	Waiting list	5 (60 – 90 min) Sessions	NR
Gay, 2002	Individual hypnosis	1)Waiting list 2) Jacobson's relaxation	8 (30 min) session	Psychologist+Students
Horton, 2000	Group therapy + Self-hypnosis	1)Waiting list 2) Relaxation	10 (90 min) sessions, once per week	NR
Haanen, 1991	Individual hypnosis	Physical therapy	8 (60 min) sessions over 3 months	Hypno-therapist
Madden et al, 2016 (Review of trials evaluating the efficacy of hypnosis for labour pain)[15]				
Downe, 2015	Group therapy+Self-hypnosis with audio recordings	Usual care	2 (90 min) sessions	NR
Werner, 2013	Group therapy + Self-hypnosis with audio recordings	1) Relaxation 2) Usual care	3 (60 min) sessions	NR
Cyna, 2011	Group therapy+Self-hypnosis using audio recordings	No treatment	3 (time NR) sessions	Hypnotherapist or a nurse with-out hypnosis training
Fisher, 2009	Hypnobirthing course (group)	Usual Care	NR	NR

Mehl-Madrona, 2004	Individual hypnosis	Supportive psychotherapy	NR	Author
Martin, 2001	Individually tailored hypnosis treatment	Supportive counselling	4 (time NR) sessions	NR
Harmon, 1990	Group session once + audio recordings	Control audiorecording (content unspecified)	7 (time NR) sessions	NR
Freeman, 1986	Individual hypnosis	Usual care	Variable: weekly (time NR) sessions from 32nd week of pregnancy	NR
Rock, 1969	"Standard" hypnosis	Usual care	NR	Medical student
Cramer et al, 2015 (Review evaluating the efficacy of hypnosis for pain associated with breast cancer treatment and evaluation procedures)[29]				
Butler, 2009	Hypnosis + Supportive expressive therapy	Self-directed education	48 (time NR) sessions, 1/week for 12 months	Physician or psychologist
Montgomery, 2007	Live standardized hypnosis	Attention control	1 (time NR) session	NR
Lang, 2006	Live standardized hypnosis	1) Usual care 2) Attention control	1 (time NR) session	Student or physician
Montgomery, 2002	Live standardized hypnosis	Usual care	1 (time NR) session	Clinical psychologist
Spiegel, 1983	Self-hypnosis +Psychological support group	1) Psychological Support group 2) Usual Care	48 (time NR) sessions, 1/week for 12 months	Counsellors

Zhang et al, 2015 (Review evaluating the efficacy of hypnosis for temporomandibular disorders)[30]				
Angelone, 2008	Hypnosis + Deep relaxation	Attention Control	NR	Psychotherapist
Winocus, 2002	Hypno-relaxation	No treatment	NR	Hypno-therapist
Adachi et al, 2014 (Review evaluating the efficacy of hypnosis for chronic pain)[16]				
Abrahamsen, 2009	Hypnosis + self-hypnosis using audio recordings	Relaxation and visualization	4 (60 min) sessions	NR
Castel, 2009	Hypnosis + CBT + self-practice using audio recordings (in group)	1) CBT 2) Usual care	12 (90 min) sessions	NR
Jensen, 2009a	Hypnosis + self-hypnosis using audio recordings	Progressive muscle relaxation	10 (time NR) sessions, frequency varied	NR
Jensen, 2009b	Hypnosis + self-hypnosis using audio recordings	Biofeedback	10 (time NR) sessions, frequency varied	NR
Abrahamsen, 2008	Hypnosis + self-hypnosis using audio recordings	Relaxation and visualization	3 to 6 sessions (time NR)	NR
Jones, 2006	Hypnosis + self-hypnosis using audio recordings	Supportive psycho-therapy	12 (30 min) sessions	NR
Gay, 2002	Jacobson's hypnosis	1) Progressive muscle relaxation 2) No treatment	8 (30 min) sessions, 1/week	NR

Palsson, 2002	Hypnosis + self-hypnosis using audio recordings	Waiting List	7 (45 min) sessions, 2/week	NR
ter Kuile, 1994	Hypnosis + self-hypnosis using audio recordings twice daily	1) Autogenic training 2) Waiting List	7 (60 min) sessions, 1/week	NR
Spinhoven, 1992	Hypnosis + self-hypnosis using audio recordings twice daily	Autogenic training	4 (45 min) sessions, 2/week	NR
Zitman, 1992	Future-oriented hypnotic imagery + audio Recordings (49 hrs of self-practice)	1) Future oriented imagery 2) Autogenic training	8 (300 min total), sessions, frequency NR	NR
van Dyck, 1991	Future-oriented hypnotic imagery + audio recordings (25hrs of self-practice)	Autogenic training	4 (150 min total) sessions, frequency NR	NR
Birnie et al, 2014 (Revie of trials evaluating the efficacy for procedural pain in children and adolescents)[28] (Note: data for two studies not provided by reviewers)				
Huet, 2011	Three-step "Ericksonian" procedure (during procedure)	Standard Care	NR	Hypno-therapist
Liossi, 2009	Hypnosis using visual imagery and analgesic suggestion + self-hypnosis training using Gardner's model + EMLA	Attention control + EMLA	NR	NR
Liossi, 2006	Hypnosis using visual imagery and analgesic suggestion +	Attention control + EMLA	NR	NR

	self-hypnosis training + EMLA			
Liossi, 2003	Analgesic or non-analgesic	Usual care + attention hypnotic suggestion before control and during procedure	NR	NR
Liossi, 1999	Hypnosis using visual imagery and analgesic suggestion + usual care	Usual care	NR	NR
Kuttner, 1988	Hypnotic suggestion using child's favourite story	1) Distraction 2) Usual care	NR	Therapist
Katz, 1987	Training for self-hypnosis based on active imagery tailored to the child's interest (pre-treatment)	Play session	NR	Psychologist
Cheseaux et al, 2014* (Review of trials evaluating the efficiency of hypnosis for pain associated with medical procedures)[18]				
Slack, 2009	Audio recorded hypnosis	Active control	1 (20 min) session	NR
Montgomery, 2007	Live hypnosis	Active control	1 (15 min) session	NR
Montgomery, 2002	Live hypnosis	Inactive control	1 (10 min) session	NR
Ghoneim, 2000	Audio recorded hypnosis	Inactive control	"Several" (time NR) sessions	NR
Liossi, 1999	Live hypnosis	Active control	2 (30 min) sessions	NR

Enqvist, 1997	Audio recorded hypnosis	Inactive control	20 min sessions, number of sessions NR	NR
Enqvist, 1997	Audio recorded hypnosis	Inactive control	"Several" (20 min) sessions	NR
Patterson, 1997	Live hypnosis	Active control	1 (25 min) session	NR
Lambert, 1996	Live hypnosis	Active control	1 (30 min) session	NR
Everett, 1993	Live hypnosis	Active control	1 (25 min) session	NR
Patterson, 1992	Live hypnosis	Both	1 (25 min) session	NR
Wall, 1989	Live hypnosis	Active control	2 (time NR) sessions	NR
Katz, 1988	Live hypnosis	Inactive control	2 (20 to 30 min) sessions	NR

Note: Trials listed with the first author and date **in bold face text** are trials that have been included in more than one review.

NR= Not reported, EMG= Electromyography; EMLA = Eutectic Mixture of Local Anaesthetics; RIA = Rapid Induction Analgesia ([37]); CBT= Cognitive Behavioural Therapy;

* Cheseaux et al, 2017- Reviewer's note: For types of hypnosis intervention used, 4 RCTs used Barber's RIA technique [37], 3 used Rhue's technique ([55]), and one each used techniques described by the authors as Ericksonian [56], Enqvist's [57], Elmal's [58], Olness and Gardner's technique [59]. 7 RCTs described hypnosis intervention in detail but they were not based on a particular model or approach. Active comparators included non-directive empathetic listening, attention support, CBT, discussion about medical procedures. For inactive comparators, 5 RCTs used no intervention.

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Review

Paradigms in Integrative Medicine and the Place of Clinical Hypnosis

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Abstract

The face of illness has changed with progress in public health, immunizations, and antibiotic medication. Today, medical clinics are more likely to see patients with chronic illnesses, stress-related conditions, and complex bio-psycho-social conditions. This is a global trend, affecting patients worldwide, as Western lifestyle and diet have produced increases in chronic lifestyle-based disorders. Integrative medicine, which attends more fully to psychosocial dimensions of illness, appears to offer promise for today's patient. One might expect hypnosis to assume a central place in integrative healthcare settings, because hypnosis is evidence-based, person-centered, and attuned to subjective and life-historical dimensions of the human being. However, hypnosis currently receives relatively little attention in integrative medicine circles, and hypnosis is underutilized in spite of the availability of many effective clinical protocols for a wide range of medical disorders. This article introduces emerging paradigms in integrative healthcare and suggests that the field of hypnosis must increase attention to these paradigms and improve educational preparation for hypnosis practitioners to function within these paradigms.

Keywords
Clinical hypnosis; integrative medicine; paradigms; lifestyle medicine; interprofessionalism; competencies

1. Background

1.1 Changing Face of Illness

The face of illness has changed [1, 2]. In 1900 physicians faced the scourge of acute conditions, which often killed quickly. Infectious diseases, bacterial parasites, and unhealed physical trauma all took a toll on human beings with heavy mortality rates for untreatable conditions. The impact of public health, immunization, and antibiotic medications have reduced the illnesses of the past to the margin in health care. Today's primary care clinic rarely sees typhoid, cholera, smallpox, or polio.

Instead, patients approach the clinic today with chronic illnesses, stress-related conditions, and in general complex bio-psycho-social conditions. Authorities in medicine have been calling for several decades for a more integrative approach to health, to address the contributions of the biological, psychological, and social dimensions to illness [3-5]. Hypertension, depression, anxiety, diabetes, fibromyalgia, chronic fatigue, and chronic pain are more common problems in the 21st century, each reflecting complex etiology, with life stress and lifestyle influencing both onset and progression [2].

These problems are global, spreading rapidly into the developing world, with the influences of urbanization, Western diet and lifestyle, and an aging world population. The World Health Organization has highlighted the trend for non-communicable diseases, largely chronic conditions, to burden populations in developing nations, which now are forced to budget for healthcare systems to deal with the old problems of infectious diseases and bacterial parasites while simultaneously treating epidemic numbers of patients with lifestyle-related problems [6-8].

Several authors have articulated a vision of integrative healthcare. Harold Koenig, a leader in the importance of religion and spirituality in health care, commented that:

> *Patients want to be seen and treated as a whole person, not as diseases. A whole person is someone whose being has physical, emotional, and spiritual dimensions. Ignoring any of these aspects of humanity leaves the person incomplete and may even interfere with healing* [9].

Andrew Weill, who founded the first fellowship for physicians in integrative medicine, defines integrative medicine as:

> *…healing-oriented medicine that takes account of the whole person, including all aspects of lifestyle. It emphasizes the therapeutic relationship between practitioner and patient, is informed by evidence, and makes use of all appropriate therapies* [10].

Since 1946, the WHO has called for treating the whole person, defining health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [11].

Integrative medicine has been promoted as a response to the global healthcare crisis, because it is focused broadly on psychosocial dimensions of illness, is person-centered, and emphasizes dietary, behavioral, and lifestyle change.

1.2 The Place of Hypnosis in Integrative Healthcare

One might expect a central role for hypnosis in integrative healthcare. Hypnosis draws on the inner resources of the person. It is delivered within the context of the patient-provider relationship. It has an extensive research base [12-15]. It addresses dimensions of the person-with-illness beyond the bio-medical, including life-historical factors such as adverse childhood experiences [16].

Hypnosis has been shown to facilitate habit change, including health-risk habits, with smoking cessation and smoking relapse prevention [17-20]. Hypnosis has been shown to prepare patients effectively for surgical procedures and other medical interventions, to a degree producing cost-savings in overall care [21, 22]. Hypnosis also moderates the adverse effects of medical procedures such as radiation therapy for cancer patients [23]. Hypnosis facilitates pain management for a wide variety of pain types, including acute pain, chronic pain, and pain accompanying medical procedures [15, 24, 25]. Hypnosis and hypnotic language can also be utilized by hospital and clinic personnel, with significant improvements in patient satisfaction [26, 27].

Early in the emergence of integrative medicine, [28] reviewed the relevance and credibility of hypnosis for inclusion in integrative medicine. He reported that NIH regards hypnosis as a complementary and alternative intervention. He reviewed outcome data on 17 medical applications of hypnosis, from allergy to urology, and concluded that "patients treated with hypnosis experienced substantial benefits for many different medical conditions" (2005, p. 511).

Nevertheless, the current dialogue on integrative medicine gives only sporadic attention to hypnosis and hypnosis remains underutilized in healthcare. The National Center for Complementary and Integrative Healthcare, the successor to the National Center for Complementary and Alternative Medicine, does not mention hypnosis in its discussion of mind-body practices, while chiropractic, acupuncture, yoga, and guided imagery are all mentioned [29]. Hypnosis is not listed among the 10 most commonly used complementary health approaches in national health statistics reporting [30], The American College of Physicians updated its recommendations for acute, sub-acute, and chronic low back pain in 2017, and called for non-invasive alternative treatments to be attempted before surgery, and further recommended a variety of alternative therapies to be implemented before medication. The guidelines differed for acute low back pain, chronic low back pain, and radicular low back pain, and included acupuncture, massage, heat, yoga, EMG biofeedback, and mindfulness, but *not hypnosis* [31]. Similarly, Lake, a leader in the integrative mental health (IMH) movement, gives minimal attention to hypnosis as a modality for IMH, while emphasizing acupuncture, herbal and nutritional medicine, yoga, and meditation [32-34].

2. Emerging Paradigms of Integrative Medicine

In the remainder of this paper I will provide an overview of several emerging paradigms in the field of integrative healthcare. I propose that for hypnosis to assume a significant role in

integrative healthcare, we must increase our attention to these paradigms, and improve educational preparation for hypnosis practitioners to function within these paradigms. Readers may also wish to consult [35] for a qualitative analysis of several definitions of integrative medicine and health.

2.1 Integration within the Traditional Medical Hierarchy

Under this paradigm, the physician remains the primary provider and will typically prescribe a biomedical regimen of medication, to be supplemented with complementary and behavioral interventions. Psychologists, nutritionists, exercise physiologists, acupuncturists, Reiki therapists, and other complementary practitioners will be included within the medical home or referral networks will be established between the medical home and the complementary providers. Those complementary therapy practitioners co-located within the medical home will often function as physician extenders, implementing physician-initiated treatment orders.

This paradigm continues the traditional assumption that the primary intervention for a patient complaint is bio-medical, and the medical physician is the best arbiter of choice of treatment. The positive advantage of the hierarchical model is that the supervising physicians may better integrate an understanding of the evidence-base of available therapies, when developing the treatment plan for the patients' disorders.

The disadvantage of this paradigm is that for many chronic conditions and functional disorders, a complementary or behavioral intervention delivered early in onset of disorder may reverse or at least manage the disorder and hinder the progression to chronicity. Too often medical providers delay referral until the pharmaco-therapies and medical procedures have been implemented for months or years, by which time the patient's condition often becomes more chronic and resistant to treatment of any kind. Biofeedback, hypnosis, or the Feldenkrais method, alone or in conjunction with lifestyle modifications, may often provide an effective intervention for emerging headache conditions, while the same therapies are challenged to address a "chronic daily headache," of ten years' duration, often exacerbated by a rebound patter of worsening head pain as blood levels of narcotic analgesics fade. Further, no one, including the physician, can reliably predict which complementary intervention might dramatically relieve the disorder.

2.2 Interprofessionalism: A New Communications Paradigm

Many advocates of Integrated Care believe that it can be optimized with *interprofessional* teams working in a single setting [36]. *Co-location* within a single setting enhances communication and increases patient follow through on referrals to other disciplines. Diverse professionals work on a *collaborative basis* in a single pediatric, family practice, or specialty medicine setting. Decision making is carried out through communication across disciplines and engaging the patient integrally in the process.

The World Health Organization advocates for *interprofessionalism* in health profession education and in clinical practice:

> *The World Health Organization (WHO) and its partners recognize interprofessional collaboration in education and practice as an innovative strategy that will play an important role in mitigating the global health workforce crisis* [37].

There are challenges for the interprofessional model. This model challenges all healthcare providers to better communicate with one another and the patient. At a time when corporate medicine drives a reduction in minutes spent per patient encounter, interprofessionalism demands time for communication among professionals and with the patient.

In addition, the evidence-base for many complementary and allied health interventions is weak and not sufficiently persuasive for medical personnel. This undermines the confidence of medically oriented professionals in giving full credibility to complementary modalities. The funding for large-scale multi-center trials for new medications comes from the profits of pharmaceutical sales, whereas in the complementary therapy domain, comparable funding sources are not available. Although publications of research, including some well-funded larger studies, have increased in recent years, overall the studies on hypnosis, acupuncture, and other complementary therapies tend to utilize much smaller samples and blinding is less feasible, when the patient's awareness is part of the therapies' pathways for action. Fortunately, the occasional dramatic improvement of medical patients with integrative care including complementary therapies can be persuasive for physicians, nurses, and other biomedically oriented members of the treatment team [1, 2].

2.3 The Smörgåsbord Paradigm

In effect, many integrative medicine programs operate on a "Smörgåsbord" principle. Patients are offered a variety of mainstream and complementary treatments, and patients select those that suit their preferences. Since much of the CAM delivery system is market driven and outside mainstream healthcare, patient preference is often the primary factor driving treatment selection.

Patient preferences are a key element in all evidence-based care, but it is critical that current knowledge on the efficacy of the various options is communicated to the patient making the choices. Research suggests that finding reliable information on complementary and alternative treatments is challenging, patients are confused by conflicting research reports and claims, and patients may be most strongly influenced by testimonials from other patients [38]. Patients often would prefer to receive information about CAM from trusted sources, such as their physicians, yet physicians are often not equipped to provide such information [39].

As a consequence, patient choices of complementary therapies may not be in synch with the evidence base on the therapies. Moves to integrate complementary therapies into mainstream medical institutions may moderate these effects of disinformation and lack of information, yet patient preference will remain an element in informed medical decision making.

2.4 Epigenetics as a Paradigm for Integrative Medicine

Bruce McEwen [16], a leader in contemporary stress theory, has promoted epigenetics as a paradigm for integrative medicine. *Epigenetics* studies how multiple variables influence the translational process determining which of the potential traits carried in an organism's genetic code actually get expressed**.** Everything occurring during the organism's life cycle can modify gene expression, to the benefit or the detriment of health. Stress, nutrition, drugs, and negative emotion can all adversely affect gene expression and health. Animal research indicates that epigenetic effects may carry over transgenerationally from the original organism, "either through

the germline or through reoccurring environmental conditions," suggesting a long-term effect for early experiences [40].

According to McEwen's model, early life experiences shape the trajectory of health and disease, influencing epigenetics. Early intervention is critical to minimize the damage caused by adverse childhood experiences (ACEs) – including abuse, neglect, and poverty -- with their lifelong health consequences. This paradigm demands interventions long before the patient presents with symptoms. McEwen emphasizes that the "lived experiences" of the person are important, since the same objective event may take on divergent significance or meaning for those impacted by it. Personal experiences, and the meaning the individual endows these experiences with, all enhance or inhibit the response to healthcare. Stress, allostatic load, and overload all can interact with genetic disposition toward bio-medical disorders.

In McEwen's model, physical exercise, social integration, and finding meaning in life can all optimize epigenesis and enhance the positive plasticity of the nervous system. Behavioral interventions, cognitive behavioral therapies, and mindfulness training can moderate the symptoms of chronic illness, enhance neurogenesis, and improve the regulation of mood and emotion, reducing negative epigenetic forces and enhancing positive epigenesis [16].

2.5 The Lifestyle Medicine Paradigm and the Health Coaching Paradigm

I have grouped these overlapping paradigms together, because they complement one another so well. Lifestyle medicine has emerged as a new movement in healthcare, based on decades of research showing that lifestyle factors shape both the onset and progression of chronic illnesses and conditions. Health coaching is a discipline that has emerged, to assist human beings to make lifestyle choices, reducing health risk behaviors and enhancing salutogenic behaviors.

2.5.1 Lifestyle Medicine

Sagner, et al. [41], published a definition of lifestyle medicine endorsed by the American College of Lifestyle Medicine, the Australian Lifestyle Medicine Association, and the European Society of Lifestyle Medicine:

> *Lifestyle medicine is a branch of evidence-based medicine in which comprehensive lifestyle changes (including nutrition, physical activity, stress management, social support and environmental exposures) are used to prevent, treat and reverse the progression of chronic diseases by addressing their underlying causes* [41].

Dean Ornish conducted many of the early studies that led to the integrative medicine movement. Ornish developed a multi-modal protocol including whole foods, plant-based (vegetarian) diet, smoking cessation, physical exercise, stress management, yoga, and meditation. Patients who completed this program showed measurable and clinically significant improvements in their cardiovascular condition. Patients with cardio-vascular illness attained reductions in triglycerides, cholesterol, blood pressure, and increases in myocardial perfusion [42-44]. Many patients in Ornish's lifestyle medicine studies showed measurable opening of coronary artery blockages, through reversal of plaque formation. Following the Ornish program, cardiac patients with depressive illness also showed significant improvements in depressive mood [45].

Sagner and colleagues described the essence of lifestyle medicine. Evidence has mounted for decades that nine lifestyle-related factors and lifestyle-induced dysfunctions account for 90% of cardiovascular illness: "smoking, excessive alcohol consumption, physical inactivity, poor diet, stress, hypertension, and poor blood lipids" [41]. The message is clear: Better health lies in the direction of correcting these nine factors. The frustration is that decades have passed, and the same correctable lifestyle variables continue to cause needless cardiovascular deaths [46].

Healthcare professionals know the behavioral changes needed to enhance health and prevent illness; patients do not make the changes. The huge published research on "medical non-adherence" illustrates the magnitude of the problem. Patients frequently do not follow prescribed regimens of medication, as well as other physician recommendations. In chronic illness, 30-50 % of medications are not taken as prescribed and medication nonadherence is associated with 125,000 deaths annually [47]. Non-adherence when physicians recommend behavioral and lifestyle change falls in similar ranges. According to one recent study, only from 35 to 63 % of patients make positive behavioral changes following physician recommendations, although those reporting more trust in the physician make more changes [48].

David Katz sums up the message of lifestyle medicine:

> *We let this happen, every day. We aid it, and we abet it – every day. And all the while, we devise new drugs and devices, new stents and statins – and we learn CPR – to contend with diabetes that doesn't need to happen fully 90 percent of the time or more, heart disease that doesn't need to happen fully 80 percent of the time or more. We seem to accept that it's a midlife right of passage: angioplasty, or CABG? Take a number – have a nice procedure – you can wait in the fast food restaurant – next!* [46]

2.5.2 Health and Wellness Coaching

Health and wellness coaching is the emerging discipline that applies research-based knowledge and techniques to assist human beings to modify lifestyle, reduce health risk behaviors, and increase health-enhancing behaviors [49, 50]. Health and wellness coaching optimizes the human capacity to make change. Coaching is a natural partner with lifestyle medicine, since health coaches facilitate patients to make exactly the kinds of lifestyle changes demanded by lifestyle medicine.

The coach begins by inviting the patient into a collaborative "alliance for health." The coach uses motivational interviewing to mobilize the patient's own motivations and goals, assists patients to establish their own goals. Many authors within the coaching field emphasize self-determination theory [51].

Self-determination theory holds that the more autonomous a behavior is, the more personal commitment is mobilized [52]. Accordingly health and wellness coaches assess the patient's current readiness for change, and proceed in a step-wise fashion, beginning with small self-directed changes, and moving to more demanding changes only when the individual has experienced some initial successes with small steps [53].

2.6 The Functional Medicine Paradigm

Functional medicine is a widely used paradigm within the larger field of integrative medicine. Functional medicine brings together the healing powers of nutrition with laboratory assessment, to identify specific deficits in the body that can be addressed nutritionally. It is clear that nutritional advice does not produce the same effects in all patients, even to those with the same diagnosis. This is the principle of biochemical individuality. Interventions must take into account this individual's history, biochemistry, genetic makeup, and nutritional deficiencies and sensitivities [54]. The goal is what is variously called "personalized medicine" or "precision medicine;" the treatment plan is unique for precisely this biochemically unique human being.

Functional medicine practitioners utilize a variety of blood and stool tests to identify any mineral or nutritional deficiencies along with food allergies and insensitivities. The practitioner assesses the current state of the microbiome of this individual, the genetic material of all of the microbes that reside in the human body [55]. This allows nutritional recommendations to be personalized for the patient.

Functional medicine includes attention to both nutrigenomics and nutrigenetics. Nutrigenomics investigates how nutrients can modify the regulation of gene expression. Diet-regulated genes play a role in the onset and progression of specific diseases. Emerging research has shown that nutrigenomics has potential for preventing, mitigating, or treating chronic disease, and certain cancers, through small but strategic dietary changes.

Nutrigenetics investigates how genetic variation influences the interaction between nutrition and disease. Research on nutrigenetics offers further tools to create a more individualized/personalized medicine based on understanding an individual's nutritional needs, health status, and genotype. In a large-scale study, those participants who had a genetic variant rs1885988 in the MT1F3 region showed greater weight loss from intensive lifestyle interventions than did those without this genetic variant [56]. The genetic evidence becomes a tool for supporting the choice of this intervention.

In this area of nutrigenetics and nutrigenomics, the causal pathways are reciprocal: Genetic markers predict response to interventions, but interventions also blunt the effects of genetic markers. In the so-called "Pounds Lost investigation," individuals carrying the A Obesity risk allele at FTO rs1558902 showed greater weight loss on a high protein diet [57]. In another study, those research participants who had a genetic marker at rs79903146 at TCF7L2, showed more frequent progression to diabetes. However, those participants with this marker who also received the intensive lifestyle intervention, showed lower frequency of developing diabetes [58].

There is also extensive research evidence for reciprocal interactions among life stress, the physiological stress response, digestive function, and the gut. Stress can cause or exacerbate digestive system symptoms, including heartburn, abdominal cramps, or loose stools. Keefer and Blanchard [59] estimated that 60% of patients with IBS have Generalized Anxiety Disorder, and 20% have depression. The microbiome may cause or exacerbate anxiety and traumatic experiencing; conversely, use of a probiotic regulating the microbiome can reduce anxiety and depression [60].

Stress influences food choices: Stress and depression are associated with less fresh fruit consumption as well as greater snack food intake, and the seeking of hyperpalatable foods [61]. Stress also induces metabolic changes that promote weight gain and body fat mass [61].

Inflammation-enhancing diets can increase depressive symptoms and pro-inflammatory responses to stressors. Stress enhances maladaptive metabolic responses to unhealthy meals. For example, total triglycerol (TG) and low-density-lipoprotein-TG areas were 50% or more higher during stress than under control conditions [62]. Accordingly, a comprehensive functional medicine plan should include mind-body elements, such as relaxation training or hypnosis, to counter the effects of stress on digestion, food choice, and metabolism.

In summary, functional medicine has drawn on the full powers of current science and laboratory testing to personalize the treatment plan for the individual patient. Practitioners guide patients to eliminate some foods, increase others, and in many cases the practitioners also prescribe nutritional or mineral supplements to address conditions identified in the laboratory. The research in this domain remains weak and inconsistent, yet most functional medicine clinicians report that many of their patients have shown dramatic improvements, enough to inspire further research on functional medicine.

2.7 The Competencies Paradigm

Education in the health sciences today is moving toward a competency-based approach, which parallels evidence-based approached to practice. In integrative medicine, we showed above that the interprofessionalism paradigm emphasizes practitioners learning better communication skills, developing an understanding and acceptance for both the patient's perspective and the viewpoints of both mainstream and complementary healthcare disciplines. Accordingly, competencies for integrative medicine training will include communication skills and sensitivity to divergent professional cultures. Research on core competencies for integrated and integrative care has focused on integration of medical and "behavioral health" services. For example, Miller and colleagues concluded that:

> *Competence as a licensed behavioral health provider working in primary care refers to the knowledge, skills, and attitudes—and their interconnectedness—that allow an individual to perform the tasks and roles in that setting* [63].

At least two organizations have identified competencies that support integration of professions in one setting.

The Colorado Consensus Conference took place in November 2015, and identified eight competencies to support highly integrated practices, where behavioral health professionals are onsite and integrated into the care team. The following are the headings for the eight competencies; further detail on each competency is available in the conference report [60]:

- *Identify and assess behavioral health needs as part of a primary care team.*
- *Engage and activate patients in their care.*
- *Work as a primary care team member to create and implement care plans that address behavioral health factors.*
- *Help observe and improve care team function and relationships.*
- *Communicate effectively with other providers, staff, and patients.*
- *Provide efficient and effective care delivery that meets the needs of the population of the primary care setting.*
- *Provide culturally responsive, whole-person and family-oriented care.*

– *Understand, value, and adapt to the diverse professional cultures of an integrated care team.*

Another organization produced a similar set of competencies. The Annapolis Coalition on the Behavioral Health Workforce is a non-profit organization focused on strengthening the recruitment, retention, training, and performance of the behavioral health workforce. This group, in collaboration with SAMSHA, published a report on "core competencies for integrated primary and behavioral healthcare" [64].

The development of core competencies provides a paradigm and a training framework for developing a new healthcare workforce, comprised of professionals who are better prepared to interact across disciplinary boundaries, engage the patient in health care decisions, listen empathically to colleagues and patients, and produce true and more seamless integration of mainstream and complementary health modalities in one setting.

2.8 The Eco-Systems Paradigm for Health and Healthcare

Sagner et al. [41] suggested that our environment can be morbidogenic or salutogenic. The WHO is promoting attention to scientifically measurable variables in the environment, the "physical, chemical and biological determinants of health external to a person" [65]. The human being is always embedded in an eco-system or environment, and that environment can contribute to illness or health. This is reminiscent of the words of Ralph Waldo Emerson, who wrote in his essay *Nature* that *"In the woods, I feel that nothing can befall me ... which nature cannot repair"* [66].

There are a number of eco-systems models for health at this time, but I will take the example of "forest medicine" and "forest bathing." One of the stimuli for global lifestyle-based illness is rapid urbanization and estrangement from nature. Forest medicine emerged in Japan to address this estrangement from nature and has become a global movement. Forest medicine and other forms of nature therapy prescribe immersion – "forest bathing" – in natural environments as a form of therapy. Organized programs provide transport for urban dwellers to protected forest environments and these individuals are immersed in the forest for periods of several days.

In Japan, the Shinrin-Yoku movement began in the 1980's and has gained a widespread following. Shinrin-yoku literally translates as taking in the forest atmosphere or "bathing" in the forest. Researchers in both Japan and South Korea have promoted forest exposure for preventative health and wellness and also as a treatment for chronic illness. One of the leading researchers in this area, Yoshifumi Miyazaki, summarized much of the Japanese research in this area in a 2014 article. He reported that time spent in forest environments in 35 different forests in Japan was shown to produce a 12.4 % decrease in cortisol levels, a 7.0 % decrease in sympathetic nervous activation, and a 5.8 % decrease in heart rate. He claimed a 55% increase in parasympathetic activation, indicating substantial physiological relaxation, and a dramatic increase in immune function that persisted for one month after the forest exposure [67]. A study by Li [68] measured natural killer cell activity in 12 research participants, who were exposed to a forest environment for a weekend. The study reported significant increases in natural killer cell activity in the study participants, lasting a month. Another study, reported by Bing Bing et al. [69], utilized a randomized control design and immersed the experimental group in a forest environment while the control subjects remained in the city. The forest immersion group showed

decreased levels of pro-inflammatory cytokines and stress hormones and decreases in negative mood as measured on the POMS.

The forest medicine movement has gained support in Europe, and research is beginning there as well. There is now a Europe-based International Congress on the Forest and its Potential for Health, scheduled annually, and promoting both research and clinical applications of forest medicine (https://www.selvans.ong/congress2019/?lang=en). Much of the research on the health effects of forest immersion consists of small studies, some of less rigorous design [70]. Nevertheless, with the shared consensus that stressful urban environments are a factor undermining health, initiatives to integrate environmental factors into health are welcome.

3. The Significance of the Integrative Medicine Paradigms for the Hypnosis Profession

Hypnosis deserves a place in integrative healthcare. As summarized above, it is evidence-based, person-centered, effective in modifying habits and lifestyle, and includes a variety of protocols with well-documented efficacy for medical disorders, and effective applications for pain management, surgery preparation, obstetrics, oncology, and many other areas.

Reviewing the paradigms for integrative medicine included above, I propose the following guidelines for professional education in hypnosis, and for health professionals wishing to increase their role in integrative care:

1. Medical hierarchy paradigm. Because the hierarchical paradigm prevails in many settings, it is important for hypnosis practitioners to become more informed about the hierarchy, the players, and their expectations. This includes everything from the expectation of communication back to the referring doctor to medical record keeping. In addition, hierarchical models require that each hypnosis practitioner understand his/her expected role within that organizational structure and take the steps to optimize that role. For example, psychologists often can achieve at least affiliate status in most North American medical settings, placing them in a peer status with medical and nursing providers. For many complementary therapists, the challenge is more daunting. Forging personal relationships with medical providers, frequent communication about patient progress, and providing medical education for the clinic professionals can all serve to overcome prejudices and barriers.
2. Interprofessionalism paradigm. In those progressive settings where interprofessionalism is cultivated, it becomes important to cultivate effective communication skills and habits, for optimizing the communication across disciplinary and specialty lines. In addition, it is critical that hypnotic professionals NOT continue to think as solo practitioners when operating in an integrative setting. The patient's long-term wellbeing will be improved most effectively with a collaborative involvement of several disciplines in a coordinated care plan. Hypnosis may also be provided by multiple specialties, and the well trained and certified practitioner can multiply her or his impact by training nurses, EMTs, and others whose scope of practice allows the use of hypnosis.
3. Smorgasbord paradigm. In settings where the patients seem to be selecting complementary therapies from a smorgasbord, the challenge for hypnosis is patient education and marketing. Any brochures or videos presenting treatment options for patients should be reviewed, so that hypnosis is presented accurately but also attractively. Can the practitioner or a

health educator convey a good grasp of the potential value of hypnosis in patient orientations, in a fashion that corrects misconceptions and awakens hope?

4. Lifestyle medicine paradigm. In accordance with the lifestyle medicine model, the challenge for hypnosis practitioners is to educate both peers and patients about the value of hypnosis for facilitating behavior change. Further, the lifestyle medicine paradigm suggests that hypnosis in the office can be supplemented by simultaneous patient-directed behavioral and lifestyle changes. For example, research shows that hypnosis can greatly moderate symptoms of irritable bowel syndrome [71], yet corresponding dietary changes can also facilitate long term digestive health [72]. The hypnosis practitioner can coordinate care with functional medicine physicians, dieticians, exercise physiologists, and complementary medicine therapists to develop a comprehensive treatment program. Lifestyle changes accompanying hypnotic treatment will also support patient wellbeing long after hypnosis sessions cease.

5. Health and wellness coaching paradigm. Health and wellness coaches specialize in facilitating active patient engagement in treatment, autonomous goal setting, and effective behavior change. Health and wellness coaches are welcomed by at least one major hypnosis organization in North America today (the Society for Clinical and Experimental Hypnosis) and can learn hypnotic techniques that can be used in service of lifestyle change to assist patient's self-directed change. Their primary model remains collaborative health-enhancing goal setting [50], but hypnotic and self-hypnotic techniques can be introduced to assist the patient in overcoming obstacles and achieving goals.

6. Functional medicine paradigm. Understanding the functional medicine paradigm primarily challenges the hypnosis practitioner toward cross-disciplinary coordination of care. As mentioned, high stress levels can adversely food choices, digestion, and metabolism. Accordingly, dietary integrated with hypnotically-assisted stress reduction may more effectively treat many disorders. In McGrady and Moss [2], we included a case history of a female patient with lupus systemic erythematosus, who benefitted greatly from a coordinated program of integrative care including both hypnosis and functional medicine. The functional medicine interventions appeared at the time to have the greatest impact, to the extent that the patient's antinuclear antibodies normalized and her lupus symptoms were significantly reduced. The patient coped with occasional "flare" in her lupus symptoms by a combination of nutritional interventions, paced breathing, self-hypnosis, and self-soothing imagery.

7. Competencies paradigm. Competency-based education is applicable in hypnosis training and education. Appropriate competencies include mastery of clinical hypnosis intervention skills, and also the communication, cultural sensitivity, and related competencies described above.

8. Eco-systems paradigm. Hypnosis practitioners frequently focus on the inner world, utilizing hypnotic experiences to reverse the impact of external stress, resolve emotional conflicts, abreact emotion-laden memories, and enhance patient resilience and coping. Yet the question remains, whether the patient is returning to a toxic "morbidogenic" environment, toxic in the sense of physico-chemical hazards or emotionally destructive interactions. The eco-systems approach is a timely reminder to pay attention to the patient's inner and outer world, seek strategies to reduce exposure to harmful surroundings and increase patient time spent in salutogenic and supportive surroundings.

9. A word about research. The research on hypnotic interventions is encouraging but not conclusive. Hypnosis research is not supported by pharmaceutical profits; many hypnosis

researchers conduct pilot studies lacking controls or controlled studies with small samples. Moving into the evidence-based world of integrative medicine, improvements in research design, collaborative studies among several sites to increase sample size, preregistration of protocols, and other steps to enhance the credibility of hypnosis research are priorities. A *Task Force to Establish Efficacy Standards in Hypnosis Research i*s currently underway, supported by the boards of the International Society of Hypnosis, Division 30 of the American Psychological Association, the Society of Clinical and Experimental Hypnosis, the American Society of Clinical Hypnosis, the National Pediatric Hypnosis Training Institute, and the Milton Erickson Foundation. Researchers from six countries have been meeting since February 2019 to address efficacy research standards [73].

4. Conclusion

In summary, if hypnosis professionals desire a place at the ever-growing table of integrative healthcare, it is time to rethink hypnosis practice. Those who are already conditioned by years of solo practice may benefit by arranging to consult and spend time in the closest integrative setting. Fortunately, many early career professionals are already growing up professionally in integrative settings, and interprofessional collaboration and communication may be their native tongue.

Author Contributions

Donald Moss authored the document in entirety. He acknowledges help in locating relevant publications from his research assistant Shannon McLain Sims, currently a post-doctoral fellow at Saybrook University.

Competing Interests

The author has declared that no competing interests exist.

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Review

The Importance of Rapport in Hypnotic Clinical Practice

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Abstract

This article is based on the assumption that the therapist's focused attention, open awareness and kind intention are the basic ingredients for creating a relationship of trust with the patient from the first session. He also stresses that when the attention of a genuine therapist, without prejudice or judgment, is centered on how the patient expresses him/herself and on the contents s/he proposes, the patient relies more easily on the competent care of the therapist. The author argues that to empower patients it is essential to accept their vulnerability, awaken hidden resources and define realistic therapeutic goals. In this way, each session focuses on the perceptual, cognitive, emotional and behavioral changes that the patient can undertake during the session and implement after the session, by himself or herself. Through the presentation of some cases, the article shows the importance of concentrating the patient's attention in the present moment with the resources s/he has in his/her current life, from which to observe significant episodes from the past. The revision of the past from the point of view of the present, which is the future of the past, helps the patient to observe what happened with different perceptions, thoughts and emotions, thus reformulating his representative memory of what happened.

The article proposes the transcription of a typical induction that the author usually uses to establish a relationship based on a secure attachment to evoke a feeling of calm and trust in the patient. It also provides the transcription of several inductions used during some highlights of a therapy session of the selected cases. Each case and each induction has been chosen to show how attachment theory concepts have been used in hypnotic practice as an indispensable tool for building and maintaining a therapeutic relationship based on mutual trust.

Keywords
Rapport; attachment; trust; hypnotic inductions

The objective of this article is to stimulate reflection on the importance of developing rapport in hypnotic clinical practice. A combination of attachment theory with several hypnotic techniques such as utilization and reframing has been proposed in this article.

This article starts with some questions such as “Is rapport a predictor of therapeutic success?”, “Is rapport the guardian of the quality of the therapeutic process?”, and “Is rapport a guarantee of the trust between therapist and patient?”. This article illustrates building and maintaining a therapeutic alliance based on “focused attention, open awareness, and kind intention” in order to develop a relationship of mutual trust and reciprocal understanding [1].

Rapport is defined by the author as the unconditional acceptance of patients' vulnerability, the empathic attunement with whom they are and the empowerment of their strengths before defining any therapeutic goal and suggesting any kind of change. Rapport is the perception of the patients experienced while the therapists employ their verbal and analogical communication to connect their conscious and unconscious minds [2].

Based on M. H. Erickson’s suggestion, a therapeutic alliance is established, irrespective of patients’ behavior, by illustrating them that they are completely accepted as they are. Rapport is when the patient has the feeling of being accepted, understood, and connected, whereby, s/he can develop trust in the therapist and therefore, count on the therapist’s care. Rapport facilitates therapists to address any emotion experienced by patients, to reduce their intensity or duration, to calm them during the session, to assist them to improve their executive functions, thereby, mitigating their fear of the future [2].

In this article, three cases are offered to illustrate those points in action.

1. Building Rapport from the First Session

Patients seeking therapeutic help are mostly in a vicious circle: they fear to be unable to overcome a past experience, to be incapable of achieving their goals and are unaware of the solution to the problem. This fear indulges in immobilization which again reinforces fear [3].

Restoration of the active and effective defensive responses is achieved by the therapist by interrupting the vicious circle, reinforced by the patient’s emotions, such as anger, sadness, guilt, shame [4]. An emotionally corrective experience is offered by the therapists to the patients,

guiding them to reduce negative feelings and rejuvenate the sense of self-confidence in a world filled with volatility, uncertainty, complexity, and ambiguity [1].

To initiate the first session, it is essential for the patient to comprehend the therapist as competent, genuine, caring, and non-judgemental. The initial acceptance of patients' behavior, followed by their collaborative response, orchestrates the path of therapeutic change paved by the relationship based on trust [2].

Hypnotists, in their first meet, convey one of the main messages to their patients that they are in a safe place where they can awaken their dormant resources. Patients are empowered by the hypnotic therapists to respect and protect their vulnerability, to increase their resources in facing challenges, to connect body and mind, heart, brain, muscle, bones, and to install lasting changes in their emotional and cognitive processes, as well as in their behavior [5].

Hypnotic techniques engage the therapist to collect and calibrate verbal and non-verbal messages sent by the patient. The process of mutual influence develops a bond and maintains a good attunement. The therapists' kind intention, motivation, and commitment to listening/helping/sustaining patients to achieve their well-being in an efficient and effective way bridge the gap between the therapists and the patients.

Rapport in hypnotic clinical settings helps patients to develop the internal locus of control, self-esteem, self-efficacy, independence, and interdependence. Patients are encouraged to depart the land where they have enacted the role of victim and explore a realm where they act as agent, as problem solvers, and improve their ability to use their critical thinking, creative imagination, and planning how to promote evolutive changes [2, 6].

At the end of the therapeutic process, patients divert their attention from problematic events of the past to projections of open future, curious to explicitly define their goals, reinforced by their aspirations, motivation, and perseverance [7].

Rapport is mainly built and maintained by nurturing the communication style of the patients. Utilization is nothing more than making good use of what happens during the session and matching what patients bring to therapy: breathing, posture, gestures, body changes, words, metaphors, tone of voice, beliefs, interests, values, and priorities [8, 9]. An important role is also played by the reframing, which is incorporating new and empowering perspective to the patient teaching skills and providing experiences that uplift his/her life [10].

2. The Role of Hypnosis in Building and Maintaining Rapport

At the beginning of the session, the consequences of the hypnotic induction are to stabilize and calm patients making them feel seen, safe, protected, calm, and secure. Once the patients realize that they are recognized for what they are, the therapists aid them in shifting their attention to their resources and regaining confidence in their future.

Therapists specialized in hypnosis are conscious regarding the importance of expressing their linguistic competence and verbal fluency. Delivering congruent messages of attunement through their body language and their tone of voice is also essential for treating patients. Eye contact of the hypnotist with the patient along with a pleasant smile, relaxed and soft body posture, warm and gentle gestures are essential in order to provide the patients a comfortable environment and to make them feel that they are acceptable as they are. Voice modulation according to the emotional strings they wish to touch is essential to deal with such patients. The modulation of

facial expressions of the therapist reflecting congruence with what the patient is narrating is a technique to portray their resonance.

An empathic resonance is established with the patient's narrative through these therapeutic sessions. Empathic resonance means not only feeling what patients feel, but also encompasses their perspective, visualizing through their eyes according to their cognitive schemes, imagining their mental experience, their attributions to what happened, and their representation of the world. Therapists who show attunement, resonance, and willingness to take care of patients' well-being, also share the happiness for their achievements [1].

Staying focused on the present therapy helps patients to concentrate on the experience of the session, aware of being in the future of their past and thus relate their story from the point of view of the present, separating the past, present, and future. The patients are asked to retrospect the past incidents that might be related to the current suffering. Unearthing a "problematic episode" that seemed to be the starting point of the suffering of their current life, help them differentiate between past and present.

Furthermore, the therapist invites patients to realize what they learned that they did not know before and that they could not have learned in any other way [7, 11].

3. Rapport Based on Secure Attachment

A secured bond involving the same attachment patterns studied by John Bowlby [12] is carefully established by the therapist in order to develop and sustain a rapport based on trust. It is important that patients in therapy feel seen, soothed, and safe, like a child with a caregiver. This helps strengthen the sense of security in the patients. They learn to maintain hope and improve their resilience even during adverse situations. [9]

My usual initial induction begins in this way, changing it according to the uniqueness of each patient.

> *At this moment, you are here in my office and today is … day, month, year.*
>
> *This is a safe place for you. With eyes closed you can perceive the luminosity of the room which is subjected to change based on the hide and seek clouds play with the sun; you hear the sound of my voice, the tic-tac of the clock reminding you of the inexorable passing of time. Time passes even if you stay still and do nothing but concentrate on finding a relaxing position. The passing of time is an alarm to remind you that the only place you are going to is the future. You can also smell the fragrance in the room. You may feel a residual taste in your mouth. And now you can start focusing your attention on all the contact points of your body, such as your feet touching the ground, thighs, and bottom on the chair, your back resting on the back of the chair, your arms supported by the arms of the chair, and your hands on your lap. Even with your eyes closed, you can sense my full presence focused on your wellbeing while we are together in this secured place. I just noticed that your breathing is becoming calmer and calmer, and your facial expression is becoming more relaxed so that you experience that the more you relax your body the more you relax your mind; the more you relax your mind the more you relax your body.*

Synchronization with the feelings, thoughts, and body language responses of the patients with the therapist generate a sense of security among the patients. They feel that they are seen, heard, held, and healed by a therapist. Distressed patients learn to calm down when they realize their therapist is able to transmit calm. Thus they feel they are protected from danger, kept safe, and cared for by their therapist, who will educate them on how to soothe themselves.

Right from the beginning the hypnotists try to impose an emotionally corrective experience of secure attachment with the patients, by seeding verbal and non-verbal messages such as "*I'm with you in the here and now* ..., *I'm in tune with you*..., *You are in a safe place*..., *I resonate with you*..., *I understand you*..., *You can learn now how to calm down*..., *In this safe place you can recognize that you have all the resources you need at this moment in your life*..."

A rapport based on secure attachment helps the therapists to utilize hypnosis to diminish patients' sense of alertness, simultaneously empowering their sense of security and confidence. A safe environment incorporates a sense of protection and fearlessness among patients. This can pave the way to discover the pleasure of exploring a new world full of opportunities, play new games, and cultivate their imagination in creating new projects that can reform their lives.

Here are the three cases.

3.1 The Case of Monica

Monica, a 32-year-old woman, is afraid of crickets and does not know what to do when she encounters them. She recently shifted to her newly purchased house with a garden. In her previous condominium apartment, she did not face the problem of crickets. However, now she finds it when she returns home from work. She is very much attached to her new house and the garden. She does not want to indulge in the risk that her fear will ruin her return to home in the evenings when she spends a lot of time hunting for crickets in every corner.

During our first session, I followed a metaphorical model of mine namely "The Five Petals of Identity", useful for discovering strengths and vulnerabilities in each petal, so that a suffering petal can receive help from the others [7, 11]. The first petal represents the qualities of body identity characterized by gender, age, and physical appearance; the second concerns the power of belonging coming from social identity. The third petal deals with a sense of self-efficacy attributed to professional identity. The fourth signifies our transcendent spiritual parts connected to virtues and values, morals and ethics. The fifth embodies secrets regarding every aspect of the previous petals.

After reaching the state of trance post-induction, I started sending these therapeutic suggestions to Monica.

> *At this moment you can focus your attention on the five petals of your identity. You can start with becoming aware of the body you've lived in since your birth. You might also recall all changes that have occurred since you were born until today since you weighed a few kilos and were a few centimeters long until your current weight and height.*
>
> *Just as you can remember the changes that have taken place in your social relationships, from the time you were mainly the daughter of your parents to the time you started going to school and met friends, from primary school to secondary school to university where you contacted people and made new*

> *friends. Over the years, your knowledge has also undergone modification, improvement, and refinement. You now know how many things you have learned that have changed your way of thinking and observing the world. Until you entered the world of work, first with one role, then with another role, then with another role. You are now aware of the alterations you went through in your job and all the skills you have improved day by day, week by week, month by month, year by year.*

Following the five petals metaphoric model, I asked Monica to recollect all the changes she came across in her life from the anagraphical, social, and professional perspectives. I modulated my voice to underline the word change. I went on to say:

> *With this awareness now imagine being in front of a cricket and perceive what you see, what you hear, what you feel, what you think, and what you do. You can now divert your attention to what you are thinking right now, knowing that thoughts are only thoughts, they come and go. You can now move your attention to what you are feeling right now, also knowing that emotions are only emotions, they came and go. Now that you have explored your sensations, thoughts, and feelings you can start being curious about noticing how you perceive yourself in the presence of a cricket. With this awareness now imagine being in front of a cricket and notice that something has changed in your way of seeing, thinking, and feeling and that you are capable of doing something different.*

At the end of the induction, Monica told me that she had experienced the differences between her and a cricket and sensed a calm which motivated self-efficacy. At the conclusion of the first meeting, Monica was keen for a second session, which we agreed would be scheduled three weeks from the first one.

In our second meeting, Monica told me that she was no longer afraid of crickets. She was able to handle them calmly and efficiently. So I was curious to know why she came back. She replied that she was in search of the origin of the fear.

The second hypnotic intervention aimed at bringing Monica back to her past to find the episode of the first time she experienced she was afraid of crickets. After the initial induction, I said:

> *Now that you are here and now in this safe place, be aware of all the resources you have and when you are ready, leave your unconscious mind free to select the oldest memory connected with that fear of crickets. After discovering that episode, when you are ready, you can open your eyes and tell me what I need to know to continue to help you.*

Monica opened her defocused eyes and told me that she had gone back to when she was a little girl (about 3–4 years old), playing in the garden of her parent's house and at one point, a cricket jumped on her. She screamed in fear, drawing her mother's attention. When the mother went to the garden and realized that her daughter had been attacked by a cricket, she invited Monica to go inside the house, telling her that she would take care of the insect. There were no further comments from her mother.

Once I received this information, I reminded Monica of the resources she had discovered during the first session. I, then, recommended her to go back to the little Monica to teach her what she now knew and help her manage the emotions of the past.

> *With the full awareness that you are in the future of what has happened in your past be ready to go back now, dressed as you are today to help little Monica of a long time ago, when she was only 3–4 years old, her body was the body of a 3–4-year-old girl, her experience was of a 3–4-year-old girl, her knowledge was of a 3–4-year-old girl. The woman who is in front of me right now is 29 years old and has a body of a 29-year-old, knowledge and experiences of a 29-year-old woman. Now that you are in the future of what happened to little Monica I ask you to go back to her and talk to her. You are the only person who knows what little Monica would have needed at that moment. You are the only person who knows what little Monica would have liked to hear and now you can tell her.*

After the induction, Monica told me that she had taught little Monica to calm down and to behave accordingly.

The experiences she gathered from the retrospective view of the childhood memory, Monica acquired two types of awareness: the one that kept implicit traces of her child self in the past and the other that recognized her adult resources in the present. She was a little girl whose mother was unable to teach her the difference between fright and fear and pursue a simple reality test: you are stronger and bigger than a small cricket.

The episode that emerged in Monica's explicit memory belonged to an implicit memory layer that had restored in her brain the primary imprint of a fearful experience. The hypnotic interventions assisted Monica to transform her implicit memory contained in sensations, emotions, images, thoughts, and behavior provoked by the old fear of the cricket into an explicit narration where she sees herself able to treat the harmless insect in an adult and efficient manner.

3.2 The Case of Elena

Elena, a seventy-year-old, came to therapy encouraged by a former patient of mine who was anxious about Elena's depression and her desire to die. In six months Elena lost her brother and a close friend, which justified her depression. Were there any reasons to want to die? Elena isolated herself, confined herself in her house and was unwilling to carry out the normal daily activities. Despite being full of resources, she felt she did not deserve to live. Termination of her life seemed to be the best solution for Elena.

During our first session, her desperation and a lack of confidence in the therapy provoked me to apply mainly conversational hypnosis. The development of a trusting alliance was the main objective for the first session so that she could attend the second session with the anticipation that she would be benefitted from our meetings. For this reason, I watered the roots of hope by inviting her to remember her past life when she had bounced back from depression by awakening the resources required to deal with her present situation. At the end of the first session, she was convinced to see me for another encounter.

During the second session, I asked her to freely talk about her desire to die. She shared her life story regarding her family where she was neglected by both her parents because their attention and expectations were toward her brother. For the purpose of this article, only an emblematic example of her narration has been selected.

Her parents were ignorant regarding her studies, though she was a good student. Elena was inclined toward culture, literature, and art. She got a job to support her college expenses and when she finally graduated she told them, “Today I graduated *cum laude*”. The father's first answer was, "What a pity your brother left college and did not graduate." Not even her mother uttered words of satisfaction, pride or congratulations. Despite the discriminatory and unfair attitude of her parents, Elena developed the ability to recover and continue to love them and she looked after them until their deaths. She also took care of her brother until his death. After the death of her brother, however, she felt guilty.

She was of the opinion that, if her parents had still been alive, they would have preferred her death to her brother’s. Thus I decided to work on her guilt.

After eliciting a hypnotic state, I suggested to Elena:

> *Let your unconscious mind remind you of some episodes of your life with your brother. Go back to the time when you wanted to study simply because you loved to spend your time reading books of literature, of art, of history, while your brother loved doing different things. Now is the time to be true to yourself and explore carefully if you did anything wrong that refrained your brother from studying. Be honest and explore now if you did anything wrong that prevented him from studying instead of doing what he liked best.*

I started my induction by highlighting the differences between her and her brother regarding studying, to let her experience that she had not committed any sin. Then I shifted her attention to her brother’s last period of life.

> *Now go back to the period when your brother was ill and you took good care of him. Go there with him, talk to him, spend all the time you need to tell your brother how much you loved him. And you can also listen to what your brother is willing to tell you before passing away.*

With these suggestions, I wanted Elena to realize that she had done her best to look after her brother and helped him to die in peace. Since she loves culture, I proceeded with the Greek myth of Admetus, Alcestis, and Apollo, as a particularly useful metaphor at this moment.

> *Let me now tell you the Greek story of Admetus, Alcestis, and Apollo that you may already know. The God Apollo expressed gratitude toward Admetus because he had hosted God during his exile. When Apollo learned that Admetus was to die, God gave him one more day of life to allow him to find someone willing to die in his place. Neither his father nor his mother wished to die in his place: the only one who accepted the exchange was his wife Alcestis. When Alcestis reached the underworld, God Thanatus was so impressed by her generosity and love that he sent her back to earth to live. You know that these things happen only in Greek mythology. In reality, nobody can bargain with any God for the life or death of someone else. Even though you would like to accept death on behalf of your brother, you know that this was impossible. Your brother accepted his fate to die before you, so you have to accept your fate to live longer than him.*

This was a cultural way to remind her that she was unable to prevent the death of her brother. So she need not be guilty in this matter. At the end of the second session, Elena fixed another appointment.

During our third session, we shifted attention to the distressing demise of her friend. This death was also associated with guilt: the two friends shared many activities. They sang in a choir, were part of a group of creative reading and writing, visited painting and sculpture lessons, and to films and exhibitions. As her friend was unable to participate in these events, Elena developed the limiting belief that, by continuing to do alone what she previously had done with her friend, might end up in deceiving her friend.

After the initial induction, I told Elena

> *Now you can go back to the days when you and your friend spent your time together, singing in the choir, going to creative writing and other activities that you liked so much. Be there with her now and enjoy doing what you liked best. Imagine you are with your friend and you are talking to her as you used to do when you were together. Now that you feel her presence here and now, you can also sense her presence next time you sing in the choir, next time you paint or sculpt, next time you write or read a poem. You know that even though she is not anymore on this earth you can still be with her. Just go inside of you and feel her spiritual presence close to you. Imagine that your friend is happy and grateful that you are still bringing her with you, continuing to carry out the same activities, honoring your friendship. Just imagine having her at your side, continuing to be with her, dedicating her the art and beauty you are surrounded by.*

Elena attended two more sessions with the aim to strengthen her resources. In the meantime, she started going back to painting class, singing in the chorus and engaged herself in writing poems. I expressed my sympathetic joy when I came to know that she accepted sketching portraits of children. Having consolidated her new attitude toward life, she realized that she was lucky to be alive. She acknowledged the fact that she would disrespect her friend's memory if she ceases doing what she used to do with her friend. She reached the conclusion that, in order to illustrate her love for her brother and friend and to honor their memory, she had to continue doing what gave meaning to her life.

Hypnosis helped Elena to gain awareness regarding the association between different experiences and integrated them into a coherent story. When she frankly discussed the veiled desire to kill herself, she confessed that it was not what she really wanted. She was looking for a life she deserved to live in her own way, surrounded by justice, art, and beauty.

The induction technique similar to the one with Elena is usually employed for a patient, lamenting the death of a loved one. This can achieve the purpose of integrating the natural phenomenon of life and death and of saying goodbye to the dead person.

Elena's case demonstrated how the hypnotic utilization of her favorite "medicine" – culture, art, and beauty – along with her attachment for the dead loved ones enlightened a new purpose in her life. I moved a "tree trunk" full of guilt to encourage Elena to proceed lighter toward the path of her well-being. Just as the river begins to flow again after the tree trunk, blocking its path, has been eradicated, patients also continue to improve spontaneously when they start integrating problematic memories.

3.3 The Case of Marilia

A 28-year-old girl named Marilia lost both her parents within one month. She was the single child of her parents. The apparently healthy father died suddenly two weeks before her mother, who was suffering from terminal cancer. The shocks induced by these two deaths indulged her to come for treatment. In the first session, Marilia stated that she missed her parents so much that she desired to reach them, as early as possible. Ignoring this veiled threat of suicide, I tried to divert her attention to her body and enquired if she ate and slept regularly. She replied she did not eat, which was not astonishing for me, considering her circumstances. She also told me that she was unable to sleep, which instead I thought needed to be solved.

I, therefore, asked her what abstained her from sleeping. She replied that she felt such a heavy burden on her chest that she was unable to breathe properly.

After eliciting a hypnotic state, I employed the strategy of pain dislocation and told her:

> *Now image it is already the end of today (naming the precise day, month, and year) and prepare to go to bed. Just do the usual ritual of taking off your clothes worn today, putting away the thoughts thought today, ignoring the sensations felt today. Get ready to take off everything you do not need to bring to bed to ensure a deep restful night's sleep. When you realize that you have taken off all that you do not need to carry into the sleeping world, feel the weight you said you felt on your chest. With your own times and your own rhythms, now imagine shifting that weight from your chest toward the shoulder and then slowly from the shoulder down your arm, until it reaches the palm of your hand. Now feel the difference in your chest, free of the weight that has now been relocated on the palm of your hand. When you're ready, move that weight from the palm of your hand to the bedside table. Make sure to place it right on your bedside table. It is important to know that when you fall asleep, you are sure that the weight is there, comfortable and quiet, so that the next morning when you wake up, you find it on the bedside table. In this way, when you wake up, you take the weight in your hand and make it move up on your arm until it reaches the shoulder and then, put it back in its old place on the chest.*

This induction worked and Marilia reported that she had slept enough when she arrived for the second session. To address the suicidal threat in Marilia, I began my second therapeutic intervention with a direct and provocative question: "Why do you want to kill your parents?" To this question, she replied that they were already dead. I repeated: "I know. If you think you want to die, it's like wanting to kill them a second time. Your death will delete the only proof that they existed on this earth and that they were good parents."

After this explicit reframe, I took advantage of her state of confusion and recommended to her to close her eyes and dive inside herself. I told her:

> *I know how much you love your parents and how much you miss them. The best way to portray how much you love them and that you continue to love them even though they are no longer here, is to honor the life they gave you. Only if you live a meaningful life, you can show that you really loved them. Now take all the time you need to be with your parents, to talk to them telling them what you*

never told them before and also listen to what they are willing to tell you right now.

The reframing proposed a change of values: if you live a good life, you show that you had good parents who taught you that the most important thing is giving meaning to your own. The communication with her dead parents helped Marilia to keep the connection with them.

4. Ending Remarks

Put your sorrow into words.
The grief you keep inside you will whisper in your heart until it breaks.
W. Shakespeare

Establishment of a relationship of trust with the patient from the first session and not being afraid to ask patients to give words to their pain, help them transform their suffering into a narrated story. This, in turn, aims to develop a distance between the patient and the past incidence. Translating their sorrow into words helps resolve any residual passivity, any guilt for what they think has committed or omitted, any shame for what wrong they think they did or any rancor for what others were not able to do. Illustrating their story with their adult voice also helps patients identify that they are no longer a victim of what happened: they are now empowered by understanding and the lesson they have learned from the past incidence.

When attention goes to the learning process initiated after a problematic event, patients discover that they do not need to dramatize the effect of what happened (Elena's and Marilia's cases), nor trivialize the meaning of it (Monica's case), nor justify the misbehavior of others (Elena's case). Thus they learn to accept the incidence as something that occurred in their past and is part of their story. They also recognize that they are more than their story.

In each person, there is a stratification of pain, some layers are distant, while others are more recent [1]. The pain narrates the patient's story: sometimes bringing limitations, other times conveying resilience. Some pains are part of the memory of the mind (Monica), other pains of the memory of the heart (Elena), and still others of the memory of the body (Marilia) [3, 4, 13] Therapists welcome each pain and each memory, in turn, teaching the patients the art of acceptance of the incidence that cannot be changed and the awareness that, after therapy, they can illuminate their old story with new words, describing new emotions and new thoughts.

A therapeutic alliance developed on a rapport based on attachment and trust established in the first session assists the patients to start perceiving themselves as empowered and legitimized to use their strengths and resources without ignoring their own vulnerability. They change their role from a victim to an agent or person ready to plan for their future, with the full right to live their lives without fear, guilt or shame, because these emotions are not necessary anymore.

The therapeutic work with Monica, Elena, and Marilia showed that the hypnotic induction imposed on them helped them to evaluate the characteristics of the past events, improve their current management and adaptation skills (coping styles), develop their self-regulation, and their ability to calm down. I empowered them by transferring my therapeutic sensitivity into their hands so that they could begin to love themselves and their lives.

Hypnotic induction started with the utilization of the problem confronted by the patient and proceeded with reframing it [2, 8]. The induction was based on accepting and utilizing what the patients brought to therapy, inviting each of them to identify their vulnerabilities as well as their

strengths. Placing the past in the past is a way to make peace with what happened and cannot be altered. Placing the past in the past is a way to fully live their present; living the present is their awareness that they are going toward the future they are creating in the present [7].

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Consuelo C. Casula is the only one author.

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Original Research

Sociodemographic Variables and History of Trauma and Disease Influence Consciousness after Hypnotic Induction

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Abstract

Over the last 30 years, several neuroimaging and neurophysiological experiments have lent support to the neuropsychology of consciousness, and several definitions have followed to describe it. The phenomenological perspective of consciousness facilitates the description of the individual's awareness experience of internal states (e.g., perception, sensations, emotion, volition, or memories), thus helping us to better understand the relationship between the brain and mind. Although significant research has been aimed at evaluating the neurobiological aspects underlying the phenomenon of consciousness, there is a lack of information regarding the effect of clinical and sociodemographic factors on the modification of the altered state of consciousness in hypnosis. Therefore, the main objective of this study was to investigate how the variables of demographic and clinical history affected the alteration of consciousness during hypnotic induction. Consciousness was investigated within a single session using the PCI (Phenomenology of Consciousness Inventory) Italian translation, during the administration of the hypnotic susceptibility scale HGSHS:A (Harvard Group Scale of Hypnotic Susceptibility, Form A) Italian translation. Three hundred and

forty-nine subjects from the general population (aged 19–72 years; 112 male and 237 female) were investigated in a single session. Twenty-six subjects (7.4%) reported a history of recent psychological trauma, 6.6% reported a history of substance misuse, 7.7% had a history of psychiatric disorder, and 9.7% had a history of medical disease. Age was observed to be a negative predictor of hypnoidal state, intended to be a general measure of trance (β=–0.12; p=0.01). However, age also contributed to changing the phenomenology of consciousness, predicting greater vividness of imagery, reduction in time sense, fear, arousal, anger, negative affect, and perception. Females were more hypnotizable than males (β=0.18; p=0.000), with a reduced memory of suggestions, and an increase in the altered state. Subjects with perceived psychological trauma were more prone to have reduced memory of suggestions (β=0.14; p=0.01). A hypnotic state is the result of a combination of several individual predisposing traits and variables that are contextual to a specific situation. Age, gender, and perceived psychological trauma play a critical role in the hypnotic state, making the experience more subjective and influencing the quality of sensation, emotion, volition, and thought (consciousness phenomenology), which are fundamental for an appropriate response to suggestions.

Keywords
Consciousness; hypnosis; trauma; illness; gender; age

1. Background

While consciousness is often investigated in several fields, its meaning is still unclear. The word ‘consciousness’ refers to the state of understanding or realizing something, the state of being awake, or acknowledging the existence of something. Vithoulkas and Muresanu [1] have described consciousness as a function of the human mind that processes information by storing or rejecting it through perception (via the five senses), reasoning, imagination, emotion, and memory. Likewise, we consider awareness (including self-awareness) (the content) and wakefulness (the state) to be the two main components of consciousness and an altered state of consciousness as the product of any condition that changes the ordinary waking consciousness.

Over the last 30 years, several neuroimaging and neurophysiological experiments have lent support to the neuropsychology of consciousness, suggesting that a phenomenological perspective of consciousness enables us to explain the individual’s awareness experience of internal states (e.g., perception, sensations, emotion, volition, or memories) [2, 3]. This perspective helps us to better understand the relationship between the brain and mind.

Brown and Fromm [4] proposed that hypnosis comprises three principal aspects: altered states of consciousness, expectation and suggestibility, and the hypnotic relationship. Extending the neurophysiological and phenomenological research into the field of hypnosis, Holroyd hypothesized that imagination/susceptibility and an altered state of consciousness, combined with expectancy, may account for how individuals experience hypnotism [4, 5]. According to Weitzenhoffer [6], “the term *hypnosis* is reserved for the state, and the term of *hypnotism* for the production, study, and use of suggestion, with the state of hypnosis presumably being present

whether or not it adds anything tangible to the situation".

On the one hand, susceptibility represents the individual's physiological ability to respond to suggestion with non-voluntary behavior; on the other, the therapeutic action of hypnosis depends on the individual's subjective ability to enter an altered state of consciousness, decreasing sensibility, and responsiveness to external stimuli, "shifting from voluntary to automatic activity (trance)" [7]. Although there have been several studies on hypnosis and the ease of entering into a trance depending on the susceptibility levels, there is scarce literature investigating whether and how demographic and clinical variables can affect the change in consciousness experienced during hypnotism. Studies specifically analyzing the age- or gender-related differences in the alteration of the state of consciousness after hypnotic induction are particularly rare. However, data can often be indirectly extrapolated from reports on the validation of hypnotic scales [8] or assessment of the clinical outcomes of hypnotic treatment [9], which have provided some evidence that there are differences in hypnosis based on gender or age. For example, although hypnosis has been reported to be more successful in female subjects when used for quitting smoking, there is no mention as to how the phenomenology of consciousness varies between the two sexes [10].

Nevertheless, the latest studies do indicate that gender influences cognitive functions such as perception, emotion, and memory [11], and that sex hormones can predict the recovery of consciousness after severe traumatic brain injury [12].

Brain imaging studies highlight specific patterns of activation of the brain structure during hypnosis-related modification of consciousness. Two of the principal methods of hypnosis, relaxation, and mental absorption, which are included in a standard hypnotic induction as well as the Stanford Hypnotic Susceptibility Scale A (SHSS:A), are modulated in an opposite manner by the same brain structure [13]. An example for this is the rostral or posterior part of the anterior cingulate cortex (ACC). This suggests different involvement of attention, cortical arousal, and self-regulation, depending on the type of hypnotic method [13]. Furthermore, a negative correlation has been observed between the self-rated score of relaxation and the activities of the mesencephalic tegmentum, brainstem area, and the thalamus, determined using positron emission tomography (PET) of the regional cerebral blood flow (rCBF). An increase in mental absorption is rather correlated with increased activity in the thalamus and upper pons [13].

Differences in the involvement of the same structures alter the phenomenological experience that characterizes the hypnotic state. Therefore, despite neurobiological research that reveals how changes in the activity of brain structures are essential for the basic regulation of the state of consciousness in hypnosis, little clinical research has investigated how clinical factors such as traumatic experiences or the presence of illness may actually influence the phenomenology of consciousness in hypnosis.

Some researchers have investigated the relationship between life-threatening events and the modification of consciousness [14, 15]. Trauma-related altered state of consciousness (TRASC) is characterized by an alteration in the sense of time (reliving the trauma as flashback), thought (negative self-referential cognition), body (depersonalization and hyperarousal), and emotion (severe emotion numbing, sadness, anger, and shame) [14], suggesting that trauma may play a role in the alteration of consciousness. Together, this evidence is fundamental, as these factors may change the phenomenology of consciousness as a response to hypnotic induction. In particular, an alteration in the autobiographical memory has been observed in subjects with an increased number of stressful life events, alongside a positive correlation with increased scores for some

dimensions of somatization and on the SGSS:A [15].

1.1 Aim

This study aimed to evaluate how certain dimensions such as age and sex, the perception of having recently experienced psychological trauma, and the presence of medical or psychiatric disorders can influence the alteration of consciousness during hypnotic induction, in a non-clinical population.

2. Method

2.1 Study Design

This was a retrospective observational study investigating the modification of consciousness during the induction of hypnosis, based on sociodemographic and medical variables in a group from the general population that was enrolled in a university setting from 2017 to 2018. Consciousness was investigated during a single session using the PCI (Phenomenology of Consciousness Inventory) [16]. Italian translation [17], after the administration of the hypnotic susceptibility scale HGSHS:A (Harvard Group Scale of Hypnotic Susceptibility, Form A) [18] Italian translation [19].

2.2 Samples and Setting

The enrolled subjects responded to an announcement (including our contact information) displayed at several sites at the University of Pisa, as well as the University website. Groups of 10–20 subjects were recruited for each session. The sessions were conducted at the GIFT Institute of Integrative Medicine in Pisa, Italy. This research was conducted in accordance with the ethical principles of the Declaration of Helsinki for medical research involving human subjects, and the anonymity of the participants was protected. All the subjects signed informed consent that contained clear and explicit information regarding data publication.

2.3 Assessment

2.3.1 CRF

The Case Report Form (CRF) was used to obtain information from the subjects regarding their gender, age, marital status (single, married, divorced, widowed), education (sum of total years starting from the first year of primary school), and income (low, medium, high). History of medical disease (MD), psychiatric disorders (PD), substance misuse (SM), and recent psychological traumas (T) were assessed using code 1 for yes and 2 for no. All the clinical dimensions were investigated using the following questions:

A: Over the last year, have you been affected by some physical disease?
B: Over the last year, have you been affected by some psychiatric disorder?
C: Over the last year, have you been affected by substance misuse?
D: Over the last year, have you been affected by any psychological trauma?

2.3.2 PCI

An interesting instrument for assessing several dimensions of consciousness, linked to subjective experience associated with hypnosis, is the self-reported measure "Phenomenology of Consciousness Inventory (PCI)" [16]. This instrument takes into account the relevance of the widely known susceptibility assessments, the Stanford C scale [20] and the Harvard Group Scale (HGSHS) [18], with which it is strongly correlated (validity coefficient 0.86) [21]. Unlike other scales that provide a measure of susceptibility, the PCI includes the predictor of HGS score (pHGS), described as the hypnoidal state or "depth of trance score", which is "a phenomenology-based measure of trance that is primarily a function of the state effects, although influenced by trait factors" [17, 22].

Wagstaff and colleagues suggested that subjects in the hypnoidal state were "less prone to distortion from response sets and demand characteristics" [23]. If hypnotizability is "an individual's ability to experience the suggested alteration in physiology, sensation, emotion, thoughts, or behavior during hypnosis [24]", the "hypnoidal state is a general measure of trance" [17]. In line with Kumar *et al.* [25], some trait factors (absorption-permissiveness, general sensation-seeking, and social desirability) and state factors (dissociated control state, positive effect, negative effect, attention to internal processes, and visual imagery) included in the PCI assessment predict hypnotizability in 9% and 22%, respectively.

The phenomenological nature of PCI means that, unlike the HGSHS:A, it does not measure "hypnotic susceptibility" (a trait), but rather "hypnotic responsivity". Hypnotic responsivity is assumed to be a "state measure" of hypnotic skill in a particular moment. The PCI is an inventory that includes 53 items in a 0–6-scale response [17]. The parameters of PCI are joy, sexual excitement, love, anger, sadness, fear, body image, time sense, perception, meaning, amount of imagery, vividness of imagery, direction of attention, absorption, self-awareness, altered state, internal dialogue, rationality, volitional control, memory, arousal, positive affect, negative affect, altered experience, imagery, and attention. It includes the hypnoidal state score (HSS), which is a unit score correlated with the degree of hypnotizability, thereby contributing to our understanding of a subject's ability to develop a hypnotic condition. Through the above dimensions, the PCI allows us to categorize subjects into nine hypnotic types, corresponding to the characteristics of the subject's phenomenological trance. These dimensions could be extremely useful in the clinical setting, providing an indication to the hypnotist as to what kind of suggestions to use.

Furthermore, by applying cluster analysis to the group of subjects with low susceptibility to HGSHS (scores of 0–2), use of the subjective experience assessed by the PCI indicated a subgroup of subjects (pseudo-lows), that reported moderate drops in self-awareness, rationality, volition control, and memory, that were moderately hypnotizable [26]. Subjects were asked to complete the PCI according to the hypnotic assessment procedure (PCI-HAP) devised by Pekala *et al.* [26]. After introducing the suggestion of eye catalepsy, and before the post-hypnotic SHSS:A suggestion, the hypnotist told the subjects to stay silent and "just continue to experience the state you are in right now" for two minutes. The subjects were then requested to refer to these two minutes to respond to the PCI questionnaire. Usually, administration of the PCI is preceded by the induction procedure of a "body scan" and "mind calm". However, due to the limited previous experience in administration of the PCI, it was preferred to follow it precisely, in order to rely on a validated scale for hypnotic induction. This version of PCI had already been translated into Italian [17].

2.3.3 HGSHS

Shor and Orne's [18] construction of the Harvard Group Scale of Hypnotic Susceptibility: Form A (HGSHS:A) is a group version of Weitzenhoffer and Hilgard's Stanford Hypnotic Susceptibility Scale: Form A (SHSS:A) [27]. This scale involves a standard hypnotic procedure with 12 standard suggestions: head falling, eye closure, hand lowering, arm immobilization, finger lock, arm rigidity, hand moving, communication inhibition, hallucination, eye catalepsy, post-hypnotic suggestion, and amnesia. Each suggestion provides a dichotomous response (positive or negative). This hypnotic scale is cost-effective, being a self-reported measure for simultaneously testing groups of people. We used the validated Italian translation, which has a Kuder-Richardson coefficient of 0.70, making it comparable to the other European samples [19].

2.4 Statistical Analysis

Data were analyzed using the statistical software SPSS version 21 (IBM). After the application of the Kolmogorov-Smirnov test that gives information on the Gaussian distribution of the data, the t-test and Pearson's correlation analysis were performed. Non-parametric analyses (Mann–Whitney *U*, χ-square, and Fisher's exact test) were used when the number of subjects was lower than five, and for categorical variables. To assess the sociodemographic predictors of variation in hypnotic phenomenology, we used linear regression analysis, taking the PCI dimensions as dependent variables, while age, gender, education, social and marital status, history of medical disease, psychiatric disorders, substance misuse, and trauma were considered as the independent variables. All the regression models were corrected for age and gender. Statistical significance was set at $p<0.05$.

3. Results

3.1 Sample Description

Three hundred and forty-nine subjects from the general population (aged 19–72 years; 112 male and 237 female) were investigated during a single session. Twenty-six subjects (7.4%) reported a history of perceived-psychological trauma (T), 22 (6.6%) reported a history of substance misuse (SM), 27 (7.7%) had a history of psychiatric disorder (PD), and 34 subjects (9.7%) had a medical disease (MD) during the previous year (Table 1).

Subjects with a history of MD were older than those without it (n.1), and there was a higher prevalence of married subjects (n.2). However, there were no differences in the prevalence of MD based on education or income. Regarding PD, subjects with PD were older (n.3) and showed a higher prevalence of divorce (n.4) compared to subjects without a history of PD. No differences were observed in terms of education, gender, or income. In the case of SM, no differences were observed in the prevalence of SM, irrespective of the age, education, gender, and income of subjects. Subjects with recent trauma were older (n.5) than those without, and showed an increased prevalence of divorce ($\chi^2=40.89$; $p<0.0001$) (n.6). No differences in the prevalence of trauma were observed irrespective of the gender, education, or income (Table 1).

Table 1 Sample description.

	MD [n./xM (sD]		**PD** [n./xM (sD]		**SM** [n./xM (sD]		**T** [n./xM (sD]	
	Yes (n. 34)	**No (n. 315)**	**Yes (n. 27)**	**No (n. 322)**	**Yes (n. 22)**	**No (n. 327)**	**Yes (n. 26)**	**No (n. 323)**
Age	40.24 (15.45)[1]	28.2 (9.78)	42.85 (14.73)[3]	28.03 (9.91)	26.73 (11.04)	29.48 (11.17)	37.62 (15.58)[5]	28.39 (10.24)
Education (n. years)	16.06 (3.52)	16.92 (2.75)	17 (2.68)	16.79 (2.87)	16.27 (2.64)	16.85 (2.87)	16.36 (3.20)	16.84 (2.82)
Males	7	105	8	104	8	104	7	105
Females	27	264	19	218	14	223	19	218
Civil status								
Single	17	259	14	261	20	256	16	260
Married	15	36	11	40	2	49	6	45
Divorced	1	13	2	12	0	14	3	11
Widowed	1[2]	3	0[4]	4	0	4	1[6]	3
Income								
Low	2	34	2	34	3	33	3	33
Medium	30	263	22	271	19	274	21	272
High	2	18	3	17	0	20	2	18

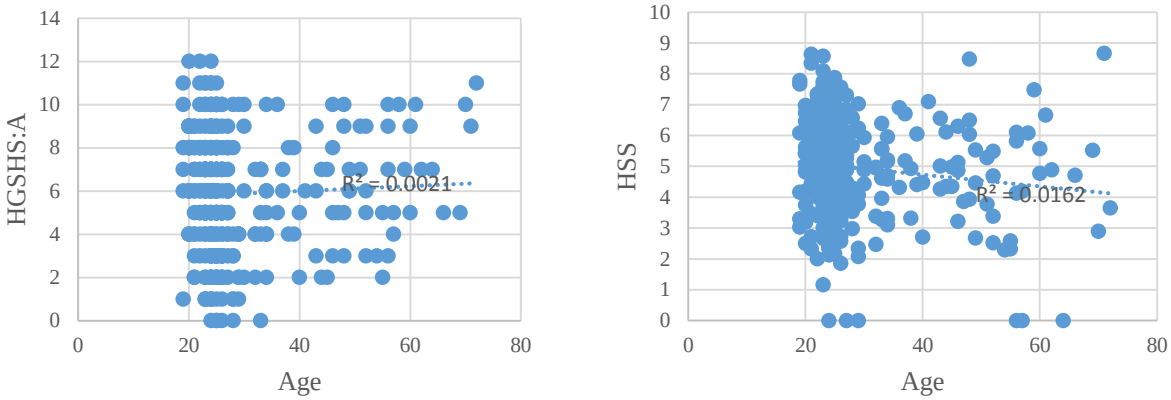
MD: medical disease; PD: psychiatric disorder; SM: substance misuse; T: psychological trauma, Harvard Group Scale of Hypnotic Susceptibility: Form A (HGSHS:A); hypnoidal state score (HSS). 1: unpaired t-test: t=6.38; p=0.000; 2: chi-squared analysis (4 missing values) $\chi 2$= 35.90, p= 0.000; 3: unpaired t-test: t=7.08; p=0.000; 4: chi-squared analysis $\chi 2$= 21.96, p= 0.000; 5: unpaired t-test: t=4.17; p=0.000; 5: chi-squared analysis $\chi 2$= 31.47, p= 0.000. The numbers given in superscript are described in the text.

3.2 Susceptibility, Hypnoidal State, Clinical, and Sociodemographic Variables

Although age was not correlated with the total HGSHS:A score, a negative correlation was observed between age and the hypnoidal state (r=–0.13, p=0.013). Using HGSHS:A and HSS scores as dependent variables and age as the independent variable, we demonstrated that age was a negative predictor of HSS (Figure 1).

No differences were observed between genders in terms of hypnoidal state score. However, there were differences in hypnotic susceptibility between the genders. Specifically, females showed higher HGHS:A total scores than males (xM=6.30, sD=2.69 for females and xM=5.09, sD=2.53 for males; t=3.79, p=0.0001). Gender (female) was a positive predictor of a high degree of susceptibility but not of degree of HSS (Table 2). Gender also remained a predictor of susceptibility

when age was included in the model (Table 2). No other differences in either hypnotic susceptibility or hypnoidal state were found when the sample was sub-divided by the other sociodemographic variables.



A **B**

Figure 1 Linear regression analysis of A: Group Scale of Hypnotic Susceptibility: Form A (HGSHS: A) total score and age (B= .01; β= .46; p= .39) and B: Hypnoidal State Score (HSS) and age (B= –.19; β= -.12; p= .017).

Table 2 Gender as a predictor of total susceptibility score.

	B	S.D.	β	t	Sig.	95%CI for Exp (B) Inf.	Sup.
Gender							
HGSHS:A	1.06	.30	.18	3.51	.000	.46	1.65
* age	1.05	.30	.18	3.50	.001	.46	1.65

Harvard Group Scale of Hypnotic Susceptibility: Form A (HGSHS:A); Linear Regression Analysis; * inclusion of age in the model.

3.3 Relationship between Sociodemographic Variables and Phenomenology of Consciousness

As mentioned earlier, age appeared to be relevant and negatively correlated with the depth of trance, i.e., the modification of consciousness during hypnotic induction. When the phenomenology of trance in subjects above 30 years of age was compared to those below this age , some differences were observed in the mean age scoring (Figure 2). Specifically, subjects older than 30 years had lesser sexual excitement, fear, internal dialogue, and arousal, but greater vividness of imagery, self-awareness, and rationality (Figure 2). As shown in Table 3, age was a predictor of several phenomena of consciousness, thereby modifying the phenomenology of hypnosis. On one hand, age increases the hypnotic state, predicting greater vividness of imagery and reduced time sense, fear, arousal, anger, negative effect, and perception (the perception of space relative to the environment where the subject is located). On the other, it contributes to a reduction in the depth of trance, negatively predicting sexual excitement, amount of imagery, altered state, altered experience, and internal dialogue, and positively predicting rationality.

Higher age predicted greater PCI reliability index score (Table 3).

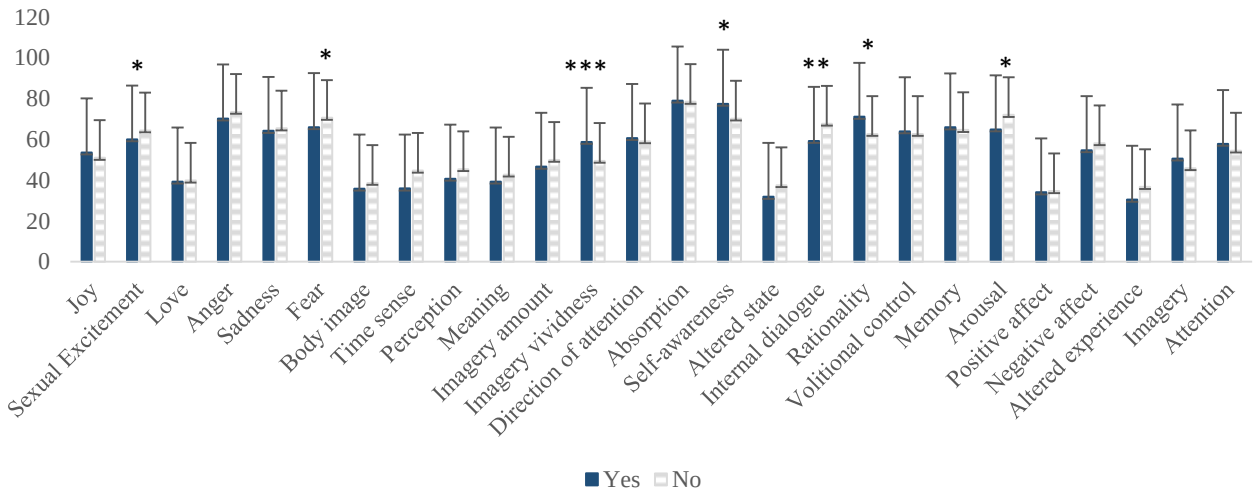


Figure 2 Difference between age groups (yes= ≥ 30; no < 30) in consciousness phenomenology (PCI) during hypnotic induction using the HGSHS:A. T-test for unpaired data analysis. *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001.

Table 3 Age as a predictor of hypnotic consciousness phenomenology

	B	**S.D.**	**β**	**t**	**Sig.**	95%CI for Exp (B) **Inf.**	**Sup.**
Age							
Sexual Excitement [a]	**-.25**	.06	-.19	-3.77	**.000**	-.38	-.12
Anger [a]	**-.25**	.06	-.19	-3.68	**.000**	-.38	-.11
Fear [a]	**-.26**	.08	-.17	-3.33	**.001**	-.42	-.10
Time sense [a]	**-.46**	.15	-.16	-3.02	**.003**	-.76	-.16
Perception [a]	**-.35**	.13	-.13	-2.62	**.009**	-.62	-.08
Imagery amount [a]	**-.23**	.11	.-.10	-1.98	**.048**	-.46	-.002
Imagery vividness [a]	**.28**	.10	.14	2.71	**0.007**	.07	.49
Altered state [a]	**-.32**	.13	-.12	-2.40	**.017**	-.58	-.05
Internal dialogue [a]	**-.47**	.12	-.20	-3.93	**.000**	-.70	-.23
Rationality [a]	**.35**	.12	.15	2.90	**.004**	.11	.59
Arousal [a]	**-.34**	.11	-.15	-2.97	**.003**	-.56	-.11
Negative affect [a]	**-.26**	.10	-.12	-2.41	**.016**	-.47	-.049
Altered experience [a]	**-.33**	.14	-.12	-2.32	**.021**	-.61	-.05
Reliability index score [a]	**.01**	.003	.21	4.17	**.000**	.00	.01

Linear Regression Analysis. a: including gender in the model, the statistical significance does not change.

As shown in Figure 3, we observed statistically significant differences between genders in several PCI parameters. Specifically, males showed greater sexual excitement, internal dialogue, memory, and positive affect than females. By assigning males with a code of 1 and females as 2, linear regression revealed that gender was a negative predictor of sexual excitement, positive affect, memory, and internal dialogue. As women were assigned with a higher code than males, one could argue that female sex was a negative predictor of these parameters of the PCI, although it also appeared that the female gender was a positive predictor of the altered state of consciousness (Table 4). Adding age to the model had no effect on the statistical significance of the observed values.

No relationship was observed between marital status and hypnotizability. However, this sociodemographic variable did affect several dimensions of consciousness, when taken individually. There were no changes to the predictive ability of the phenomenology of trance when gender was added to the linear regression model, but this was totally annulled when age was added to the model (Table 4).

Education also affected the profile of trance, and was observed to be a negative predictor of positive effect and the reliability index score. For both of these variables, the statistical significance of the regression analysis did not change when age and gender were added to the model. Based on this analysis, income did not represent a predictor of trance phenomenology.

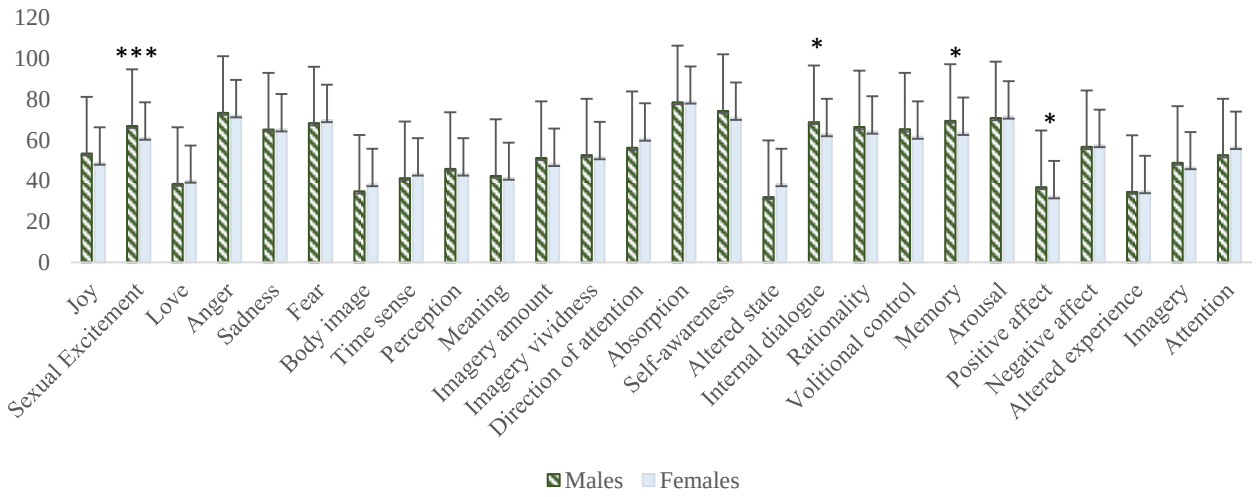


Figure 3 Differences between genders in consciousness phenomenology (PCI) during hypnotic induction using the HGSHS:A. T-test for unpaired data analysis. *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001.

Table 4 Gender and sociodemographic parameters are predictors of phenomenology of consciousness after hypnosis induction.

	B	**S.D**	**β**	**t**	**Sig.**	95%CI for Exp (B) **Inf.**	**Sup.**
Gender							
Sexual Excitement	**-5.78**	1.52	-.20	-3.80	**.000**	-8.78	-2.74
Altered state	**6.28**	3.06	.10	2.04	**.041**	.25	12.31
Positive affect	**-4.56**	2.04	-.11	-2.23	**.03**	-8.58	-.54
Memory	**-5.86**	2.86	-.10	-2.04	**.041**	-11.48	-.23
Internal Dialogue	**-5.84**	2.78	-.11	-2.10	**.036**	-11.30	-.37
Education							
Positive affect	**-.94**	.35	-.14	-2.68	**.008**	-1.63	-.25
Reliability index score	**-.03**	.01	-.16	-3.12	**.002**	-.05	-.01
Civil Status							
Sexual excitement [a.b].	**-4.47**	1.68	-.14	-2.65	**.008**	-7.80	-1.15
Fear [a.b]	**-6.05**	1.97	-.17	-3.06	**.002**	-9.95	-2.16
Time sense [a.b]	**-8.20**	3.81	-.12	-2.15	**.032**	-15.70	-.70
Imagery amount [a.b]	**-7.67**	2.89	-.14	-2.65	**.008**	-23.37	-1.97
Internal dialogue [a.b]	**-8.15**	2.97	-.15	-2.74	**.006**	-13.99	-2.30
Rationality [a.b]	**7.84**	2.98	.14	2.62	**.009**	1.97	13.71
Arousal [a.b]	**-7.89**	2.83	-.15	-2.78	**.006**	-13.47	-2.31

Linear regression analysis. a: putting gender in the model, statistical significance does not change; b: adding age to gender in the model, statistical significance is annulled.

3.4 Relationship between Clinical Variables and Phenomenology of Consciousness

In this study, comparing subjects with a history of PD or SM from those without these issues revealed no differences. Using linear regression analysis with each PCI parameter as a dependent variable, a history of PD or SM yielded no statistically significant difference.

In contrast, the sample did display differences in the phenomenology of consciousness during hypnosis, if they had a medical disease or perceived psychological trauma during the last year. In fact, as shown in Figure 4, the subjects with MD showed lower values of sexual excitement and meaning, compared to the subjects without MD. Using the linear regression analysis, we demonstrated that MD predicted these two parameters in a statistically significant manner, even when gender was added to the model as an independent variable. However, this significance was lost when age was also added to the model (Table 5).

Subjects that perceived psychological trauma during the previous year showed lower internal dialogue, rationality, and memory, and had higher scores for negative affect than subjects without

trauma (Figure 5). The subjects with trauma were scored as 1 and subjects without trauma as 2. Linear regression analysis indicated a positive and statistically significant relationship between trauma and memory (Table 5). This could be interpreted as a positive relationship with subjects without trauma (coded with higher scoring). This analysis remained statistically significant even when gender and age were included in the model (Table 5).

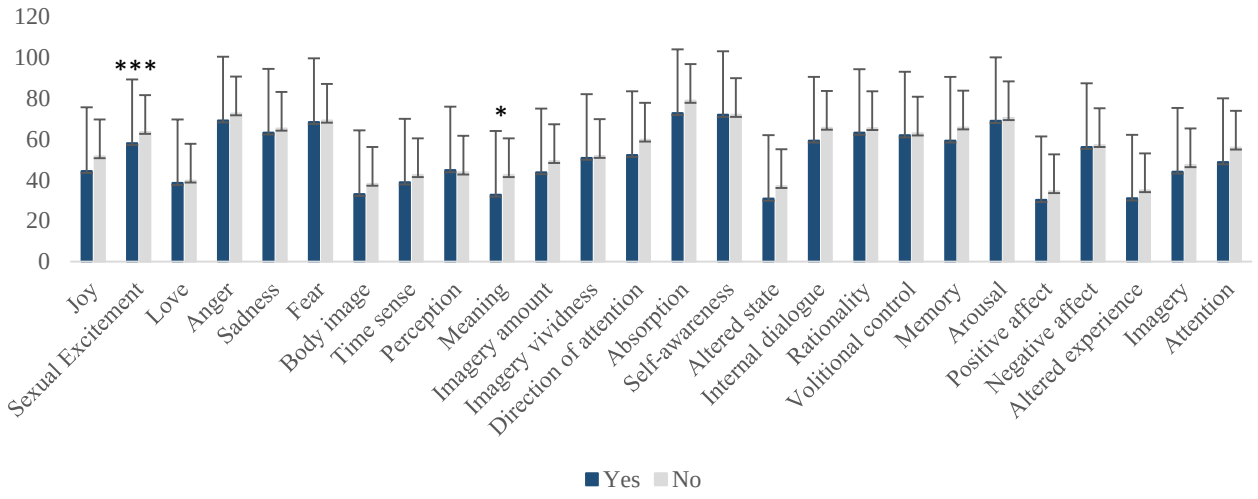


Figure 4 Differences between the subjects with and without medical disease in consciousness phenomenology (PCI) during hypnotic induction, using HGSHS:A. T-test for unpaired data analysis. *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001.

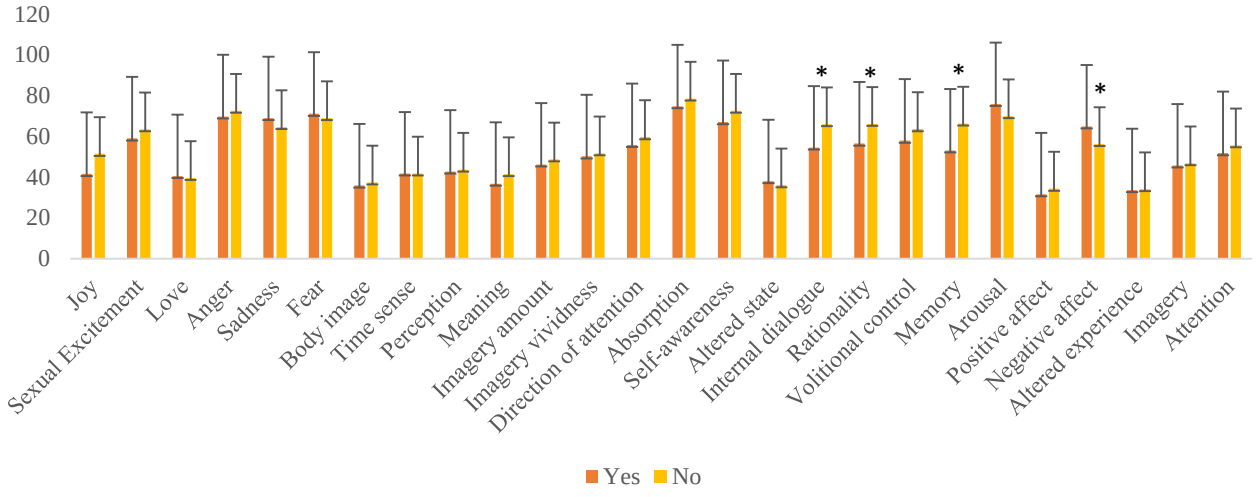


Figure 5 Difference between the subjects with and without perceived psychological trauma in consciousness phenomenology (PCI) during hypnotic induction, using HGSHS:A. T-test for unpaired data analysis. *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001.

Table 5 Clinical variables as predictors of phenomenology of consciousness after hypnosis induction.

	B	S.D.	β	t	Sig.	95%CI for Exp (B)	
						Inf.	Sup.
Medical Disease							
Sexual excitement [a b]	**5.48**	2.52	.12	2.17	**.030**	.52	10.44
Meaning[a b]	**9.66**	4.29	.12	2.25	**.025**	1.22	18.10
Trauma							
Internal dialogue [a b]	**11.50**	4.99	.13	2.30	**.022**	1.68	21.33
Memory [c]	**13.19**	5.11	.14	2.57	**.01**	3.12	23.26
Reliability index score [a b]	**-.22**	.11	-.11	-2.06	**.040**	-.44	-.01

Linear regression analysis. a: putting gender in the model, statistical significance does not change; b: adding age to gender in the model, statistical significance is annulled. c: the statistical significant values do not change adding gender and age to the model.

4. Discussion

If we consider hypnosis as a "state" that is distinct from "normal" wakefulness, some assumptions should be made. Hypnosis should produce change in the experience that is not limited to specific domains of the perceptive experience, and this is associated with specific neurophysiological mechanisms for the regulation of the state of consciousness. Therefore, according to the concept of consciousness proposed by Revonsuo [28], "the science of consciousness needs to develop a phenomenological level of description that systematically captures the phenomenal level of organization in the brain". Therefore, the best way to study hypnosis is to investigate changes in the conscious state from a "phenomenology of consciousness" perspective. Deviations in the phenomenological experience from general wakeful consciousness and changes in the regulation of the states of consciousness through modification of activities of the brain systems trigger the altered state of consciousness due to hypnosis [29].

Although some individuals have a strong predisposition (as a trait) to get hypnotized, almost all people have moderate to low levels of susceptibility. Therefore, it is obvious that they will have little benefit from the therapeutic effects of hypnosis. However, research by Pekala *et al.* [26] introduced the possibility of recognizing individuals defined as "pseudo-low", a type of hypnotic profile that is characterized by a particular phenomenology of consciousness with a moderate level of susceptibility to hypnosis. From a clinical perspective, this evidence highlights the great subjectivity in the experience of hypnosis, and that the quality of sensation, emotion, volition, and thought (phenomenology of consciousness) plays a central role in response to suggestion.

Some research has discussed the role of context in the process of hypnosis. Subjects with a high level of hypnotizability show a "fine-grained variation" in responsiveness to suggestion. The appropriate response to suggestions could be affected by motivation, certain cognitive factors, or the hypnotic relationship [30]. On the other hand, our results indicate that the response to hypnosis may be modified by other contextual dimensions, such as sociodemographic factors or clinical conditions. Furthermore, it is now known that there are differences in the adult brain function between genders [31], and that these can change the neurophysiological mechanisms

involved in the regulation of the conscious state during hypnosis. As we have already mentioned, previous experience of life-threatening events also changes the state of consciousness [14].

In this study, age was also observed to be a relevant factor influencing the phenomenology of consciousness during hypnosis. It negatively predicted the hypnoidal state, intended as a "general measure of trance" (i.e., decreased sensitivity or responsiveness to external stimuli, where voluntary activity becomes automatic) [17]. However, from a phenomenological perspective, considering the PCI parameters, greater age can actually induce a good level of hypnosis, as it also predicted greater vividness of imagery, and a reduction in time sense, fear, arousal, anger, negative affect, and perception (loss of awareness of the body's location). Greater age also contributed to a reduction in the depth of trance, negatively predicting sexual excitement, amount of imagery, altered state, altered experience, and internal dialogue, and positively predicting rationality (Table 3). On the other hand, age does not influence hypnotizability; in fact, we found no relationship between age and HGSHS:A (Figure 1), although its influence on some phenomena of consciousness could account for its negative impact on the hypnoidal state.

Our results corroborate the findings of previous research, in which females showed greater hypnotizability than males [32]. Compared to males, females had higher HGSHS:A scores, and gender was observed to be a positive predictor of hypnotizability, even after age correction (Table 2). As mentioned in the 'Results', a positive β score in the linear regression was associated with the female gender, which was coded with the highest value (1 for male and 2 for female). While females were more prone to hypnosis and loss of memory of suggestions, this study showed that males tended to have an altered state of consciousness, with increased sexual excitement, positive affect, and internal dialogue (Table 4). From a neurophysiological perspective, it can be suggested that hypnosis does modify the brain's mechanism in an age- and gender-dependent fashion, and that these two demographic factors play a critical role in the altered state of consciousness associated with hypnosis.

The present results also indicate that the level of education plays a role in hypnosis, acting to decrease positive affect. In addition, although marital status may influence the modification of consciousness after hypnosis, its effect is annulled after age-correction of the model, unlike in the case of education (Table 4).

Another interesting aspect of this research was the evaluation of clinical conditions (used as context variables) such as a history of medical disease, psychiatric disorders, substance misuse, and perceived psychological trauma for the past year. Surprisingly, no differences were observed in the phenomenology of consciousness between subjects with and without psychiatric disorders or substance misuse. However, there were differences between subjects who reported medical disease or psychological trauma during the past year. Specifically, subjects with the medical disease showed lower levels of sexual excitement and meaning after hypnosis, compared to subjects without (Figure 4). Furthermore, the medical disease also appeared to predict reduction in sexual excitement and meaning (with MD coded "1"; without MD coded "2"). Correction for gender did not alter these results, but adding age to the model annulled the statistically significant regression for both the parameters (Table 5).

In contrast, subjects with perceived psychological trauma during the preceding year showed lower levels of internal dialogue, rationality, and memory of suggestions, as well as an increased level of negative affect, compared to subjects without perceived trauma (Figure 5). The perception of trauma proved to be a negative predictor (trauma coded "1"; no trauma coded "2") of internal

dialogue and memory (Table 5). However, when gender and age were added to the linear regression model, the prediction was only confirmed for PCI memory (Table 5).

This study has some limitations. In particular, it would have been preferable to administer a questionnaire on the phenomenology of consciousness before inducing hypnosis, in order to pinpoint the variations in consciousness induced by suggestion (i.e., suggesting two min of silence without hypnotic induction). It might also have been more enlightening to explore clinical variables in further detail, using specific instruments. Furthermore, dividing patients into specific age groups could have enabled better exploration of the age-related changes. Considering these limitations, it would, therefore, be desirable to explore these aspects in a future study using a larger sample.

5. Conclusion

The results of this research confirm the subjective experience of hypnosis. Besides the degree of hypnotizability, several other factors can affect the change in subjective experience induced by suggestion. "The mental ease, absorption, reduction of self-orientation, and automaticity that characterized the altered state of consciousness of hypnosis" [29] is, therefore, the result of a combination of several individual predisposing traits with some contextual variables in a specific situation. These results demonstrate the influence of age and gender in hypnosis. Specifically, gender affects the level of hypnotizability, while age affects the depth of trance. Both factors also affect the phenomenology of consciousness, with age playing a critical role in reducing negative emotions, perception, and arousal, and increasing temporal distortion and vividness of imagery, while gender reduces the memory of suggestions in females, and increases dissociative phenomena and body perception in males.

Reduced memory of suggestions was also found to be associated with perceived psychological trauma, corroborating the findings of previous research that correlated trauma with a change in the state of consciousness. Memory could represent the cognitive area that is primarily affected by the experience of trauma, and from the perspective of clinical application [33], could represent a gateway to trance for hypnotic induction in these subjects.

In summary, this retrospective study highlights how important it is to consider contextual variables that, although limited to sociodemographic factors, might also include clinical conditions which are yet to be thoroughly investigated from this perspective.

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Author Contributions

Antonella Ciaramella is the sole author who conceived, carried out and wrote this study.

Competing Interests

The authors declare that no competing interests exist.

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Research Article

Electrodermal Correlates of Hypnosis: Current Developments

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Abstract

Hypnosis has proven to be an effective treatment in disorders that affect the autonomic nervous system (ANS). However, the studies investigating the nature of its effect on the ANS have reported contradictory results. Measurement of electrodermal activity (EDA) is an objective way to assess the activity of the sympathetic branch of the ANS. We aim to elucidate the effects of hypnosis on EDA. Here, we report the results of two studies, both investigating the psychophysiological effects of hypnosis.In the first experiment, subjects engaged in an HGSHS:A group hypnosis session to measure their hypnotizability. EDA was measured bilaterally from their wrists. We found a significant reduction in EDA levels and the number of nonspecific responses during the hypnotic induction phase. This effect was observed in all three hypnotizability groups—high, medium, and low hypnotizables.

A three-way interaction confirmed that EDA patterns on the left and right sides were characteristically different in these three groups. Left-side dominance was typical in high hypnotizables, whereas low hypnotizables were characteristically right-sided. EDA levels of

the two sides remained synchronous in medium hypnotizables. During the suggestion phase, we found significant differences in EDA levels depending on the test suggestions, modulated by hypnotizability. A suggestion, harder to respond to, elicited higher arousal in high hypnotizables as compared to low hypnotizables.

In the second experiment, we performed five consecutive hypnosis sessions to confirm the reproducibility of the most prominent effect found in Study 1—a gradual decrease in the level of skin conductance during hypnotic induction. We also confirmed that this effect is independent of the hypnotizability level.

We conclude that arousal is bilaterally reduced during hypnosis induction, which is persistent across different levels of hypnotizability. At the same time, lateral differences define unique EDA patterns in the induction phase, characterizing high, medium, and low hypnotizables.

Keywords

Bilateral; electrodermal; EDA; group measurement; hypnosis

1. Introduction

Hypnosis is a state of consciousness that is characterized by focused attention and decreased peripheral awareness, accompanied by an increased capacity to respond to suggestions [1]. During hypnosis, the subjects often report changes in time sense, body image, memory, self-awareness, and volitional control, all associated with an altered state of consciousness [2]. Hypnosis is a product of the procedure called hypnotic induction [1]. A hypnotic state is achieved when individuals respond to suggestions in an automatic fashion, ignoring environmental stimuli, other than those pointed out by the hypnotist. In this state, the individual tends to see, feel, and smell in accordance with the hypnotist's suggestions, even though these suggestions may be in contradiction to the actual stimuli present in the environment. The degree to which people respond to suggestions is called hypnotizability. It is typically measured on a scale ranging from low to high. It is a stable, trait-like characteristic that does not change significantly over time; measured 25 years later, the correlation remains high with $r = 0.75$ [3]. We usually divide people into three groups—low, medium, and high hypnotizable individuals. Low and high hypnotizables are often compared in research as the two ends of the continuum [4]. There are standardized procedures to induce hypnosis and to measure hypnotizability. They involve rapport building followed by a hypnotic induction, various test suggestions, and a deinduction [5, 6].

Hypnosis has long been known as a useful therapeutic tool for various psychological and physiological disorders, including chronic headaches, hypertension, and various forms of anxiety [7]. It is particularly efficient for disorders that are characterized by changes in the autonomic nervous system. The reason for this efficacy may lie in the reduction in psychophysiological arousal and the modulation of autonomic activity [8-10]. Forbes and Pekala (1993)[8] reported that self-hypnosis training produced psychological improvements associated with reduced anxiety, reduced pulse rate, and increased skin temperature [8]. Kanji and colleagues (2006)[11] demonstrated that eight sessions of autogenic training lowered state and trait anxiety levels as

well as systolic and diastolic blood pressure [11]. Hypnosis can also be an adjuvant treatment for major depression, a disorder that is associated with autonomic nervous system changes, such as decreased heart rate variability [12]. Chen and colleagues (2017) [12] found that heart rate parameters significantly improved in the hypnotic and post-hypnotic conditions compared to the pre-hypnotic condition. Thus, they concluded that hypnotic treatment might bring improvements in vegetative functions [12].

Measuring electrodermal activity can be an unobtrusive and cost-effective way to gain information about the autonomic nervous system [13]. The ease of use and the widely available technology have made the measurement of electrodermal activity (EDA) a popular tool in hypnosis research. Tools measuring skin conductance (SC) make use of the eccrine sweat glands, which are exclusively innervated by the sympathetic nervous system (SNS) [14, 15]. Thus, the tonic component of skin conductance, skin conductance level (SCL), is an excellent way to gauge the background level of the SNS. In contrast, the phasic component, skin conductance response (SCR), provides information about the autonomic responses to the given stimuli. The tonic component is characterized by slow changes; whereas, the phasic components change faster. Dawson and colleagues provided a detailed description of the different components of skin conductance [15, 16]. Determining the measurement sites for EDA is important since the density of eccrine sweat glands differs in different parts of the body. The most responsive sites to measure electrodermal activity are the palmar and plantar surfaces (for a recent bilateral analysis of traditional and alternate measuring sites, see Kasos et al., under review).

In the following section, we summarized the research results concerning the relationship between EDA and hypnosis. The studies are listed in chronological order.

Table 1 Summary of research results regarding EDA and hypnosis.

Authors & year	**Purpose of the research**	**N**	**Measurement**		**Type of induction**	**Hypnotizability measurement**	**Main findings**
			side	**place**			
Levine, 1930	EDA during hypnosis	6	Bi	palms of hands	-	-	No differences between waking state and hypnosis.
Estabrooks, 1930	EDA during hypnosis	20	Uni	hand	-	-	EDA decreased in hypnosis.
Davis&Kantor, 1935	EDA during hypnosis	71	Uni	medial phalanges of index and middle fingers of the right hand	-	-	Difference between active and passive hypnosis. In the active part of hypnosis, EDA resembled EDA in the awake state while in passive hypnosis resembled EDA during sleep.
Brown & Vogel, 1938	hypnosis during pain stimulation	3	-	-	-	-	No electrodermal signs of pain perception in hypnosis.
West et al., 1952	effects of hypnosis on noxious stimuli	7	-	-	-	-	Hypnotic suggestions reduce electrodermal responses to painful stimuli.
Sears & Beatty, 1956	differentiate between waking state and hypnotic state based on EDA	24	-	-	-	Davis and Husband scale of hypnotic susceptibility	No difference between the hypnosis and awake condition.
Barber & Coules, 1959	EDA during hypnosis	6	Uni	palm	-	-	Three subjects had high, and three had lower EDA during the induction. Subjects showed rising EDA during test suggestions; in addition, active suggestions (for example, suggested hallucination) elicited higher arousal.
Shor, 1962	physiological effects of	16	Uni	palm	-	-	No differences in electrodermal

	painful stimuli in hypnosis						response between hypnosis and simulator group to painful stimuli.
Tart, 1963	effects of self-reported hypnotic depth and EDA	11	Bi	foot	arm levitation,	-	Falling EDA during induction and varied EDA (rising and falling) during test suggestions.
Stern et al., 1963	how hypnotically induced amnesia alters recently acquired behavior and electrodermal correlates	14	-	-	free induction	-	No differences in EDA between hypnosis and control condition. EDA showed an increase at the beginning, followed by a decrease and an eventual increase again in hypnosis.
Edmonston & Pessin, 1966	the relation between hypnosis, learning, and EDA	22	Uni	index and middle fingers	-	not measured	No differences in skin conductance between hypnosis and control group.
Fehr & Stern,1967	effects of hypnosis on relevant and irrelevant stimuli	24	-	-	SSHS:A	HGSHS: A	The hypnosis group showed lower electrodermal orienting responses than the control group.
O'Connel et al., 1968	the relation between self-reported hypnotic depth and EDA	51	Uni right	palm	passive trance induction	HGSHS: B	Arousal correlates with hypnotizability. EDA changes during hypnosis reflect the quality of the rapport more than self-reported hypnotic depth.
Pessin et al., 1968	effects of hypnosis induction on EDA	40	-	-	the modified version of the Stanford scale	not measured	Lower number of nonspecific responses in the hypnosis condition than in the control condition.
Edmonston, 1968	effects of hypnosis on EDA	45	-	-	SHSS:B	HGSHS	The hypnosis group had lower number of spontaneous fluctuations than the control group. The groups did not differ in the number of electrodermal orienting responses.
Serafetinides, 1968	effect of hypnosis on EDA	1	-	-	-	not controlled	More frequent electrodermal responses during hypnosis compared

							to baseline.
Paul & Trimble, 1970	compared live and recorded hypnosis	30	-	-	eye fixation method	not controlled	EDA reduction during hypnosis, no difference between live or recorded sessions.
MC Ammond et al., 1971	effectiveness of relaxation and hypnosis training on stress reactions at the dentist	27	-	-	specific induction performed by the dentist	not controlled	High baseline EDA level subjects benefitted more from hypnosis and relaxation training.
Tebecis et al.,1976	EDA differences between hypnosis and awake conditions	33	Bi	palms	audio recorded self-hypnosis induction	controlled but not specified	EDA decreased during both hypnosis and control condition; however, there was a more substantial decrease in the hypnosis condition.
Bauer & McCanne,1980	effects of hypnosis on the ANS	12	Uni	medial phalanges of the index and fourth fingers	standardized audio recorded induction	HGSHS: A	Lower levels of nonspecific responses during hypnosis compared to post hypnosis. EDA was reduced in both simulator and hypnosis group.
Gruzelier et al., 1985	habituation to auditory stimuli in hypnosis	30	Bi	medial phalanges of the index and middle fingers	audio recorded eye fixation method	scale prepared for this experiment	Both high and low hypnotizables showed higher right-side skin conductance level. High hypnotizables had a lower number of nonspecific SCRs. High hypnotizables showed higher left side responses to tones during baseline compared to right side responses, and this was the opposite in hypnosis. High hypnotizables showed faster habituation to standard tones than low hypnotizables, and hypnosis had a suppressant effect on sensitization.
Gruzelier et al., 1988	differentiate between those who are in hypnosis and	18	Bi	medial phalanges of	Hypnosis induction was	Barber Suggestibility	Induction phase: higher left side SCL compared to the right side in the

	those who simulate hypnosis			the index and middle fingers	audio recorded	Scale	hypnosis group while the simulator group had higher right side SCL compared to left side SCL. Simulators showed more frequent nonspecific SCRs in the beginning stages of the induction. Hypnosis phase: both groups showed higher left side SCL. Habituation to tones facilitated in the hypnosis group, while retarded habituation characterized the simulator group.
Sturgis & Coe,1990	psychophysiological responsiveness during hypnosis	22	Uni	proximal phalanges of the non-dominant hand	the modified version of SHSS:C	HGSHS: A and SHSS: C	No baseline differences between high and low hypnotizables. No differences in EDA between high and low hypnotizables. Lower skin conductance during induction and dream suggestion than during other suggestions.
Kinnunen et al., 1994	detecting deception in the hypnotized	22	Uni	distal phalanges of the index and middle fingers of the non-dominant hand	-	HGSHS: A	No difference in SCR magnitudes between hypnosis and awake condition.
Paul et al., 1996	physiological effects of relaxation and hypnosis	60	Uni	dominant foot	eye fixation method	not controlled	Both relaxation and hypnosis produced lower SCL. Training effect reported in the hypnosis condition. Lower skin conductance in the second session than in the first session.

De Pascalis et al., 1999	psychophysiological effects of hypnotic analgesia	29	Uni	medial phalanges of the index and middle fingers of the left hand	Stanford clinical scale	SHSS: C	The fewer number of SCRs in hypnosis than in awake condition in response to pain stimulation. High hypnotizables had a lower number of SCRs than low hypnotizables. High hypnotizables had lower amplitude responses than medium and low hypnotizables. Higher amplitude responses for all in the waking condition than in hypnosis.
De Pascalis et al., 2004	evaluating the cognitive load of hypnotic analgesia	30	Uni	medial phalanges of the index and middle fingers of the left hand	Stanford clinical scale	SHSS: C	High hypnotizables had lower amplitude SCRs, in response to auditory stimuli in hypnosis, than medium and low hypnotizables.
Kekecs et al., 2016	effect of hypnosis on the ANS	121	Uni	medial phalanges of the index and middle fingers of the non-dominant hand	audio recorded WSGC	HGSHS: A	No differences between low and high hypnotizables. Lower SCL was found between pre and post induction in the hypnosis group compared to the music control condition.
Kinnunen et al., 2016	true hypnosis experience or complying	14	Uni	non-dominant hand	modified version of SHSS	HGSHS: A	In the hypnosis condition there was no difference in SCR amplitude between neutral and critical questions. SCR amplitudes differed in the control condition.

The studies are listed in chronological order. "N" –number of participants; "Uni" –unilateral measurement; "Bi"–bilateral measurements; HGSHS – Harvard Group Scale of Hypnotic Susceptibility [17]; WSGC–Waterloo Stanford Group Scale [5]; SHSS–Stanford hypnotic Susceptibility Scale [6].

The characteristic points related to hypnosis and EDA, based on the above results, may be summarized as below:

1. Regarding EDA levels, eight studies reported lower skin conductance during hypnosis compared to pre-hypnosis, post-hypnosis, or control conditions. Only one study observed a higher level of skin conductance during the hypnotic induction. Three studies found no difference between the skin conductance levels in hypnosis and control condition.
2. Many studies reported that the number of skin conductance responses (SCRs) or nonspecific SCRs were fewer during hypnosis than in control conditions. Others found that high hypnotizable individuals had less nonspecific SCRs than the low hypnotizable subjects. SCRs have smaller amplitudes in hypnosis, which is more prominent in high hypnotizables.
3. A research group published two studies with contradictory results regarding bilateral EDA.

1.1 Methodology in Hypnosis Research

Hypnosis research is riddled with methodological diversity. It would be most effective to use a standard induction procedure to ensure the reproducibility of results. Using standardized scales for measuring hypnotizability would also be beneficial to compare results.

From Table 1, it is clear that the standardized methodology of electrodermal measurements and reporting would be beneficial. Dawson (2007) [16] recommended taking the measurements from the distal phalanges of the index and middle fingers of the non-dominant hand. If those are unavailable, current studies have reported alternative measurement sites (see Kasos et al., under review). In the present study, we took the measurements from the wrists, as some of the test suggestions required use of both the hands, including fingers. SCR window should be set between 1 and 5 s after stimulus onset [15]. The minimum threshold for SCR amplitude should be set to the recommended 0.01 μS [14, 15].

Based on the above methodology, we hypothesized that:

1. SCL will reduce during the full hypnotic induction phase.
2. There will be fewer SCRs at the end of the induction compared to the beginning of the induction.
3. The above differences will be more prominent in those who are more susceptible.
4. There will be lateral differences in EDA during the hypnotic induction and during test suggestions, modulated by hypnotizability.

We performed a follow-up study to demonstrate that the most prominent effects found in Study 1 are reproducible.

2. Methods

2.1 Study 1

We recruited 38 university students as our subjects (N = 38, Mean age = 21.11, SD = 1.75), who were right-handed and had no prior experience in hypnosis. Exclusion criteria included the

presence of mental illness and the use of drugs and alcohol, based on self-reporting. All participants were Hungarians (Caucasian).

Procedure: Participants were invited to take part in a group hypnosis session, where their hypnotizability was measured with the HGSHS: A (Költő, 2015). On arrival, the participants were asked to fill out an informed consent form and briefed about the experiment. We attached the electrodermal sensors to their left and right wrists. The wrists were chosen as an alternative to the traditional palmar locations because certain test suggestions required both to be close together (finger lock and hands moving together), which could cause unwanted artifacts. Participants were asked to sit comfortably but as still as possible, to avoid movement throughout the EDA measurement. A certified hypnotist read the hypnosis script, in the presence of a co-hypnotist. After the hypnosis session, EDA sensors were removed, and the participants were asked to fill out our questionnaires. At the end, the participants were debriefed.

2.2 Study 2

We recruited 19 Hungarian university students as subjects (N = 19, Mean age = 21.58, SD = 4.07), who received course credit for their participation. This optional course was about test-anxiety reduction techniques, and one of the techniques, they could experience was hypnosis. Exclusion criteria included the presence of mental illness and the use of drugs and alcohol, based on self-reporting.

Procedure: participants filled out an informed consent form, in the beginning of the semester. Their hypnotizability was measured with the HGSHS:A on the same day. On the following five occasions, each two-weeks apart, electrodermal sensors were attached to the proximal phalanges of the middle and index fingers of their non-dominant hand. They were asked to sit as still as possible to avoid movement during the measurements. An audio-recorded hypnosis script was played for the participants. In all five sessions, hypnosis was induced according to the Hungarian version of the Stanford Clinical Scale (SCS) (Morgan and Hilgard, 1978–1979), followed by suggestions with the purpose of reducing test-anxiety. The SCS induction was chosen because it is shorter than the HGSHS used in the first experiment. It was an important criterion in keeping the interventions short. The hypnosis sessions lasted between 17 and 20 min. Once the recording was over, electrodermal sensors were removed.

2.3 Data Collection and Processing

Hypnotizability scores were based on participants' reactions to the suggestions in the hypnosis session. Based on the scores, they were divided into three hypnotizability groups—i) low hypnotizables with scores 4 or below, ii) medium hypnotizables with scores between 5 and 8, and iii) high hypnotizables with scores of 9 and above.

First, we measured raw skin conductivity every 125 ms for the first 10 min of the hypnosis session (induction phase) and during suggestions (hypnosis phase). EDA was analyzed in Ledalab 3.4.8 [18]. For smoothing, a Gaussian window was applied. SCL was extracted by optimized continuous decomposition analysis.

Next, we calculated subject-independent EDA measures for the detailed analyses of the induction phase of study 1. We aimed to reduce individual variability in electrodermal levels to detect lateral changes with time, a characteristic of the three hypnotizability groups. Thus, data

were standardized within individuals, using the average SCL values and the standard deviations (SD) of the 2 × 480 data points of induction phase from both wrists, to calculate the Z-scored EDA for every raw data point. Similarly, the number of SCRs was also standardized (Z-scored SCR) within individuals, using the number of SCRs in every two minutes of the induction phase measured from both wrists. The average number and SDs of SCR counts within the 2-minute intervals were used for calculating Z-scores.

Then, we calculated the laterality coefficient. This procedure standardized the values between −1 and +1. Negative numbers represent right side dominance, and positive numbers represent left side dominance [4].

Finally, we applied the analysis of variance (ANOVA) to test the effects of time, suggestions, hypnotizability, and laterality on psychophysiological responses during the induction/suggestion phase. The following EDA measures were dependent variables—Z-scored SCL, laterality coefficient values based on average SCL in every 2 minutes, and z-scored number of SCRs for each 2 minutes. We tested the within subject factors, time and side (left and right), as well as the between subject factor, hypnotizability (low, medium, and high).

3. Result

3.1 Study 1

3.1.1 Detailed Analyses of the Skin Conductance Level of the Hypnosis Induction

In the hypnosis induction phase, a standard set of preliminary instructions and suggestions are communicated to the individuals being hypnotized. The way people reach or fail to reach the hypnotic state is of vital importance; thus, we decided to analyze EDA responses to the first 10 min of the induction phase in a detailed fashion.

Based on the literature, we hypothesized a reduction in SCL during the hypnotic induction, especially in those who score high on the hypnotizability scale. The three-way mixed ANOVA on SCL during the 10-minute induction phase using side (left/right) and time as within-subject factors and hypnotizability (low/medium/high) as a between-subject factor, resulted in a prominent effect of time with $F(4,140) = 2.65$, $p = 0.036$, $\eta p^2 = 0.07$. The level of skin conductance decreased on both sides during the induction process in all three groups. Figure 1 depicts changes in Z-scored SCL during induction, averaged for the left and right hands of the three hypnotizability groups. There were no other main effects.

There were no significant two-way interactions. The analysis resulted in a significant three-way interaction of side, time, and hypnotizability with $F(8,140) = 2.49$, $p = 0.015$, $\eta p^2 = 0.13$. Low, medium, and high hypnotizables showed characteristically different EDA patterns on their left and right sides (Figure 1). The low hypnotizable individuals displayed right-side dominance, while high hypnotizable individuals displayed left-side dominance throughout the induction phase. On the contrary, the left- and right-side SCLs were similar in medium hypnotizables. High and medium hypnotizables showed lower EDA variability compared to that in the low hypnotizables. For the medium hypnotizables, SCL gradually decreased throughout the 10 minutes of induction phase. On the other hand, both low and high hypnotizable individuals showed variable EDA patterns within this timeframe.

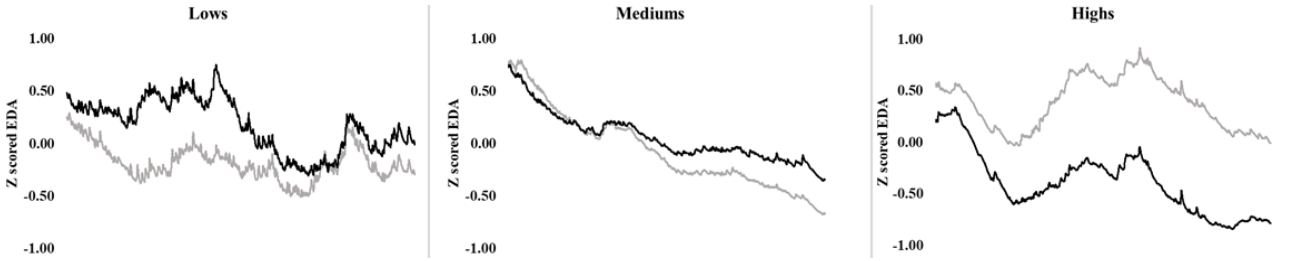

Figure 1 EDA during the induction (10 minutes). Black lines represent EDA measured from the right wrist. Grey lines represent EDA measured from the left wrist.

3.1.2 NonSpecific Responses

We predicted that fewer SCRs would characterize the end of the induction phase compared to the beginning of the induction. Findings from the literature also suggest less nonspecific SCRs in EDA patterns of high hypnotizables as compared to the low hypnotizables. Three-way mixed ANOVA analysis was performed on the number of Z-scored SCRs for every two minutes of the induction phase. We used time and side as within-subject factors, and hypnotizability (low/medium/high) as a between-subject factor. The results showed the main effect of time with $F(4,116) = 2.839$, $p = 0.027$, $\eta p^2 = 0.09$. There were no other significant main or interaction effects. The number of SCRs was reduced significantly during the induction, regardless of side or hypnotizability (Figure 2).

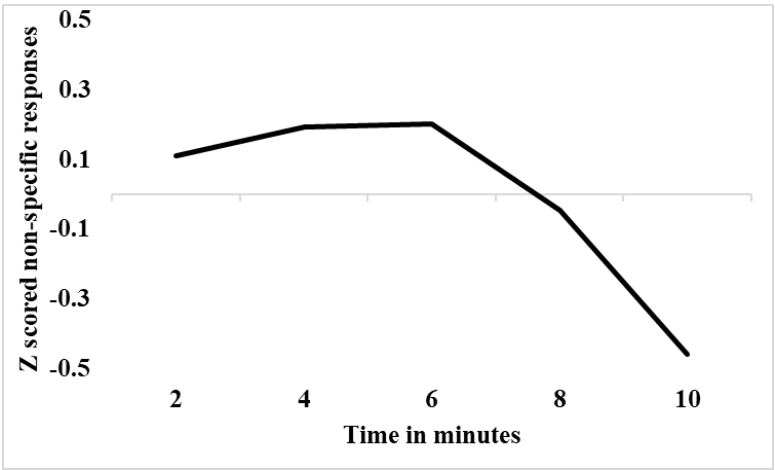

Figure 2 Z-scored nonspecific responses during every two minutes of the induction phase averaged for the two sides of EDA measurement (on the left side) and the three hypnotizability groups (on the right side).

3.1.3 Electrodermal Activity (EDA) Patterns during Test Suggestions

We hypothesized differences in EDA patterns of the three hypnotizability groups during hypnotic suggestions. First, we used a two-way mixed ANOVA to test raw SCL measured from the right-side. The nine suggestions were used as the within-subject factor, and hypnotizability was

used as the between-subject factor. The results displayed a significant main effect of suggestions with F (8,272) = 6.00, $p < 0.001$, $\eta p^2 = 0.15$. The level of arousal changed significantly from one test suggestion to the other. A suggestion hypnotizability interaction effect was also found, F (16,272) = 3.14, p = 0.001, $\eta p^2 = 0.16$ (Figure 3, left side).

We also analyzed differences in EDA patterns during hypnotic suggestions on the left side, using the three hypnotizability groups. Similar to the right-side results, the two-way mixed ANOVA, with the suggestions as the within-subject factor and hypnotizability as the between-subject factor, yielded a significant main effect of suggestions with F (8,256) = 4.53, $p < 0.001$, $\eta p^2 = 0.12$. A suggestion hypnotizability interaction effect was also detected, F (16,256) = 3.14, p = 0.001, $\eta p^2 = 0.14$ (Figure 3, right side).

These results demonstrated that EDA changes significantly during the different test suggestions and that this change is modulated by hypnotizability.

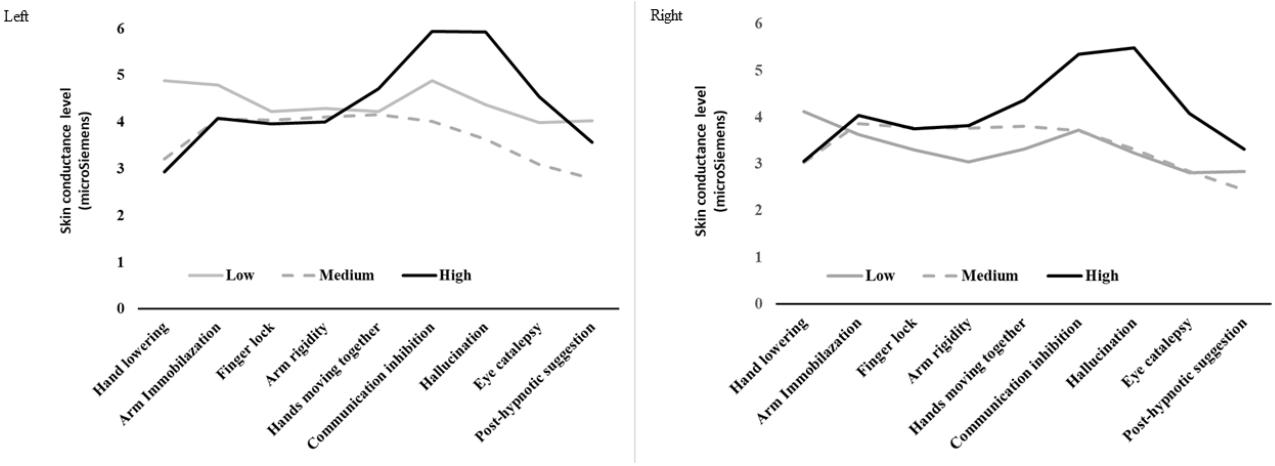

Figure 3 SCL during the test suggestion phase, measured from the left and right sides.

3.1.4 Laterality during Test Suggestions

We hypothesized lateral differences during the suggestion phase of hypnosis, modulated by hypnotizability. To test this hypothesis, we applied two-way mixed ANOVA. We used average laterality during the test suggestions as the within-subject factor and hypnotizability as the between-subject factor. They yielded no significant effects (Figure 4). Electrodermal laterality does not seem to change significantly from suggestion to suggestion. Also, there is no significant difference among the hypnotizability groups. Although, it is clear from Figure 4 that high hypnotizables remained left-dominant throughout the hypnosis, while medium and low hypnotizables were right-side dominant.

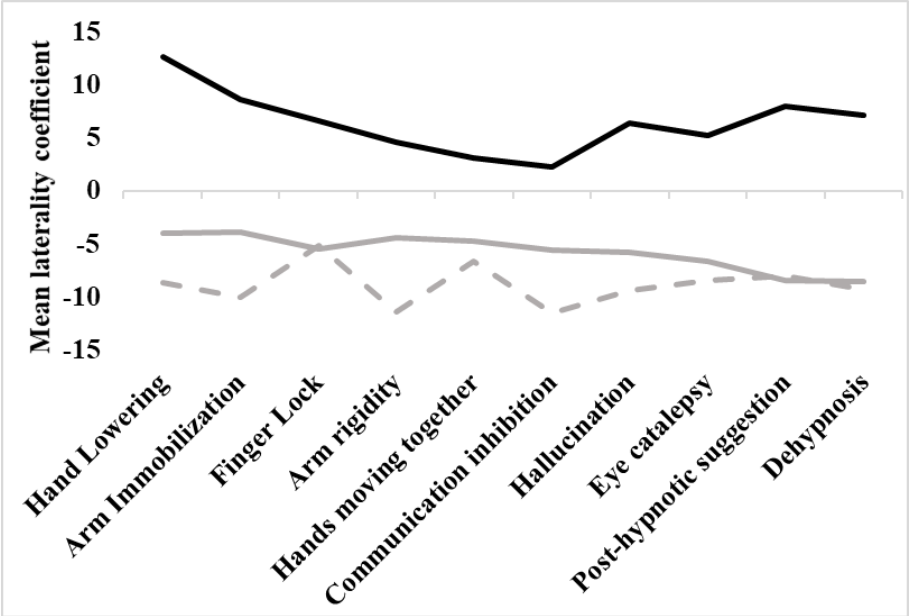

Figure 4 The laterality coefficient during the test suggestion phase. Positive numbers represent left side dominance, while negative numbers represent right side dominance.

3.2 Study 2

We performed a follow-up study to show the reproducibility of the most prominent effect found in study 1, namely, the gradual decrease in the level of skin conductance during hypnotic induction. We also examined the differences in this decrease in high, medium, and low hypnotizables. Two-way mixed ANOVA was calculated for each of the five sessions (Figure 5). We found no significant effects of hypnotizability in any of the sessions. The main effect of time was clear in the first session [$F(3,10) = 7.32$, $p = 0.006$, $\eta p^2 = 0.42$], the second session [$F(3,13) = 5.90$, $p = 0.026$, $\eta p^2 = 0.31$], the third session [$F(5,70) = 6.08$, $p = 0.012$, $\eta p^2 = 0.30$], and the fifth session [$F(6.72) = 5.48$, $p = 0.015$, $\eta p^2 = 0.31$]. The fourth session on the other hand yielded no significant effect of time; although, this result could probably be due to the high variability of SCL. As seen in Figure 5, there was a gradual decrease in the average SCL during the induction phase, characteristic for all the hypnotizability groups, except for the low hypnotizables in session 4.

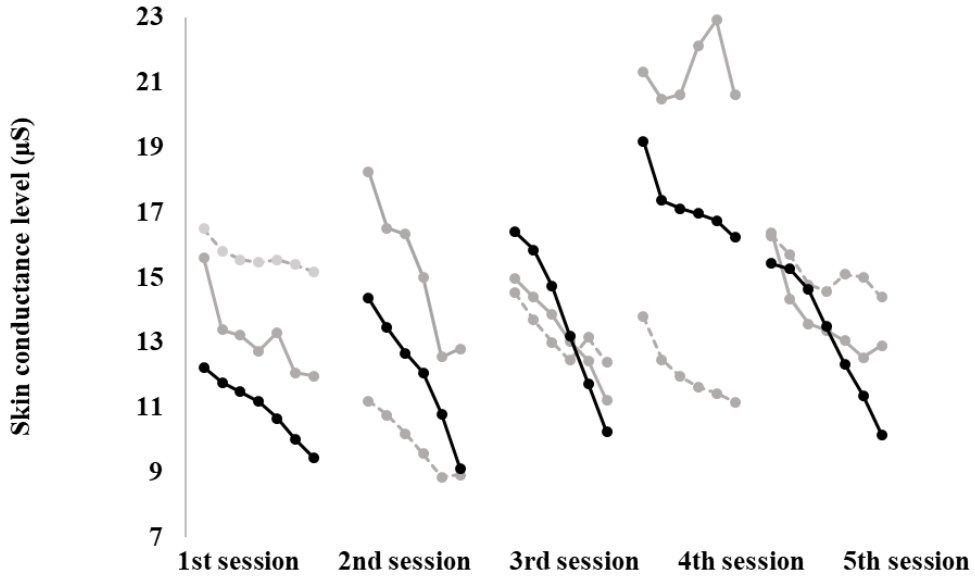

Figure 5 Skin conductance level during the induction period of the five hypnosis sessions of the experiment. Solid black lines represent high hypnotizables, dashed grey lines represent medium hypnotizables, and solid grey lines represent low hypnotizables.

4. Discussion

4.1 EDA Levels during the Induction Phase

By measuring electrodermal activity in the induction and/or test suggestion phases of hypnosis, we identified typical electrodermal attributes related to the hypnotic state. The most prominent of these characteristics is the reduction in skin conductance level (SCL). Several studies have reported similar conclusions (Table 1).

During hypnosis induction, we observed a consistent decrease in skin conductance level across the 10-minute induction phase (Study 1). This effect was bilateral and characteristically different for the three hypnotizability groups. For the low and high hypnotizables, a variable electrodermal activity (EDA) pattern was detected; whereas, in medium hypnotizables, EDA gradually decreased throughout the induction phase. Reduction of arousal in hypnosis may be one of the important factors leading to therapeutic success in treating disorders associated with higher sympathetic arousal [7].

In our follow-up study (Study 2), we intended to reproduce the above findings. Five consecutive measurements from the same subjects demonstrated that the EDA reduction effect of the hypnotic induction remained pronounced for all hypnotizability groups (Figure 5).

4.2 EDA Laterality during Hypnotic Induction

Our results show evident bilateral differences during the hypnotic induction phase. High hypnotizables display left-side dominance, while low hypnotizables display right-side dominance. A number of previous studies had also highlighted these bilateral differences [19, 20]. Our previous study also reported lateral differences during active-alert induction [4].

The medium hypnotizables showed a synchronous EDA activity of the two sides (Figure 1). Picard and colleagues (2015) [21] suggested a high correlation between the left and right sides with respect to EDA [21]. This high correlation has been confirmed in a number of studies (Kasos et al., under review) [13].

However, in high and low hypnotizables, EDA diverged on the two sides and stayed separated for the whole duration of the induction phase (Figure 1). The divergence of the two sides could be an indication of psychological distress. Picard observed right-side dominance in situations when the self was threatened [21]. Translating this to a hypnosis situation for low hypnotizables, they could be experiencing induction as a threatening situation, having to give up control to the hypnotist. This may be causing them to be distressed.

In contrast, high hypnotizables showed a strong left dominance (Figure 1). This may be explained by the multiple arousal theory [21]. According to this, positive emotions would cause EDA to be either close to synchronous or left-side dominant. For high hypnotizables, the induction process could be a positive experience. In addition, Gruzelier's induction theory hypothesizes left-side hemispheric dominance at the beginning of induction [22]. Another study focuses on the verbal processing of induction, which in right-handed subjects would lead to left hemispheric dominance [23]. The amygdala is the foremost contributor to EDA and is mostly concerned with processing emotional information [24]. Hence, we hypothesize a strong emotional component behind the observed lateral differences during the induction process.

4.3 EDA Levels and Laterality during Test Suggestions

During test suggestions in Study 1, we observed that arousal levels fluctuated from one suggestion to the other, as reported previously [25]. The arousal level of high hypnotizables was higher during the hallucination suggestion and communication inhibition suggestion, confirming the findings from prior research [26]. Elevated levels of arousal may be explained by the pronounced cognitive effort required in responding to these suggestions. This implies that responding to suggestions requires considerable effort, as suggested by proponents of the dissociative experience theory and the social cognitive theory [27, 28].

Contrary to the induction phase, lateral disposition during test suggestion was not significantly different among the three hypnotizability groups. Figure 3 shows that high hypnotizables remain left-side dominant, while medium and low hypnotizables remain right-side dominant for the whole duration of the suggestion phase. The suggestions, which are harder to respond to, such as hallucination, cause a more prominent left dominance in high hypnotizables.

The above results imply that responding to more difficult suggestions, such as hallucinations and communication inhibition, comes with a price that high hypnotizables showing higher arousal and a more left-sided electrodermal activation.

4.4 Non Specific SCRs

We hypothesized that a lower number of nonspecific skin conductance responses (SCRs) would be present at the end of the induction phase compared to the beginning. We also predicted that this effect would be modulated by hypnotizability. Our study confirmed that SCRs are fewer at the end of the induction. However, we found no evidence for differences based on hypnotizability. A reduced number of nonspecific responses could be explained by the nature of the hypnotic

induction. During the induction, attention is mainly focused on the hypnotist and the inner experiences, with reduced peripheral awareness, resulting in fewer non-intended responses.

5. Limitations

The limitations of the present paper include the homogeneity of subjects in terms of their gender, age, and race. Our research could have benefitted from a higher number of participants.

6. Conclusion

In this article, we review the correlation between hypnosis and electrodermal activity (EDA) from the past 90 years of studies. We report the laterality and hypnotizability effects of electrodermal activity, during hypnotic induction and suggestion phases.

Most studies have highlighted lowered skin conductance level (SCL) during hypnosis, than pre- or post-hypnosis or in control conditions; however, contradictory findings have also been reported. In our study, we observed a prominent, bilateral reduction of SCL throughout the hypnotic induction phase, regardless of the level of hypnotizability. We also replicated this effect consistently in five independent hypnosis sessions.

Only a couple of studies have previously investigated bilateral EDA during hypnosis, with contradictory results. Our results highlight substantial differences in laterality during the hypnotic induction phase, with patterns characteristically differing depending on hypnotizability. Laterality differs throughout the hypnosis phase—high hypnotizables remained left-side dominant, whereas, medium and low hypnotizables were right-side dominant.

Nonspecific skin conductance responses (NS-SCRs) appear spontaneously, not related to any specific event. According to literature, the number of theseNS-SCRs is fewer during hypnosis than in control conditions. We, too, observe a decreasing number of SCRs in the induction phase. NS-SCR frequency typically shows great individual variety, with high levels of arousal, resulting in a higher frequency of NS-SCRs. Also, some findings indicate that high hypnotizables have less NS-SCRs than low hypnotizables. In contrast, we found no evidence for differences in the rate of NS-SCRs in relation to hypnotizability.

We conclude that arousal is reduced bilaterally during hypnotic induction and is persistent across different levels of hypnotizability. At the same time, lateral differences produce unique EDA patterns in the induction phase, defining high, medium, and low hypnotizables. The post-induction phase produces EDA that varies with suggestions. Typically, difficult suggestions produce higher arousal. Thus, our findings are novel, in terms of lateral differences of EDA in high versus low hypnotizables in the hypnotic induction phase. These results provide an objective, psychophysiological evidence for both, the multiple arousal theory and the left-side hemispheric dominance suggested by the induction theory of hypnosis.

On the basis of our findings, we strongly support that bilateral measurements should be used in hypnosis research. The ability to analyze laterality differences adds valuable information regarding the experiences of hypnosis participants. The changes that take place in a matter of a few minutes, altering one’s state of consciousness, make hypnosis induction a magnificent model situation to study electrodermal laterality.

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Author Contributions

Krisztian Kasos: data collection, data analysis, statistical analysis, prepearing and writing manuscript. Luca Csirmaz: data collection, data analysis, writing and contributing to manuscript, Fanni Vikor: data collection, data analysis, contributing to manuscript, Szabolcs Zimonyi: data collection, Katalin Varga: providing essential theoretical knowledge regarding hypnosis, organizing and supervising hypnosis sessions, Anna Szekely: statistical analysis, writing and prepearing manuscript.

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Competing Interests

The authors have declared that no competing interests exist.

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Original Research

States of Consciousness, the qEEG, and Noetic Snapshots of the Brain/Mind Interface: A Case Study of Hypnosis and Sidhi Meditation

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Abstract

Noetic analysis is a methodology to quantify the mind during hypnosis, meditation, or other stimulus conditions/states of consciousness in a reliable and valid manner. The methodology uses retrospective phenomenological assessment (RPA) to comprehensively assess subjective experience. By having the participant complete a first person, self-report questionnaire, the Phenomenology of Consciousness Inventory (PCI), in reference to a short stimulus condition, the researcher can generate a "snapshot" of the mind, and its qualia, in reference to that condition. Using such an approach with the qEEG may be able to better decipher the mystery of the brain/mind interface during states of consciousness associated with hypnosis and meditation by giving quantifiable subjective referents to the neurophysiology of such stimulus conditions. QEEGs were obtained during a standardized hypnotic assessment, the PCI – Hypnotic Assessment Procedure (PCI-HAP), and also during sidhi meditation of a long-term TM meditator. The PCI was completed in reference to a sitting quietly period during the PCI-HAP and also in reference to sidhi meditation. On the PCI-HAP, the participant obtained a hypnotic responsivity index (HRI) percentile score

suggesting moderate hypnotic responsivity. Concerning noetic differences between hypnosis and sidhi meditation, meditation was associated with higher scores on self-awareness, altered awareness, and altered experience (altered body image and meaning), in addition to greater feelings of love. Sidhi meditation was also associated with more alpha and higher beta activity than hypnosis, with greater high beta in the left pre-frontal cortex. How such qEEG differences may relate to differences in noetic experience was explored. This case study suggests that, when quantifying the brain with the qEEG, and the mind with the PCI, a "noetic snapshot" of the mind can be obtained that may be used to better quantify the brain/mind interface, and augment the ability of neurophenomenology to unravel the mystery of hypnosis, meditation, and possibly other (altered) states of consciousness.

Keywords
qEEG; noetics; phenomenological experience; altered states of consciousness; hypnosis; sidhi meditation; brain/mind interface; mind

1. Introduction

1.1 Hypnosis and Meditation

The clinical usefulness of hypnosis [1] and meditation [2] are undeniable, and their similarity [3, 4], intriguing. Yet comparisons and contrasts between the two techniques remain daunting: "The terms 'hypnosis' and 'meditation' are used to refer to a bewildering array of practices across different cultural settings and in different historical epochs." ([5], p. 313). So writes Jamieson in the introduction to his chapter: "A unified theory of hypnosis and meditation states" in the edited tome by Raz and Lipshitz [6], *Hypnosis and Meditation*. As the book illustrates, a fuller understanding of the dynamics of hypnosis and meditation, and their similarities and differences, must comprehensively investigate hypnosis and meditation across various different levels of analysis.

In support of such cross-level analysis, Jensen, Adachi, Tome-Pires, Lee, Osman, and Miro's [7] "scoping review" of hypnosis, suggests that *"hypnosis and hypnotic responding are probably best explained by more comprehensive models that take into account factors from biological, psychological and social domains"* (p. 63). Hence, differences and similarities between hypnosis and meditation are probably best assessed across multiple levels of analyses, and then scrutinized as to how these levels compare and contrast with one another. Is it hence no wonder that research on meditation and hypnosis has *"been fraught with oversimplification that have hidden differences across procedures and goals, changes in state, and individual differences"* ([8], p. 281)?

1.2 Noetic Analysis

1.2.1 Epistemological Underpinnings

Part of that oversimplification concerns researchers in hypnosis, meditation, and even psychology in general, having failed to take a more sophisticated, comprehensive, and articulated

examination of the nature of subjective experience [9-12]. William James [13] over a century ago in his *Principles of Psychology* defined psychology as the study of consciousness: "*Psychology is the science of mental life, both of its phenomena and their connections. The phenomena are such things as we call feelings, desires, cognitions, reasonings, decisions, and the like*" (p. 1).

In contrast, the many decades of behaviorism during the last century erroneously suggested that a sophisticated and articulate analysis of the mind was unreliable, invalid, and impossible to quantify [14]. It was "physicalism" at its worst [15]. We disagree:

> *The mind can be quantified, as can quarks, the economy, or a neutron star: 'precise descriptive first-person reports about subjective experience' can be obtained in a reliable and valid manner. Physics became queen of the natural sciences because it wedded mathematics to the description of natural phenomena... By quantifying a phenomenon of interest, we then use mathematical tools and models to better predict and control our universe* ([16], p. 405).

This same model can be, and has been, applied to the mind [16-21]. There is a famous dictum in philosophy which states: "*Epistemology precedes metaphysics*." Epistemology is "*the study or a theory of the nature and grounds of knowledge especially with reference to its limits and validity*" ([22], p. 280). Since what we know is a function of how we know what we know, epistemology must necessarily precede metaphysics/ontology, which concerns itself with the essence and nature of being, Hence, the level of epistemological analysis determines what will be assessed and analyzed.

The present paper reviews a methodology to quantify the *"noetic"* (the Greek word for *'mind'* is *'nous'*), or the mental/subjective, level of inquiry via reliable and first person self-reports in reference to hypnosis and also meditation. This is a level of analysis that has not been developed very well in hypnosis, meditation, nor in psychology at large. (Notice that the noetic, or subjective/mental, level was omitted from Jensen et al.'s, 2015 "scoping" review of hypnosis.).

We need to comprehensively quantify the qualia [23] of human subjective experience, i.e. the "*properties of sensations and perceptual states, namely the properties that give them their qualitative or phenomenal [our italics] character – those that determine 'what it is like' to have them*" (p. 507).

Why are such *qualia* important? We have a level of analysis to study the neurophysiology of the brain, and we have a cognitive-behavioral level of analysis to study human cognition/behavior. A *noetic level of analysis* is needed to study those subjective aspects of the brain typically called the *mind*. In addition, we need to comprehensively quantify the mind just as physics comprehensively quantifies physical reality. Furthermore, it is not going to be possible to find the mind (the qualia of human consciousness) underneath the knife of the neuroscientist or pulled from an fMRI (functional magnetic resonance imaging).

> This is the "hard problem" of human consciousness, as defined by Chalmers [24]: *The hard problem of consciousness is the problem of experience. When we think and perceive, there is a whirl of information-processing, but there is also a subjective aspect... Then there are bodily sensations, from pains to orgasms; mental images that are conjured up internally; the felt quality of emotion, and the experience of a stream of conscious thought* (p. 226).

To make any significant headway in better understanding hypnosis, meditation, other states of

consciousness, and their relationship to awareness, attention, and the brain; we need a comprehensive *quantitative phenomenology* to scientifically investigate the mind. The need for such a perspective was lamented several years ago by Lifshitz [25] "*whereas scientists have access to a plethora of advanced methods for investigating brain and behavior, they face a dearth of techniques for the empirical analysis of phenomenology* [26]" ([25], p. 9).

The same complaint has been echoed more than a decade ago: "*A growing number of cognitive scientists now recognize the need to make systematic use of introspective phenomenological reports in studying the brain basis of consciousness*" ([27], p. 31); "*there is also the growing realization, however, that it will not be possible to make serious headway in understanding consciousness without confronting the issue of how to acquire more precise, descriptive first-person reports about subjective experience*" ([28], p. 2).

1.2.2 Noetic Analysis: Rationale

Noetic analysis [16, 21], built upon almost four decades of research, is a reliable and valid introspective methodology designed to quantify subjective experience from a first person perspective. The methodology uses first person self-reports, as assessed by well-validated inventories, such as the Phenomenology of Consciousness Inventory (PCI: Pekala, [29]), to quantify various dimensions of subjective experience.

Such inventories are retrospectively completed in reference to a preceding stimulus condition/state of consciousness, and allow for the various structures, or dimensions of consciousness associated with that stimulus condition/state of consciousness, to be not only quantified, but visually diagramed, and statistically compared. This process of retrospective phenomenological assessment (RPA) yields quantitative reliable and valid phenomenological data associated with various stimulus conditions, and consequently, their associated (altered) states of consciousness.

The methodology assumes stimulus-state specificity. This principle posits a relationship, when assessed across groups of randomly selected individuals, that the same behaviors in the same stimulus settings will be associated with the same phenomenological state, i.e. the same intensities and/or patterns of subjective experience; while different stimulus environments will be associated with differing intensities/patterns of phenomenological experience. (For a critique of the statistical and methodological underpinnings behind this approach, including that of stimulus-state specificity, see Pekala, [18])

Stimulus-state specificity can be considered a phenomenological variant of *psychophysiological isomorphism* [30] i.e. "*a one-to-one correspondence between mind and brain states*" ([31], p. 222), comparing rather the mind/behavior interface, while taking into account variables related to the stimulus setting. Combining such noetic data with corresponding neurophysiological data, such as the qEEG (quantitative electroencephalogram), may give the researcher a better means to map the brain/mind interface during hypnosis, meditation, and related states of consciousness by more comprehensively quantifying the subjective referents associated with the neurophysiology of the qEEG.

Such neurophenomenological approaches, as exemplified in the current literature [32], typically employ less comprehensive approaches to quantify subjective experience than is available with RPA inventories like the PCI. Interestingly, the PCI has previously been used by researchers

investigating the neurophenomenology of hypnosis during an OBE (out-of-body) experience [33] and meditation-related kundalini [34]. Additionally, Markovic and Thompson [35] have theoretically addressed the neurophenomenological comparison of hypnosis and mediation via the *"phenomenological and neurocognitive matrix of mindfulness"* (p. 79) using a multidimensional model proposed by Lutz and colleagues. Markovic and Thompson cite the possible usefulness of the PCI and several of its dimensions (internal dialogue, imagery, rationality and volitional control) as *"additional relevant features that could be incorporated into future effects at mapping"* (p. 98) hypnosis and related states.

Noetic analysis is concerned with quantifying and analyzing the contents and processes of consciousness, i.e. the mind from a first person perspective (without necessarily referencing any neurophysiological processes associated therewith), and does so in a reliable and valid manner. Neurophenomenology, on the other hand, integrates descriptive phenomenology, its quantitative cousin, noetics, and the various self-report methodologies in between, with neurophysiology. Whereas neurophenomenology looks at the brain/mind interface; noetics is specifically concerned with empirically quantifying the mind/consciousness and its qualia. By defining and measuring the various structures and dimensions of consciousness, it includes the ability to quantify states, and altered states, of consciousness, visually illustrating both intensity (via radar graphs and pips: phenomenological intensity profiles) and pattern (via psygrams) parameters.

1.2.3 Questionnaires

The two main questionnaires that the author and colleagues have used with RPA for noetic analyses are the Phenomenology of Consciousness Inventory (PCI: Pekala, [29]), and the Dimensions of Attention Questionnaire (DAQ: Pekala, [36]). These instruments, respectively, quantify consciousness in general, and attention, in particular. The PCI has been especially useful in mapping the subjective experience of hypnosis and has been shown to have adequate construct and discriminant validity [37-48]. Predictive validity has also been assessed [49-55].

In addition, the PCI has been used to map and quantify such stimulus conditions (besides hypnosis) as: epilepsy [56] and schizophrenia [57], psi phenomena [58], mediumship [59], meditation [60], fire-walking [61, 62], charismatic leadership [63], music perception [64], shamanistic trances [65], holotropic breathing [66], an OBE within an NDE [67] and OBEs associated with hypnosis [33], drumming [68], a virtual reality environment [69], and religious/spiritual narratives [70]. The PCI has been translated into 14 languages; the DAQ has been translated into 4 (see www.quantifyingconsciousness.com for additional information).

1.3 The Present Investigation

This case study involves investigating the mind/brain of a long-term TM meditator while he is doing sidhi meditation, and also during hypnosis (when assessed with the Phenomenology of Consciousness Inventory – Hypnotic Assessment Procedure: PCI-HAP: Pekala [71, 72]). As Woody and Sadler [73] have observed, most "*hypnotic scales in widespread use... do not provide important information about the client's subjective experience*s" (p.40). The PCI-HAP protocol remedies that deficit.

During both hypnosis and meditation, a qEEG was obtained, while subjective experience was quantified with the PCI. The model, we believe, will illustrate the potential for combining noetics

with neurophysiology, quantifying the subjective referents associated with differential qEEG activation during hypnosis and meditation.

1.3.1 A Brief Review of the Neurophysiology of Hypnosis and Meditation and Their Interface

There are numerous studies on the neurophysiology of hypnosis and meditation. The following several paragraphs will give a selected summary of a few of such studies relevant to the case study reported below, focusing on the overall EEG frequency band differences between hypnosis and meditation, but also including an fMRI study or two of relevance.

Hypnosis. Rainville and Price [74] almost two decades ago suggested that hypnotic protocols lead to changes in body relaxation and mental absorption, resulting in changes in brain activity, which, in turn, lead to alterations in body image and alterations in states of consciousness.

Jensen et al. [7] suggest that EEG-assessed measures of brain states during hypnosis show *"(1) a fairly consistent pattern of more theta activity among highs, relative to lows; (2) both increases and decreases in most bandwidths with hypnosis except for theta, which tends to show increases with hypnosis in both highs and lows,…"* (p. 42). Somewhat similarly in reference to theta activity, De Benedittis [75] wrote that the subjective experience of hypnosis, including hypnotic responses, tend to be associated with increases in both theta and gamma activity. Additionally, increased theta is associated with not only higher hypnotic responsivity, but an increased level of hypnotic responding, citing Ray [76], Williams and Gruzelier [77], and Jensen et al., [7]. However, as De Benedittis reported, these findings are not without controversy [78].

Jamieson and Burgess [79] found that a hypnotic induction was followed by state-like alterations in the organization of EEG functional connectivity in the theta and beta frequency bands in high-hypnotically suggestible participants. Terhune, Cardeña and Lindgren [80] investigated frontal-parietal phase synchrony during hypnosis as a function of hypnotic suggestibility. They found that *"highly suggestible participants reliably experienced greater state dissociation and exhibited lower frontal-parietal phase synchrony in the alpha2 frequency band during hypnosis than low suggestible participants"* (p. 1444). Cardeña, Jonsson, Terhune, and Marcusson-Clavertz [81] investigated neutral hypnosis across 37 low, medium, and high hypnotizables looking at baseline, a hypnotic induction, and multiple rest periods. They reported that hypnotic "*depth correlated moderately to strongly with power and/or power heterogeneity for the fast EEG frequencies of beta2, beta3, and gamma, but independently only among highs*." (p. 375); in other words, with high hypnotically susceptible individuals, their hypnotic depth was found to be significantly correlated with increased beta and gamma activity.

Landry, Lifshitz and Raz [82] completed a comprehensive and sophisticated "systematic and meta-analytic" review of neuroimaging studies of hypnosis. They concluded that in probing hypnosis, *"there remains little consensus concerning the neural mechanisms and a great deal of inconsistency among findings [83, 84]"* ([82], p. 92). Landry et al. suggested that the inconsistencies appear related to the multifactorial nature of hypnosis, combined with differences in the methodologies enacted across the various hypnosis studies. Although their initial review highlighted higher-order networks as implicated in not only hypnotic susceptibility, but also the experience of being hypnotized, and response to hypnotic suggestions; their results did not confirm the role of higher order networks. Rather, their results "*revealed that hypnotic responses correlate most robustly with activation of the lingual gyrus, likely indexing mental imagery*" (p. 92).

Landry et al.'s comprehensive review suggests the tremendous challenge that awaits a comprehensive understanding of the basic neural mechanism of hypnosis, let alone, the interface among brain, mind, and behavior; in addition to hypnosis's relationship to the many varieties of meditation.

Meditation. A well-designed study out of Australia [85] suggested that alpha and theta rhythms are enhanced in meditators with an average of 4 years of daily meditation experience; in addition to which beta (12 to 24 Hertz) and gamma (25 to 42 Hertz) activity is significantly enhanced in advanced meditators. De Benedittis [75] found that when reviewing EEG studies there was a significant increase in both alpha and theta activity during meditation [86], that was associated with an overall slowing of the processes of consciousness [87]. Such increases in alpha and theta wave activity tends to be correlated with states of inner calm and stability [88].

Citing Ott [89], Jamieson [5] suggests that increased gamma activity may play a crucial role in the euphoric meditational "samadhi" experience, "described in both the Yoga and Buddhist traditions, and perhaps the 'enlightenment' experience found in other contemplative traditions, as well as spontaneously occurring mystical experiences" (p. 333). Fell et al. [31] suggests that meditation results in a slowing of the 8 to 12 Hertz alpha rhythm to theta. With continued and diligent practice, beta and gamma are significantly increased.

Using the fMRI, Modestino [34] reported on an investigation of an individual with spontaneous Kundalini awakening. Kundalini awakening is associated with the subjective perception of psychospiritual energy flowing up the spine with concomitant feelings of euphoria and ecstasy [90]. Although usually the result of intensive meditation practices [91], the participant investigated by Modestino reported spontaneous awakening of the syndrome.

An fMRI was completed while the participant was experiencing kundalini. The PCI was retrospectively completed in reference to his kundalini experience. The kundalini experience was associated with activation of the left prefrontal cortex, i.e. primarily Brodmann's areas 46 and 10. The results suggested an ecstatic experience, with very high levels of joy (99^{th} percentile) and sexual excitement (93^{rd} percentile) as measured by the PCI, along with percentile scores above 90 percent for altered perception, altered meaning, absorption (99^{th} percentile), altered experience (92^{nd} percentile), and an alteration in state of consciousness (100^{th} percentile).

Modestino summarizes by saying that the left prefrontal areas have been shown to be activated during meditation using various modalities, in addition to the fMRI. Goleman [92] wrote that when people are feeling good and in a positive mood – "upbeat, enthusiastic and energized;" there is heightened activity in the left prefrontal cortex. Modestino reports that other studies have confirmed that such activation is associated with happiness and joy: "the feelings of joy, happiness and the left prefrontal brain region found in this study are consistent with many published neuroimaging and electrophysiological studies of meditation" ([34], p. 128).

1.3.2 The Present Case Study

Given the aforementioned, the present study sought to examine the neurophysiology (as assessed by the qEEG) and noetic experience (as assessed by the PCI) of a long-term TM meditator during both hypnosis (using the hypnotic assessment procedure of the PCI-HAP) and sidhi meditation. Specific questions were proffered: a) how does the qEEG during a sitting quietly period during hypnosis compare to sitting quietly during sidhi meditation of an advanced TM

(Transcendental Meditation) meditator; b) is the use of the PCI helpful in differentiating the noetic experience of hypnosis from that of meditation in this particular participant; and c) might combining the PCI with the qEEG provide useful information in further elucidating the subjective referents associated with neurophysiology?

2. Method

This single participant case study is based on research done through the first author's private practice in West Chester, PA. Informed consent was procured. This research is in compliance with The Belmont Report and the declaration of Helsinki.

2.1 Participant

The participant for this case study is a 67-year-old white male with a 46-year history of TM meditation. The participant was also a participant/observer; he is the second author on this paper. KC was aware of the literature on hypnosis and meditation, being a clinical psychologist.

2.2 Measurement

2.2.1 Phenomenology of Consciousness Inventory-Hypnotic Assessment Procedure [1] (PCI-HAP)

The Phenomenology of Consciousness Inventory-Hypnotic Assessment Procedure [1] (PCI-HAP) [71, 72] is a state instrument used to assess hypnotic responsivity. The protocol consists of a pre- and post-assessment and a hypnotic induction protocol. For the pre-assessment, the participant reported if he experienced hypnosis before, and if so, how hypnotizable he felt he was at that time. He was also asked to estimate his subsequent level of hypnotic depth on a "1" to "10" scale (estimated hypnotic depth). Additionally, the participant was told to visualize himself in a hot tub and estimate the vividness of his visual and kinesthetic imagery. Finally, he was told to estimate how helpful the hypnotic session was going to be to help him with his issues and concerns.

The hypnotic protocol consists of a progressive relaxation protocol, but without the tensing ("a body scan"); followed by a "10" to "1" count while "you let your mind become more and more calm, more and more empty" ("a mind calm"). The participant is then asked to "have a wonderful and relaxing time" [93] while experiencing a mental vacation in his mind at his favorite place (the hypnotic dream or imagoic suggestibility item).

Next, the participant is asked to raise his left index finger (the finger response item - to assess as to whether the participant was alert during this time period or may have drifted off towards sleep). He is also instructed that his eyes are "heavy like lead" and asked to try to open his eyes (the eye catalepsy item). This is followed by a five-minute sitting quietly period wherein the participant is told to "just continue to experience the state you are in right now." The participant then has a 15 second pause to mentally review what he experienced. This is followed by the de-induction using a "1" to "5" scale.

2.2.2 The Phenomenology of Consciousness Inventory (PCI)

The Phenomenology of Consciousness Inventory. The participant subsequently completed the 53-item PCI in reference to the 5-minute sitting quietly period during the hypnotic induction. The

PCI assesses subjective experiences across 12 major and 14 minor dimensions (in parentheses) of consciousness in a reliable and valid manner: arousal, memory, attention (direction and absorption), imagery (vividness and amount), positive affect (joy, love, sexual excitement), negative affect (sadness, anger, fear), internal dialogue, rationality, volitional control, self-awareness, altered state of awareness, and altered experience (unusual meaning, body image, perception, time sense). (The PCI[1], complete with manual and EXCEL scoring program, is available at www.quantifyingconsciousness.com.)

2.2.3 Debriefing form

After completing the PCI, the participant completes a post-assessment debriefing form rating the vividness of his imagery in reference to going "on a vacation somewhere to a beautiful place and have a very relaxing and very wonderful time;" whether the participant opened his eyes during the eye catalepsy item; if he raised his finger when asked to do so (the *finger response* item); and whether he had fallen asleep on a 4-point scale (the *sleep state* item). These last two items were included in the PCI-HAP to determine if participants, especially when tested in groups, may have drifted off towards sleep. The participant is also asked to evaluate his depth of hypnosis (to measure the participant's self-reported hypnotic depth, srHD), and how helpful hypnosis was going to be to help with his problems or concerns (post-hypnotic therapeutic efficacy).

2.3 Procedure

Before the PCI-HAP began, an electrode cap (Electro-Cap, Inc., Easton, OH) was fitted to obtain a 19 channel qEEG for the subsequent hypnotic assessment, and also the sidhi meditation, conditions. The participant experienced the PCI-HAP, a 20-minute break, and then 20 minutes of sidhi meditation. The PCI-HAP induction was digitally recorded and event marked, so the qEEG administrator (the first author: RP) could differentiate the different sections of the PCI-HAP while the participant listened to the pre-recorded induction protocol. (A copy of the event marked protocol, digital/audio version of the protocol, and paper transcript of the protocol is available from the first author upon request.) The full PCI-HAP protocol was event marked into 11 sections, for a total time period of 28.04 minutes. This paper, for the PCI-HAP condition, reports on only the qEEG recordings obtained during a 5-minute sitting quietly period during the PCI-HAP (which was near the end of the protocol: after the eye catalepsy suggestion, but before the "1 to 5" de-induction).

After the PCI-HAP protocol (including completion of the PCI and debriefing form in reference to that protocol) and a ten-minute break, the participant then completed 20 minutes of meditation. The meditation protocol consisted of 10 minutes of Transcendental Meditation (TM) practice followed by 10 minutes practicing the TM-Sidhi (TMS) program [94]. The TMS practice is based on a meditation procedure called *Samyama*. Samyama [95] involves the combined simultaneous practice of *dhāraṇā* (concentration), *dhyāna* (meditation) and *samādhi* (union). It is used to obtain a deeper knowledge of the object of the practice, e.g. in the present study, compassion, and requires the participant to concentrate completely on an object until that object occupies all of his field of consciousness.

This practice is described in the Yoga Sutras of Patanjali [96]. Specifically for the present investigation, it involved: 1) practicing transcendental meditation for a period of time with the

objective of establishing, as much as possible, 2) a state of pure awareness/inner silence; then 3) mentally introducing a "sutra", i.e. a word or short phrase, e.g. "compassion," and allowing the effect of the sutra to emerge into the participant's awareness. Step number 3 is then repeated every 15-20 seconds. The PCI was retrospectively completed in reference to the 10-minute sidhi meditation period.

2.3.1 EEG Data Collection

QEEGs were obtained during the standardized hypnotic assessment, the PCI – Hypnotic Assessment Procedure (PCI-HAP; Pekala, [71, 72]) as delineated above, and also during sidhi meditation. The amplifier used for the EEG acquisition was the Brainmaster Discovery 24E (Brainmaster Technologies, Inc., Bedford, OH; Collura, [97]), with an EEG bandwidth of 0.43-80 Hz, A/D conversion of 24 bits (resolution of 0.01 μV EEG, 0.4 μV DC), a sampling rate of 1024 samples per second (data rate to the computer of 256 samples per second), and an input impedance of 1000 GΩ (see Collura, [98], for technical details concerning the measurement of the qEEG).

QEEG signals were artifacted by S.A.R.A. (standardized artifact rejection algorithm; Keizer, [99]). The EEG data was subsequently processed with Neuroguide software (Applied Neuroscience Inc., St. Petersburg, FL), allowing the EEG data to be compared with the Lifespan Normative database [100]. This database has been normed, for both eyes open/closed conditions, with over 600 individuals (ages of 2 months to 82 years). The electrode montage adhered to the International 10-20 System, referenced to (A1-A2) linked ears, with NuPrep skin preparation gel, and Ten20 conductive paste. Electrode impedances were adjusted to be below 10 kΩ for all sensors (as determined by a Checktrode electrode tester).

The EEG recordings were acquired during eyes closed conditions in a waking-relaxed state, sitting in an upright position for both the PCI-HAP hypnotic assessment and the sidhi meditation conditions. The digitally filtered frequency bands, for metrics of absolute power, relative power, amplitude asymmetry, coherence, and phase lag were as follows: 1 to 4 Hertz (delta), 4 to 8 Hertz (theta), 8 to 10 Hertz (alpha 1), 10 to 12 Hertz (alpha 2), 12 to 15 Hertz (beta 1), 15 to 18 Hertz (beta 2), 18 to 25 Hertz (beta 3), and 25 to 30 Hertz (high beta).

3. Results

3.1 qEEG Neurophysiological Results

Figure 1 and Figure 2, illustrate the z-score analyses for absolute power, relative power, amplitude asymmetry, phase coherence, and phase lag for the eyes closed period during the PCI-HAP, and the (eyes closed) sidhi meditation, conditions, respectively. Overall, Figure 1 and Figure 2 are somewhat similar, suggesting that the qEEG of the sitting quietly period during the PCI-HAP is similar to sidhi meditation with especially high levels of theta activity across both conditions. However, there was greater alpha activity during sidhi meditation versus hypnosis. Conversely, there was greater delta activity during the hypnosis, versus the meditation, condition. (The participant reported possibly falling asleep during the hypnosis, per the debriefing form – see below.)

Additionally, alpha levels are increased during meditation, in contrast to hypnosis, for the anterior half of the brain. This difference is even more apparent for the beta, and especially the

high beta, ranges for the sidhi meditation versus the hypnosis conditions for the left prefrontal area of the brain.

In support of significant anterior/posterior laterality for sidhi meditation versus hypnosis for high beta is the significant amplitude asymmetry for the high beta brain map, versus the meditation high beta map. Fp1 was found to be associated with several significant positive lateralities with more posterior sites.

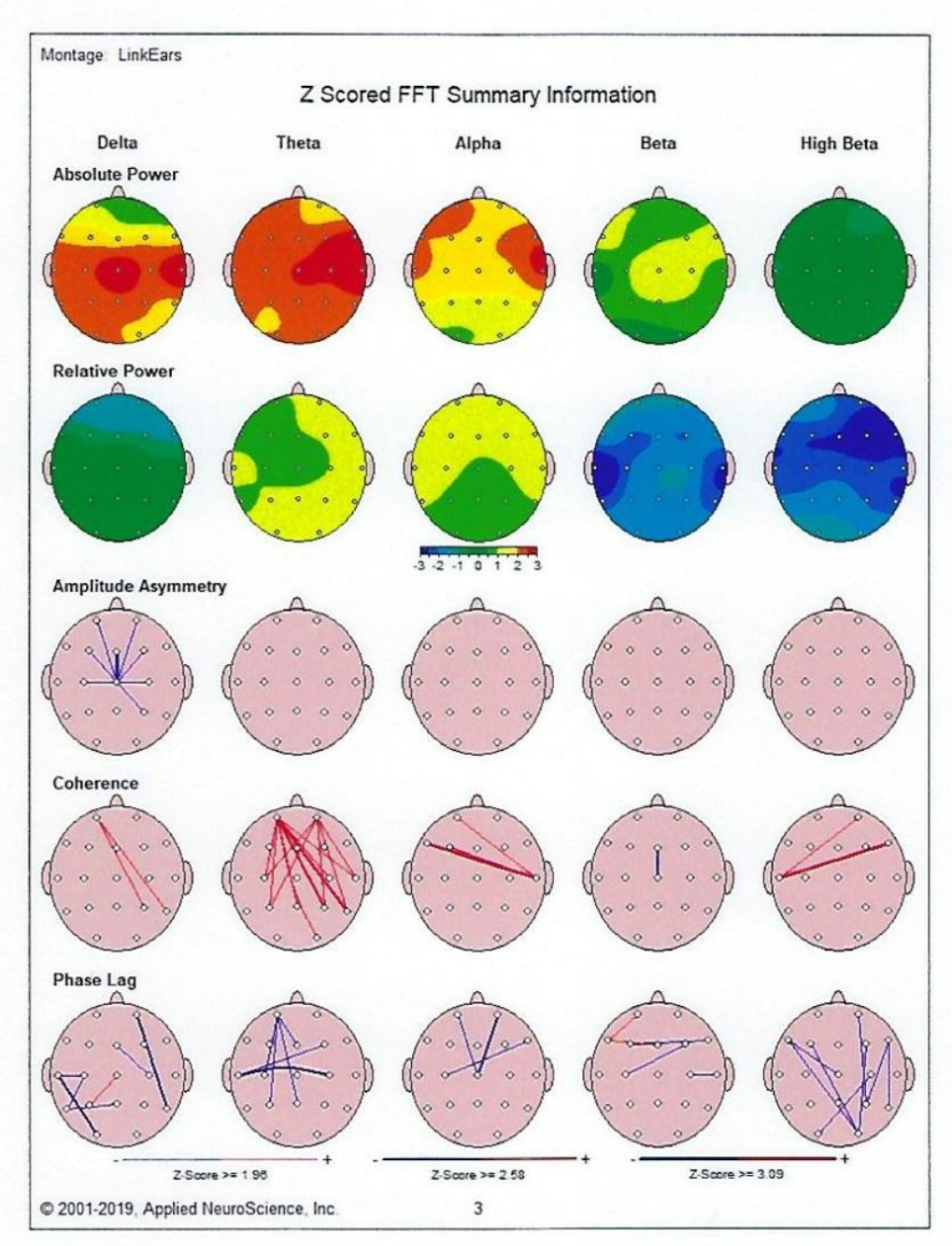

Figure 1 Eyes closed period during the PCI-HAP.

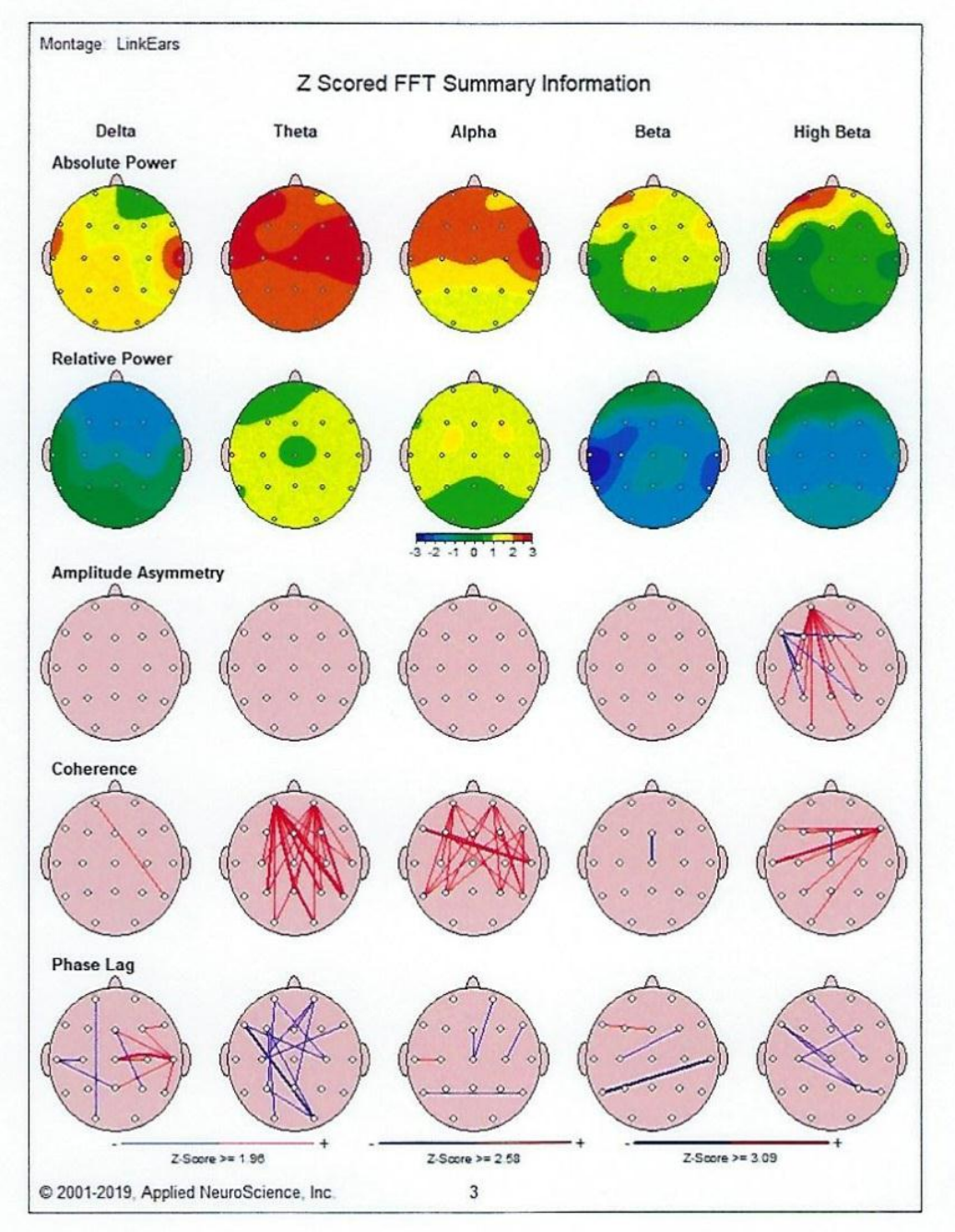

Figure 2 Sidhi meditation.

There was little significant coherence in the alpha band for sites for hypnosis, whereas there was more significant frontal to posterior coherence in the alpha band for sidhi meditation. In addition, there was significant coherence for frontal to posterior regions for hypnosis across sites for the theta band; in contrast, meditation was associated with somewhat increased theta coherence, versus hypnosis, across sites.

Figure 3 and Figure 4 show the 1-hertz bins for hypnosis and sidhi meditation, respectively, for 21 through 30 Hertz. The hypnosis brain map shows no left frontal increase in amplitudes for the hypnosis condition. In contrast, the sidhi brain map shows significantly increased left frontal amplitudes.

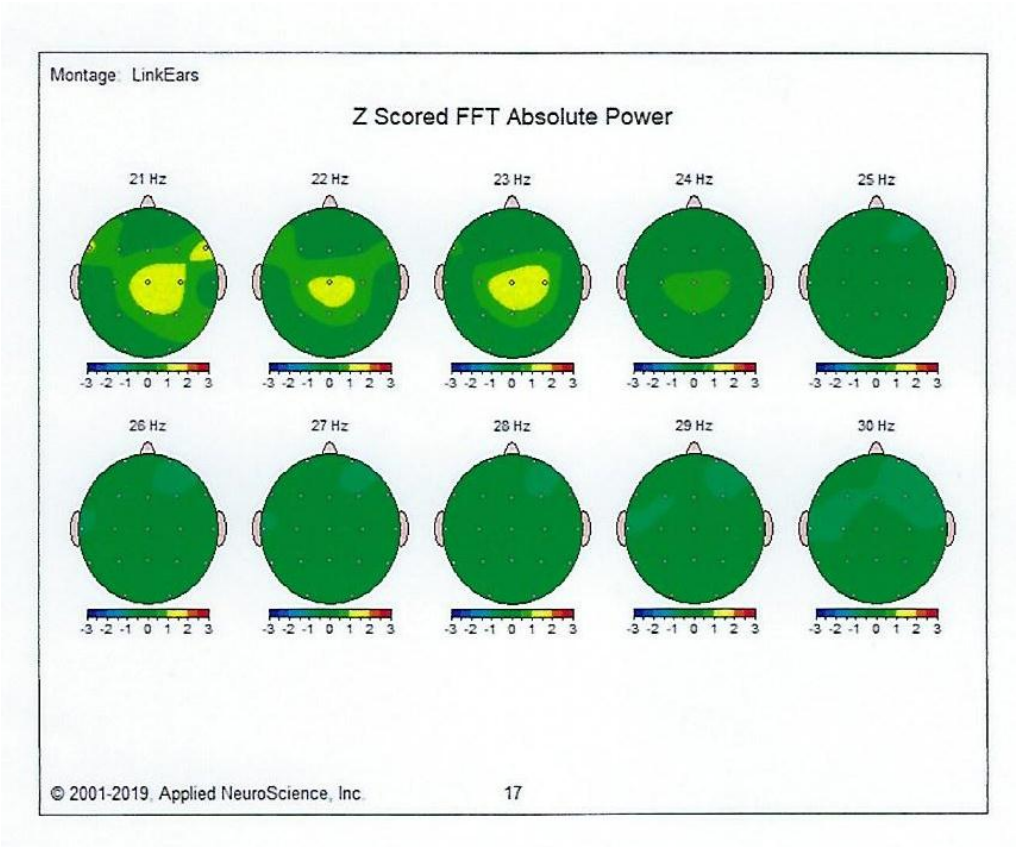

Figure 3 Eyes closed period during the PCI-HAP.

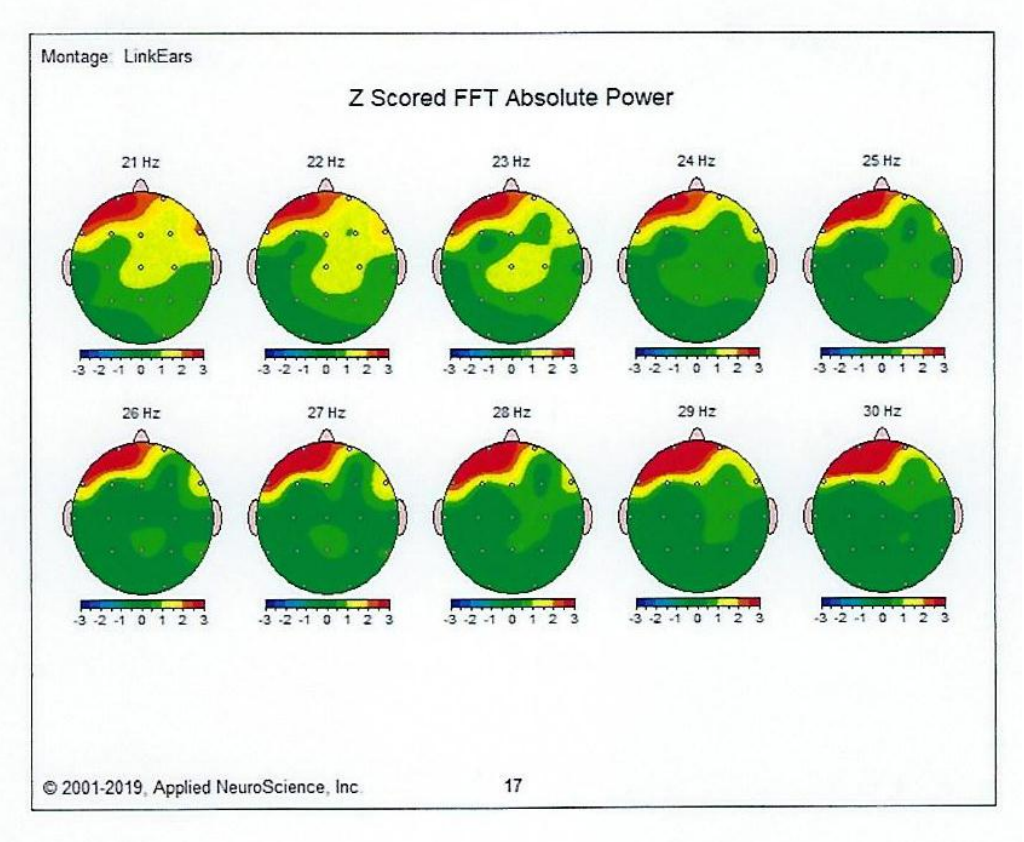

Figure 4 Sidhi meditation.

Table 1 shows the actual *z* scores for absolute power for the left, right, and center leads for the sidhi meditation condition. Only for Fp1 was there a significant z score for beta, beta 3, and high beta. There were no significant beta z scores for Fp1 for the hypnosis condition. Although not shown as a table, there was significantly higher delta activity across the majority of left, center, and right sites (11 out of 19 leads) for the hypnosis, but only T3 and T4 for the meditation, conditions (see Figure 1 versus Figure 2).

Table 1 Sidhi meditation.

Z Scored FFT Absolute Power								
Intrahemispheric: LEFT								
	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP1-LE	1.29	2.59	2.22	1.99	2.47	1.77	1.70	2.20
F3-LE	1.40	2.43	2.14	1.12	0.64	1.38	1.05	1.01
C3-LE	1.54	2.51	1.99	0.98	0.33	1.18	0.98	0.84
P3-LE	1.51	2.13	1.42	0.86	0.31	0.91	1.03	0.72
O1-LE	1.70	2.04	1.07	0.46	0.09	0.41	0.70	0.37
F7-LE	1.94	2.57	2.08	1.74	1.95	1.63	1.71	1.86
T3-LE	2.00	2.59	2.06	0.48	0.11	0.54	0.56	0.38
T5-LE	1.80	2.21	1.57	0.68	0.24	0.69	0.83	0.57
Intrahemispheric: RIGHT								
	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
FP2-LE	0.70	2.01	1.97	1.38	1.62	1.29	1.20	1.53
F4-LE	1.21	2.63	2.21	1.28	0.62	1.55	1.24	1.12
C4-LE	1.38	2.66	2.07	1.33	0.65	1.54	1.37	1.10
P4-LE	1.47	2.35	1.48	0.96	0.61	0.94	1.19	0.84
O2-LE	1.58	2.12	1.14	0.56	0.27	0.48	0.83	0.50
F8-LE	1.47	2.86	2.46	1.73	1.25	1.69	1.72	1.80
T4-LE	2.66	2.94	2.78	1.09	0.34	1.29	1.21	0.93
T6-LE	1.59	2.37	1.60	0.96	0.61	0.92	1.12	0.88
Intrahemispheric: CENTER								
	DELTA	THETA	ALPHA	BETA	HIGH BETA	BETA 1	BETA 2	BETA 3
F_Z-LE	1.16	2.40	2.07	1.21	1.01	1.45	1.12	1.11
C_Z-LE	1.73	2.55	2.09	1.48	0.64	1.55	1.56	1.38
P_Z-LE	1.61	2.30	1.42	1.05	0.69	0.97	1.29	0.94

3.2 PCI/PCI-HAP Noetic Results

On the PCI-HAP, the participant obtained a hypnotic responsivity index (HRI) percentile score of 69%. Trance level (his hypnoidal state score) was at the 84th percentile, and imagoic suggestibility was the 59th percentile. A person's HRI is an average of the aforementioned items, plus "total expectancy" and the "self-reported hypnotic depth" score [101]. These results suggest that the participant was of moderate hypnotic responsivity. In reference to item #4 of the debriefing form,

the participant endorsed: "I probably fell asleep, but I'm not sure," suggesting the participant thought he may have drifted off towards sleep during the hypnotic protocol.

The PCI-HAP generates a 5-page report concerning the client's hypnotic responsivity. Page 3 of the EXCEL report is shown as Figure 5. The upper graphs (left-sided) represent the PCI major and (right sided) minor dimensions in terms of raw scores (on a "0" to "6" scale); while the lower graphs represent the percentile scores for the major and minor dimensions, respectively. This allows the researcher to obtain a "snapshot" of the client's mind for a given stimulus condition in reference to the intensity variations associated with the PCI (sub)dimensions.

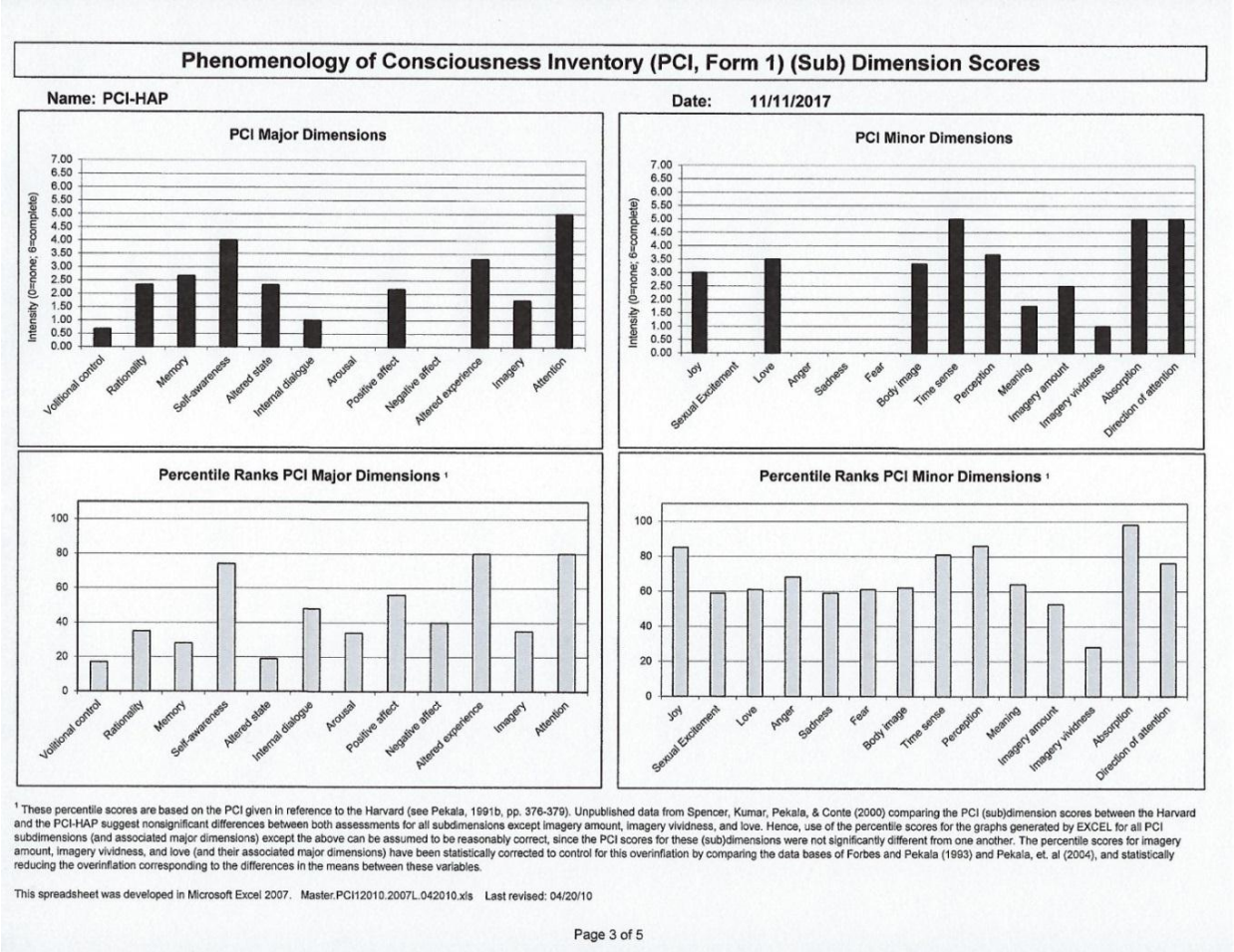

Figure 5 Phenomenological Intensity Profile (PIP) during the PCI-HAP (Eyes Closed Sitting Quietly).

Notice that the participant reported very high levels of absorption during hypnosis (98th percentile). No negative affect (neither anger, sadness, nor fear) was reported, although feelings of joy (85th percentile) and love (61st percentile) were reported. Imagery vividness was at the 28th percentile; while imagery amount was the 53rd percentile (See Pekala, [101], for the interpretative manual for scoring and interpreting the PCI-HAP results.)

Figure 6 (PCI major dimensions) shows the radar graph of sidhi meditation versus hypnosis (as measured during the sitting quietly period during the PCI-HAP), and eyes open and closed conditions for the PCI major dimensions. The center of the circle represents a value of "0" ("none or little"); while the circumference, a value of "6" ("much or complete"). Sidhi meditation was associated with no internal dialogue, compared with very mild levels of such during hypnosis. Notice also that the eyes open and eyes closed conditions – from the Pekala et al. [48] data base -

were also higher for internal dialogue than sidhi meditation.

Both altered awareness, self-awareness, and altered experience were also higher during sidhi meditation than during hypnosis (see Figure 6). Self-awareness was rated to be intense: "6" out of "6": "I was very aware of being aware of myself; my self-awareness was intense" (right dipole of item 13 from the PCI, Form 1). Concerning Figure 7 (PCI minor dimensions), what is striking is the higher level of love (also rated "6" out of "6") during sidhi meditation compared to hypnosis and the other two conditions.

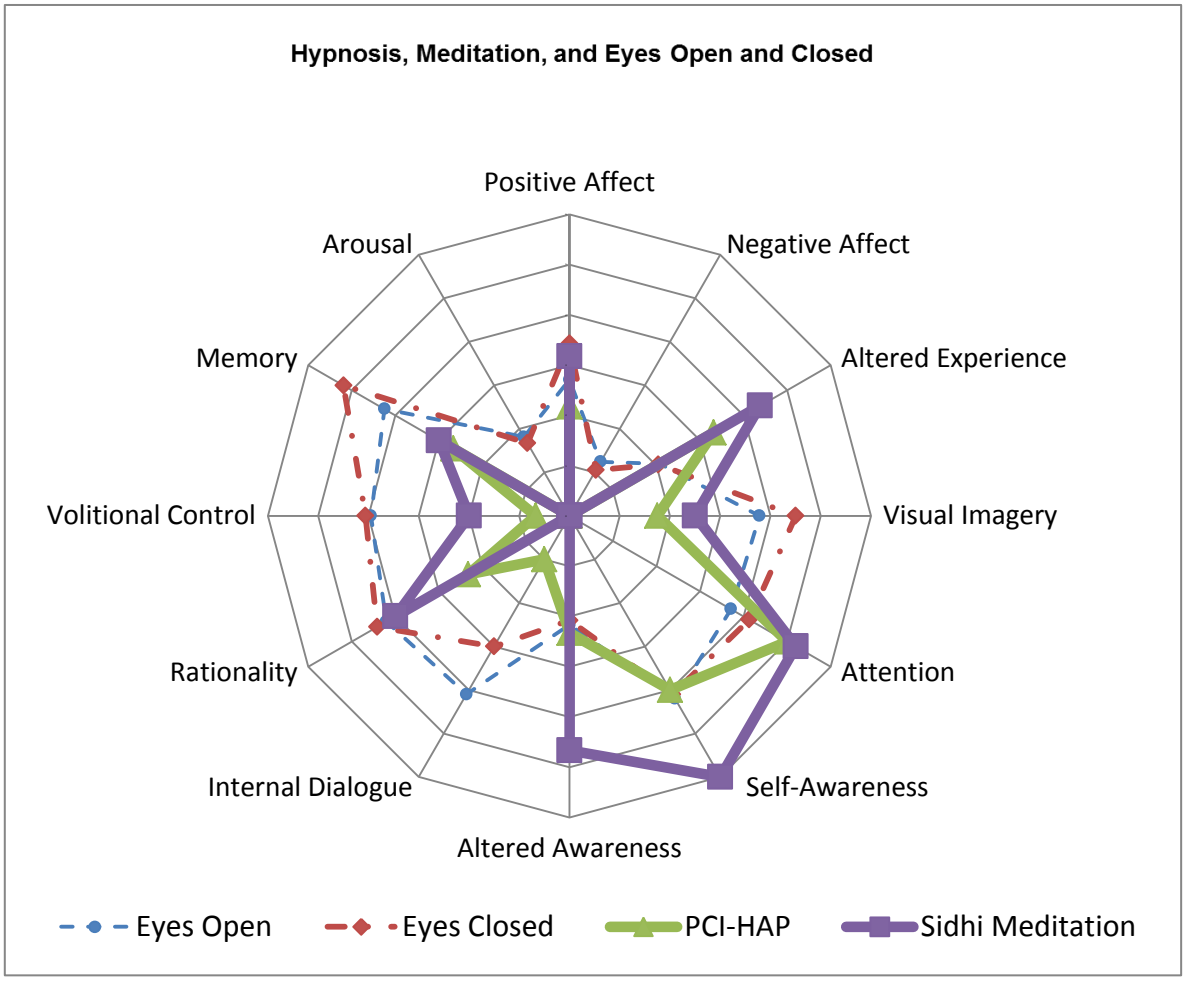

Figure 6 Radar graph of PCI major dimensions.

Additionally, sidhi meditation, per the PCI, was associated with an increased altered body image effect versus that of hypnosis, and also an increase in altered meaning. During this time KC reported his phenomenological consciousness as having a sense of "unboundedness," with consciousness seemingly "expanded;" his sense of awareness was intense. He reported that his consciousness was "floating," "immersed" in feelings of compassion.

4. Discussion

4.1 Neurophysiological Findings

The long-term TM meditator had significantly higher levels of alpha and especially theta activity

across both the hypnosis and meditation conditions, congruent with the findings of Thomas et al. [85] and De Benedittis [75] for meditation, and Jamieson and Burgess [79], De Benedittis [75] and Jensen et al. [7] for hypnosis. Whereas there appears to be no significant increase in high beta activity during hypnosis for this moderately hypnotizable individual, there were such increases in the left frontal lobes during sidhi mediation, consistent with the theorizing and research of Fell et al. [31], Thomas et al. [85], and Modestino [34].

Interestingly, there was significantly more delta during the hypnosis, versus the meditation, conditions. This would be consistent with the participant endorsing "I probably fell asleep, but I'm not sure" (on the debriefing form of the PCI-HAP); which would also be consistent with less self-awareness during the hypnosis, than the sidhi meditation, condition (see Figure 6).

There was only very mild significant coherence in the alpha band for hypnosis; whereas there was more significant frontal to posterior coherence in the alpha band for sidhi meditation. In addition, there was significant coherence for the frontal to posterior regions for the theta band for hypnosis; in contrast, meditation appears to have increased that theta coherence. Coherence can be considered a measure of functional connectivity [102] among the different modules of the brain: *"EEG coherence may yield information about network formation and functional integration across brain regions"* (p. 42).

These results suggest that sidhi meditation was associated with increased alpha and theta coherence versus hypnosis for this moderately hypnotically responsive individual. Beauregard and Paquette [103] wrote that *"theta connectivity between frontal and posterior association cortices in the left hemisphere has been proposed to be related to positive emotional experience"* (p. 3).

Fell et al. [31] and Thomas et al. [85] report an increase in alpha/theta activity in relatively novice meditators, followed by increased beta and gamma activity in advanced meditators. To paraphrase Fell et al. [31], the research on long-term meditation experts suggests both an increase in synchronization and power of low frequency oscillations, along with an increase in synchronization of gamma waves. They point out that this is typically unusual since an increase in feelings of relaxation and a drop from alpha to theta (sleep transition), is usually associated with decreased synchronization and power in the gamma range.

Thomas et al. [85] in their research with medium and long term Satyananda Yoga meditators, found increased theta activity in intermediate Yoga meditators, while advanced Yoga meditators demonstrated *"greater activity in high frequencies (beta and especially gamma^2) in all conditions but greatly expanded during meditation practice"* (p. 1), The increased theta and high beta qEEG results for this long-term sidhi meditator appears consistent with that of Thomas et al. above, although the high beta of KC, was much more left, than right sided, as was the case with the Thomas et al. study.

4.2 Neurophenomenological Findings

We believe that the PCI noetic results can be used to supplement and augment interpretation of the EEG results, which give no indication as to the nature or the content of the subjective experience, the qualia, or subjective referents, associated with both conditions, nor the intensity of such qualia. Before commenting on those results, however, the PCI-HAP hypnotic responsibility index (HRI) of the participant suggests that he was moderate in hypnotic responsivity. As of moderate hypnotically responsivity, his phenomenology is hence likely to be less similar to the very

highly hypnotizable participants tested by Cardeña [104].

Concerning Figure 6, which lists a radar graph of the PCI major dimensions, the meditation condition was associated with increased self-awareness and somewhat increased altered experience versus hypnosis. When queried about this, the sidhi meditation condition was experienced (the subjective sense of consciousness) by KC as "a sense of unboundedness," that was not evident during the hypnosis condition. This sense of "unboundedness" is hard to put into words. It might be described as a different type of awareness that is not so focal as in normal waking consciousness; more diffuse, but yet somehow expanded – as if the aperture of consciousness had been "widened." (Notice from Figure 7 that body image, and meaning were all more altered during the sidhi meditation than during hypnosis.) The increase in alpha and theta activity in sidhi meditation, along with the increased fast beta activity, seems to juxtapose both a "slowing" of consciousness [75], and yet it's (beta) activation, consistent with the Thomas et al., paper [85] concerning the EEG effects of long-term meditation and the Fell et al. [31] novice/advanced "meditation frequency band hypothesis."

Per the PCI, there was no internal dialogue during sidhi meditation (the internal chatter than goes within one's self), versus very mild internal dialogue with hypnosis and moderate amounts of such dialogue for the baseline eyes open and closed conditions (across groups of subjects from a prior data base, [48]). These results are consistent with the meditation literature wherein the object of the meditation is to quiet and empty one's mind (samyama) [105], and moderate drops of such internal dialogue, as reported, during hypnosis [18].

Per KC, it is important to note that the TM samyama practice versus hypnosis generated relatively different subjective states of consciousness. Heterohypnosis, in general, involves a passive state wherein the individual responds to the hypnotherapist's suggestions. On the other hand, the TMS procedure is more active and requires an initial period of meditation and then involves the participant deliberately introducing a sutra into the mind with the intention/ expectation that it will produce a certain subjective effect while becoming "immersed" in the experience.

KC explains that the sidhi mediation condition is a more "active" process than the more "passive" hypnosis sitting quietly period: *"for the next several minutes I'm going to stop talking and I want you to continue to experience the state you are in right now"* (instructions for hypnosis sitting quietly period: Pekala, Kumar, & Maurer, [93], p. 11). This would be congruent with less loss of volitional control during meditation than hypnosis, as seen in Figure 6.

The arousal dimension of the PCI assesses "subjective tension." Both meditation and hypnosis were associated with no subjective arousal/tension. This would be consistent with the increased alpha and theta activity found across both conditions. However, KC reported "complete" self-awareness during sidhi meditation ("6" out of "6"), whereas self-awareness during hypnosis was "3.33" out of "6.0". Drops in self-awareness are typical of hypnosis [18, 37, 38].

One of the goals of meditation is to try to always maintain reflexive self-awareness [105], and a long-term meditator would be expected to do that well. Hence, meditation appears to increase "meta-awareness," e.g. reflective self-awareness [106], consistent with KC's self-awareness score. Such increased self-awareness is also consistent with left high beta activation [107] as was found for KC during meditation, but not, hypnosis.

In addition, there were intense feelings of love ("6" out of "6") reported during sidhi meditation; more so than hypnosis. We believe this is consistent with the "cultivation" of

compassion that was generated during the sidhi meditation from the sutra repetition. Interestingly, both hypnosis and meditation were associated with moderate levels of joy (see Figure 7). Here, in this advanced TM meditator, greatly increased love (and moderate joy) was also associated with increased beta activation of the left prefrontal cortex. Interestingly, Kundalini [34] was also associated with positive feelings of joy (and sexual excitement) with concomitant activation of the left prefrontal cortex. Per Davidson [108], one of the activities of the left prefrontal cortex is to downregulate negative affect associated with the amygdala, which, in turn, may then be associated with increased positive affect.

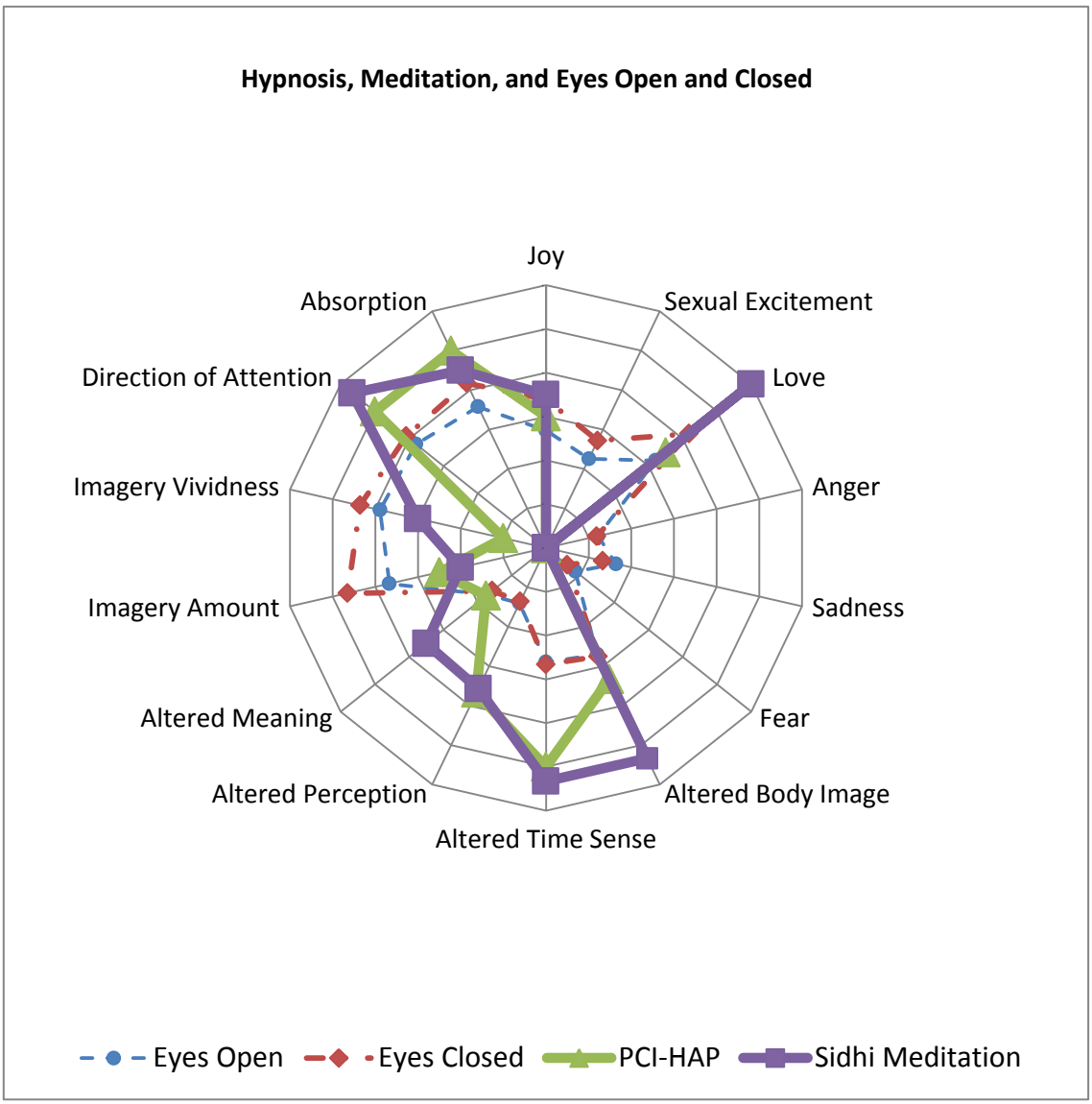

Figure 7 Radar graph of PCI minor dimensions.

Concerning the theta activity, theta increases as one falls asleep and also when awakening in the morning, i.e., the hypnogogic and hypnopompic states [109]. It is unknown if the theta waves before falling asleep [110] may be similar/dissimilar to the theta in KC's EEG. However, if one watches oneself as they are falling asleep (having one's arm in the vertical position, lying supine, and being aware of the nature of awareness/consciousness as one's arm falls as muscle flaccidity

sets in [111] and one starts to drift off to sleep, one will notice that the "aperture" of consciousness seems to widen as the general "focus" of attention becomes more diffuse, until one loses consciousness (self-awareness) and drifts off to sleep (a procedure RP has done at times while falling asleep, to better discern the nature of awareness/attention during this transition to sleep).

The "unboundedness" that KC reports appears to be consistent with the increased theta during siddhi mediation, but without the delta activity ("sleepiness") that was evident during hypnosis. That tendency towards sleepiness, associated with the theta activity, may be partially "counterbalanced" by the left frontal high beta (associated with increase self-awareness and positive feelings, per the PCI). Hence, the long-term meditator is able to sustain theta without falling asleep, which may be like being on the "verge of sleep," but yet more alert and aware. The sustained theta would also be consistent with the change in body image from the PCI, some loss of volitional control, and the feelings of "expanded awareness" per KC, as if the "aperture" of awareness has been widened. The very high levels of self-awareness, concurrent with a change in bodily awareness and meaning (altered experience) and a subjective sense of an increasingly altered state of consciousness, as measured by the PCI, would be consistent with this.

There was little significant coherence in the alpha band for hypnosis. In contrast, there was much more significant frontal to posterior coherence in the alpha band for sidhi meditation. There was significant coherence for frontal to posterior regions for the theta band for hypnosis; meditation appears to have increased that theta coherence. Coherence can be considered a measure of functional connectivity [102] among the different modules of the brain, suggesting that sidhi meditation was associated with increased alpha and theta coherence versus hypnosis for this moderately hypnotically responsive individual. Ott [89] has suggested that increased phase synchronization of EEG activity across the whole cortex, especially gamma, will be associated with increasingly joyful, ecstatic, and "expansive" mystical experiences.

4.3 Limitations and Constraints

4.3.1 Demand Characteristics

The sidhi meditator reported in this study is also a psychologist and second author on this paper. Hence, he has read a great deal on hypnosis, and especially meditation. Although the qEEG results are much less likely to be due to demand characteristics [112]; the noetic results, because they are based on first person self reports, are more so likely to be so influenced. Future research will need to be conducted across groups of participants, who have little or no knowledge of the scientific basis of meditation and hypnosis, to better evaluate these preliminary, case study results.

On the other hand, the description concerning the "unboundedness" of sidhi meditation helps make the PCI/qEEG results more interpretable, which might not have been possible without the collaboration/discussion of KC's elaboration of his phenomenological experience of meditation, and his scientific knowledge of meditation and hypnosis.

4.3.2 The Possible Ineffability of Various Altered States of Consciousness

The state of consciousness of the meditator during sidhi meditation is hard to talk about or put into words, via-a-vis normal, everyday waking consciousness, per KC. The intense self-awareness

without any internal dialogue for this advanced TM meditator would be an anomaly for most people, since such internal chatter would typically be associated with DMN (default mode network) activation [113] and mind-wandering or daydreaming. Deactivation of the DMN [114] is not addressed neurophysiologically in the current paper. It needs to be scrutinized in future noetic/neurophysiological research, as well as how neurophysiological connectivity issues [89, 115] may play a role in generating the particular state of consciousness associated with deep hypnosis or long-term meditation.

Tart [116, 117] suggested almost 50 years ago that it is the pattern of relationship ("connectivity") among the various "processors" that determine the particular state of consciousness that is activated, and not the activated intensity of those processors. There is conjecture that the nature of the meditational experience, especially when in "deep states of consciousness," such as with samadhi experiences [118], may be rather ineffable [118], and hence extremely difficult to put into words. Consequently, it can be asked as to how valid the PCI may be to accurately access/assess such "altered" states of consciousness?

The PCI is a third-generation questionnaire, developed from the first author's dissertation [17], and another iteration of an earlier version of the PCI [18]. Consequently, it is believed to "sample" several, but not all, of the major noema and noeses of consciousness [119, 120] that phenomenological psychologists [121] had postulated as defining the nature of subjective consciousness. (See Pekala, [18], for a review of this theorizing and development of the approach, which, in the past, has also been labeled, "psychophenomenology," Pekala, [122]) The PCI, and its associated methodology was developed to operationalize Tart's [116, 117] and Singer's (In Zinberg, [123]) theorizing on the nature and essence of altered states of consciousness.

A companion questionnaire, the Dimensions of Attention Questionnaire [36], was similarly developed to measure various facets of attention [124], since the PCI has only two subdimensions addressed to attentional experience. Numerous research studies by various researchers have attested to the usefulness of the PCI for assessing subjective experience associated with a variety of stimulus conditions, i.e., hypnosis, meditation, virtual reality, ictal consciousness, mediumship, psi phenomena, religious experiences, etc. (see the "Introduction").

However, the PCI has not been used with extremely altered states of awareness, as might be associated with the psychedelics [125], such as lysergic acid diethylamide [114, 126], ayahuasca [127, 128], psilocybin [129, 130] or dimethyltryptamine (DMT) [131, 132]. Here is where administering the PCI with questionnaires developed to specifically assess such altered psychedelic states [133], such as the Altered States of Consciousness Rating Scale (ver: 11D-ASC) [134], or the MEQ30 [135] may be especially useful [136]. Future research will need to continue to build upon the foundations laid here by the PCI, the 11D-ASC, the MEQ30, and others.

The brain/mind approach espoused in this paper may be especially useful when looking at the many variants of parapsychological phenomena [137, 138], psi phenomena and hypnosis [139, 140], anomalous experiences [141], and methodologies used to generate such experiences, such as the ganzfield [142]), to name only a few of the many areas of potential interest.

Additionally, various Buddhist texts talk about the increasingly "fine" levels of awareness achieved by long-term meditation, when looking at the domains of mindfulness and concentration [143]. Comparing the PCI, and also the DAQ, with meditational questionnaires [144-147] would also be useful, especially when looking at changes in attentional experience associated with different types of meditation.

As mentioned earlier, Facco et al. [33] have used hypnosis, the PCI, and the qEEG, to assess the nature of the out-of-the-body experience (OBE). This is an area where the PCI may be especially helpful in further understanding such experiences as documented by Buhlman [148, 149], Tressoldi et al. [150], and Ziewe [151, 152], especially if neurophysiology, as quantified by the qEEG or the fMRI, can also be concomitantly assessed.

4.3.3 Quantifying States of Consciousness via Pattern Effects

If there were a large enough group of meditators/hypnotic participants involved in the research as a function of stimulus condition, a psygram (a graph of the psychophenomenological state of consciousness of the group of participants experiencing that stimulus condition) could be constructed to show the patterns of relationship among the various PCI dimensions [122]. Significant pattern/connectivity differences were found among PCI dimensions between low and high suggestible individuals during hypnosis versus a baseline, eyes closed sitting quietly condition [43, 44, 153]. Such differences were replicated by Cleveland, Korman, and Gold [154].

Hence, besides looking at variations in intensities among the 12 PCI dimensions via radar graphs or pips (phenomenological intensity profiles – see Figure 5), the researcher can visually diagram and statistically assess the strength of the patterns of association [155, 156] among such dimensions via psygrams. This would hence allow for the state of consciousness, as theorized by Tart [116, 117], to be quantified and visually diagrammed for the different conditions/groups of participants [18]. Rock and associates [66, 157] have been using psygram theorizing and analysis rather extensively in their research on altered states of consciousness.

4.3.4 Conjectures Based on an *n* of One

A major concern with the aforementioned theorizing is the fact that the authors are making conjectures between the qEEG and what has been reported on the PCI/PCI-HAP using an *n* of 1. Such "case study" conjectures, although supporting interesting hypotheses between mind and brain, are just that: conjectures. The case study research reported herein, needs to be supplemented with research conducted across groups of participants, and compared against controlled conditions, to better determine the nature of the brain/mind relationships. The study by Thomas et al. [85] is an excellent example of such controlled research.

4.3.5 The Complexity of the Task Involved in Assessing Neurophysiological Data

As mentioned earlier, Landry, Lifshitz and Raz [82] in their comprehensive and sophisticated "systematic and meta-analytic" review of neuroimaging studies of hypnosis, concluded that *"there remains little consensus concerning the neural mechanisms and a great deal of inconsistence among findings"* (p. 92). Instead of finding that the central executive network (CEN), the salience network (SN), and the default mode network (DMN) were main contributors in parsing out the variance associated with hypnotic responsibility, their sophisticated analyses, employing activation likelihood estimates (ALE), implicated the lingual gyrus and visual processing mental imagery "as the sole reliable neural pattern relative to the current body of neuroimaging findings" (p. 91).

Interestingly, the importance of imagery (amount and vividness) was found to account for about 28% of the relative variance (as assessed by standardized coefficients) in predicting the hypnotic

responsivity index (HRI) score of about 100 Italian participants who completed the PCI-HAP [55]. Two earlier studies [158, 159] also implicated the importance of imagery, and its relationship to imagery vividness before and during a hypnotic induction, in better understanding hypnotic responsivity as noetically assessed by the PCI-HAP. Hence, use of the PCI-HAP in better determining the neurophenomenology of hypnosis and hypnotic responsivity, appears warranted.

Palmiero and Piccardi [160], in their "mini-review" of frontal EEG asymmetry and mood, concluded that regardless of the *"research line considered, there are contrasting results that cannot be unequivocally interpreted according to one frontal asymmetry model rather than another"* (p. 5). The complexity of the task of mapping the brain are mind-boggling.

About ten years ago, Baars and Gage [161] reported there to be about 100 Brodmann areas, suggesting that this may be taken as a general estimate concerning the number of specialized areas of the cortex. Additionally, there are about 100 billion neurons of the human brain and about 1000 synaptic connections per the average neuron [162]. This means that there are trillions of connections amongst these 100 billion neurons. In summary, the brain is the "most complex object in the known universe" [162]. Is it no wonder that different laboratories employing somewhat different methodological procedures lead to conflicting results, given the astronomical number of resulting permutations that may be induced by slight changes in the stimulus set/instructions?

Psychophysiological isomorphism [31] posits *"a one-to-one correspondence between mind and brain states"* ([31], p. 222). Close to 40 years ago the first author [163] posited the principle of "stimulus-state specificity," as a means to relate quantifiable phenomenological (mental) experiences with their corresponding behavioral and stimulus settings/environments. This principle posited that different stimulus environments (when assessed across groups of randomly chosen participants), which includes all instructional sets and associated environmental/behavior cues, will be associated with different intensities and/or patterns of noetic (phenomenological) experiences, while the same stimulus environments will be associated with nonsignificantly different intensities and patterns of noetic (phenomenological) experiences.

Combining these two principles means that changes in the stimulus setting (instructional and environmental set), will lead to activation of the different modules (and their associated connectivities) in the brain, which, in turn, will reflect subtle changes in neurophysiology and hence corresponding changes in the qualia experienced by the participant. So, even changing the instructional set slightly concerning what participants are to do, will likely affect not only the neurophysiology, but also the noetics of what will be experienced. In practical terms, the instructional sets and the stimulus settings may have significant impact on neurophysiology and its corresponding noetic enactment. So near identical studies with slightly different instructional sets, may lead to somewhat different noetic/neurophysiological involvement.

4.3.6 The Reliability and Validly of First Person Self-Reports

Davidson and Kasznik [164] talk about the myriad of conceptual and methodological issues that need to be resolved in better researching the mind, mindfulness, and meditation. They specifically address the rationale popularized by Varela and colleagues [165, 166], a view that the current authors believe is mistaken: *"that reports of conscious experience derived from minds that have not had this form of [meditation] training will be tainted by distraction and thus be compromised with respect to both reliability and validity"* (p. 585).

Neurophenomenology, as defined by Lutz and Thomson [27] uses "first-person methods," which they deem to be well rehearsed subjective practices that participants can use to "fine tune" their sensitivity towards, and articulation of, their ongoing subjective experiences. This training involves the self-monitoring and regulation of attention, emotion and consciousness, in such a manner to give the participant more accurate awareness and perception of the fleeting and evanescent nature of conscious experience, so as to more fully ascertain the nature, and quality, of that experience.

On the contrary, we believe that such "training" establishes subtle stimulus expectancies and biases into the nature of introspection, which may subsequently influence the qualia of that phenomenological experience. The aforementioned argument is not new, as historians of classical introspection will attest. Such trained introspection was used by the classical introspectionists over 100 years ago, and this approach was "buried" by Watson's classic rebuttal of introspectionism: "Psychology as the behaviorist views it" [167]. The results, as summarized by Boring [14], suggested that different laboratories will train introspectionists in slightly, and subtly, different ways. The result were differences in the qualia reported by various introspectionists across different laboratories, and the *"consciousness of action, feeling, choice, and judgment"* (p. 176) were neither reliable nor valid.

Noetic analysis, on the other hand, uses "untrained" introspectionists, i.e., individuals with no specific training in introspection. Such training is not necessarily due to the fact that participants retrospectively quantify their subjective experience via standardized (self-report) questionnaires in reference to short periods of time. (See Pekala, [18], for a more thorough review of the "pros and cons" for and against the use of retrospective first person self-reports with standardized inventories.) Additionally, a search of the term, "Phenomenology of Consciousness Inventory (PCI)," with google will reveal scores of articles on the reliable and valid use of the PCI to map states of consciousness, and the noetic experiences associated with a myriad of stimulus conditions.

4.3.7 Assessment Length and Order Effects

The sitting quietly period during the PCI-HAP was 5 minutes, whereas the sidhi meditation period was 10 minutes. It was felt that 10 minutes were needed for the effects of the sidhi mediation to be fully discernable. The usual period for the PCI-HAP sitting quietly period is 3 minutes [93]. Because the typical sitting quietly time period was shorter than the 10 minutes for the sidhi mediation, this sitting quietly period during the PCI-HAP was increased to 5 minutes for the present study. Future research will need to have equivalent periods of time for both hypnosis and meditation conditions. Order effects were also not addressed, and may have had some impact on the results.

5. Conclusions

Lifshitz [25] said several years ago that *"whereas scientists have access to a plethora of advanced methods for investigating brain and behavior, they face a dearth of techniques for the empirical analysis of phenomenology"* ([26], p. 9). Noetic analysis [16, 21] provides a reliable and valid methodology to not only quantify and statistically analyze phenomenological experience, but provides a means to assess and diagram states and altered states of consciousness [116, 117] associated therewith [168]. When combined with the qEEG, noetics may be especially helpful in better understanding not only consciousness and states of consciousness, but the various

processes associated therewith, including emotional regulation, decision making, psychopathology, and their influence upon mental health and individual differences factors [169].

Based on the aforementioned discussion, the reader can understand how combining the qEEG with the PCI allows for the qualia associated with the aforementioned qEEG frequency, asymmetry, and coherence results, to be compared and contrasted. The results may be even more interesting when combining noetics with sLORETA [170], and the host of other neurophysiological methodologies, such as the fMRI (functional magnetic resonance imaging) as Modestino [34] has done. By quantifying the qualia of mental experience, we believe it will be easier to generate quantitative hypotheses concerning the mind/brain interface associated with that experience. Its use across groups of participants with different stimulus conditions is an important next step.

Combining the PCI with the qEEG allows for subjective referents associated with neurophysiology to be quantified and statistically evaluated during hypnosis, meditation, and possibly other altered states of consciousness [171]. Evaluating the brain with the qEEG during meditation or hypnosis, while neglecting the qualia [23] associated therewith, is like measuring the neurophysiological parameters of the orgasm, but ignoring the nuances of the subjective experience of its associated ecstasy [172]. Several different levels of analysis are needed for a more complete understanding of the phenomenon of interest.

Use of this approach to better quantify the brain/mind interface across groups of low and high hypnotically responsive participants during hypnosis and meditation, may be especially helpful in allowing for a more rigorous mapping of the brain/mind continuum than is currently available. Paraphrasing Jamieson and Jensen et al., we believe that in trying to better unravel the *"bewildering array of practices [of meditation and hypnosis] across different cultural settings and in different historical epochs"* ([5], p. 313) such investigations *"are probably best explained by more comprehensive models that take into account factors from biological,* ***noetic*** *[our italics/addition], psychological and social domains"* ([7], p. 63).

Phenomenological experience needs to be comprehensively quantified [25, 27, 28] as an important, but equal, domain in being able to truly decipher the mystery of altered states of consciousness [109] and their many and varying, associated qualia. Almost 30 years ago the first author suggested that

> *the next revolution in psychology, mental health, and cognitive science... will be a noetic-behavioral one from both a research and an applied perspective... by showing that noetic aspects of human experience can be quantified and statistically assessed in a comprehensively reliable and valid manner... Only an approach that considers both man's objective and subjective environments, his world and his psyche... will be able to do justice to that complexity we call human* ([18], p. 350).

Hopefully, the present case study suggests the usefulness of such an approach. Future research appears warranted.

Footnotes

This paper does not represent the views of the United States Government nor the Department of Veterans Affairs. Requests for reprints should be sent to: Ronald J. Pekala, Ph.D., 309 North Franklin St., West Chester, PA 19380-2765; ronald.pekala@gmail.com. The authors wish to thank

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[1]Copies of the PCI [29], and the user's manual and EXCEL scoring protocols for the PCI [173] are available at www.quantifyingconsciousness.com. Copies of the PCI-HAP [71, 72], the self-report and therapist versions of the pre- and post-assessment forms, the administration manual [93], the interpretative manual [101], and the EXCEL scoring protocol for the PCI-HAP [174] are also available at www.quantifyingconsciousness.com. [Please note: while anyone can download and procure a copy of the PCI and its EXCEL scoring sheet; you must be a clinician or researcher with validated experience in hypnosis to procure the PCI-HAP.]

[2]Gamma activation - 25 to 42 Hertz - for Thomas et al.'s study was defined to include "high" beta - 26 to 30 hertz – as assessed in the present study. Hence the present study's "high" beta activation, can be considered a part of Thomas et al.'s gamma activation.

Authors Contributions

This paper is based on numerous conversations between the authors concerning the nature of hypnosis, but especially meditation, for whom the second author is the "practicing" phenomenological expert. The first author designed and conducted the study, and wrote the paper. The second author was involved in "fine tuning" the results and discussion sections of the paper.

Competing interests

The authors declare that there are no competing interests.

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Review

Neural Mechanisms of Hypnotic Analgesia

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Abstract

There is increasing evidence demonstrating that hypnosis could be effective in the down-modulation of pain sensation in both acute and chronic pain states. In the neurophysiological context, recent evidence has deciphered, to a certain extent, the mystery of pain relief upon hypnosis. It is probable that hypnotic suggestions of analgesia are able to modulate pain processing at multiple levels and sites within the central nervous system (CNS). At the peripheral level, hypnosis may modulate the nociceptive input through the down-regulation of the stimulation of A delta and C fibers and reduction of sympathetic arousal. At the spinal level, sensory analgesia occurring during hypnosis has been demonstrated to be linearly associated with the reduction in the nociceptive flexion (RIII) reflex, a polysynaptic spinal reflex. At the supraspinal cortical level, neuro-imaging and electrophysiological studies have demonstrated that hypnotic suggestions of analgesia could directly modulate both sensory and affective dimensions of pain perception, and the affective dimensions exhibit more significant reduction compared to the sensory ones. Moreover, highly hypnotizable subjects possess stronger attentional filtering abilities in comparison to the low hypnotizable subjects; this greater cognitive flexibility of the former might result in better focusing and diverting the attention from the nociceptive stimulus as well as in better ignoring of the irrelevant stimuli in the environment. Cognitive control

processes are associated with a "supervisory attentional system" which involves fronto-temporal limbic cortices.

Multiple hierarchical pain control systems functioning during hypnotic suggestions of analgesia, demonstrating specific patterns of peripheral and central activation associated with the hypnotic state and with the processing of hypnotic suggestions, provide a novel description of the neurobiological basis of hypnotic analgesia.

Keywords

Hypnosis; hypnotic analgesia; mechanisms; review

1. Acute and Chronic Pain: Definition and Magnitude of the Problem

Pain is defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" by the *International Association for the Study of Pain* [1].

Pain is the most common reason for physician consultation in most of the developed countries [2]. It is a major symptom in several medical conditions, and may interfere with the quality of life and general functioning of a person [3].

Pain that persist for a long duration is referred to as "chronic" or persistent pain, while the pain that resolves within a short period of time is referred to as "acute". Chronic pain is defined as the pain that persists or recurs for greater than three months or beyond the expected period of healing [4].

Pain is the main reason for visits to an emergency department in greater than 50% of the cases [5]. In 30% of family practice visits, the presence of pain is there [6]. Epidemiological studies have reported that 10.1%–55.2% of the people in various countries experience chronic pain [7].

According to a global-level epidemiology report by Tsang et al. [8], there was a 37.3% age-standardized prevalence of chronic pain conditions in the previous 12 months in developed countries, 41.1% in developing countries, and an overall prevalence of 38.4% globally.

1.1 Pathogenetic Pain Phenotypes

Pain may be broadly categorized into nociceptive pain and neuropathic pain. Nociceptive pain is caused by the stimulation of sensory nerve fibers that respond to the stimuli approaching or exceeding the harmful intensity (nociceptors). Nociceptive pain may be classified on the basis of the mode of noxious stimulation (*e.g.*, inflammatory or cancer pain).

Neuropathic pain, on the other hand, is caused by damage or disease affecting any part of the nervous system involved with bodily feelings (the somatosensory system) [9]. Neuropathic pain may be experienced in CNS disorders (such as spinal cord injuries, multiple sclerosis, and certain strokes) or peripheral neuropathies (such as herpes zoster and diabetic neuropathy). It is also common in cancer, as a direct consequence of cancer on peripheral nerves (e.g., compression by a tumor) or as a side effect of chemotherapy (chemotherapy-induced peripheral neuropathy), radiation injury, or surgery [10].

1.2 Economic Burden of Pain

In addition to worsening the quality of life of those who experience it, pain also presents an economic burden, both for the suffering individuals and the health care systems.

Individual costs comprise direct costs (e.g., medical care payments) and indirect costs (e.g., paying for the activities these people are no longer able to perform). Among the indirect costs, loss in work productivity constitutes the majority of the overall costs associated with pain [11]. Furthermore, in several countries, the workforce is in the continuous process of aging, which could lead to a major economic impact when these individuals would require early retirement owing to their painful health conditions.

1.3 Access to Treatment for Pain Relief as a Human Right

According to the international human rights law, countries are required to provide pain treatment medications as a part of their core obligations under the right to health. Despite the importance and magnitude of the problem and the existence of several inexpensive and effective pain relief treatments, inadequate treatment of pain, particularly that of chronic pain, is widespread [12]. Tens of millions of people worldwide continue to suffer from moderate to severe pain each year, without relief. Failure to undertake reasonable steps for ensuring that the people who suffer from pain have access to adequate pain treatment may represent a violation of the obligation to protect against cruel, inhuman, and degrading treatment.

The *International Association for the Study of Pain* [13] advocates that receiving pain relief should be recognized as a human right, chronic pain should be considered a disease in its own right, and pain medicine should receive the full status of a specialty.

1.4 Addressing Pain beyond Medications

Primarily, chronic pain is not a biomedical problem, and is, therefore, not easily resolved using a single simple biomedical treatment approach. Instead, chronic pain is a biopsychosocial problem that requires the consideration of and treatments that address the several biological, psychological, and social factors that may contribute to its severity and the impact caused by it [14].

Owing to their limited efficacy, simple pain medications are useful only in 20%–70% of the cases [15]. Moreover, there are frequent significant side effects of medications, such as the recent opioid epidemic in USA [16], which is the most common reason for people shifting to the use of complementary and alternative medicine [17].

The experience of pain may be dramatically influenced by cognitive modulation [18].

Among all the cognitive interventions for pain modulation, hypnosis may be the most effective in clinical and experimental pain [19-21]. A few studies have addressed the important issue of the long-term effects of hypnotic analgesia. There is a consensus among outcome studies which suggests that analgesic effects of hypnosis are long-lasting and are maintained over time [22-26].

2. What is Hypnosis?

The term "hypnosis" refers to a state of consciousness that involves focused attention and reduced peripheral awareness, which is characterized by an enhanced capacity for response to suggestion [27]. This term also refers to the procedure through which the afore-stated state is induced. It is possible to modify physiological, cognitive, and affective processes, as well as behavior, during a hypnotic trance. Hypnotic state and hypnotic phenomena may be induced by another person (therapist) or by oneself (self-hypnosis). The subjective experience of hypnosis is characterized by focused attention, absorption capacity, a high degree of authenticity (experienced as real), involuntariness ("it happens by itself"), and cognitive/perceptual flexibility [28, 29].

Hypnosis has been an elusive concept for science for a long time due to the lack of objective neurobiological markers for the state of trance. However, persistent advances in the field of neuroscience in the last few decades (largely because of the introduction and refinement of sophisticated electrophysiological and neuro-imaging techniques) have opened up a 'bridge of knowledge' connecting the classical neurophysiological studies with the psychophysiological studies of cognitive, emotional, and sensory systems [28, 30]. These neuroscience studies have provided novel insights into the neural basis of hypnotic experience. Furthermore, an ambitious area of research focusing on mapping the core processes of psychotherapy and their underlying neurobiology has emerged recently. Research related to hypnosis has offered powerful techniques for the isolation of psychological processes in ways that allow their neural bases to be mapped. The *Hypnotic Brain* [31] could serve as a tool to approach the neurocognitive questions, and the cognitive assays may, in turn, provide insight into the neural bases of hypnosis. This cross-talk shall enhance related research and clinical applications.

While the recent advances in neuroscience have undoubtedly contributed to unraveling the nature of hypnotic reality [29, 32], i.e., its neuro-cognitive structure, hypnosis is also being increasingly recognized by the international scientific community as a valid and flexible physiological tool for the exploration of the central and peripheral nervous systems. This might be a real Copernican revolution in this field [28].

3. Neural Correlates of Hypnosis

Current research on hypnosis comprises two major areas [31]: (a) *intrinsic research*, i.e., the line of research concerned with the functional anatomy of hypnosis per se, in the absence of specific suggestions referred to as 'neutral hypnosis' or 'default hypnosis', and on the neurophysiological mechanisms underlying the hypnotic experience in dynamic conditions, and (b) *instrumental research* (or extrinsic studies), which involves the use of hypnosis and suggestion for studying a wide range of cognitive and emotional processes, as well as for creating 'virtual analogs' of neurological and psychopathological conditions, to elucidate their basis, and eventually positively alter the manner in which they are treated.

An array of novel electrophysiological and neuro-imaging techniques has contributed to the significant advances in the knowledge regarding hypnotic phenomena, including functional neuro-anatomy of neutral hypnosis. These techniques include electrophysiological studies (*e.g.,* bispectral analysis), neuroimaging (e.g*.,* single-photon emission computed tomography (SPECT), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET)), advanced neuro-imaging (*e.g.,* real-time fMRI and brain–computer interface), and neurofeedback [31].

EEG studies. Hypnotic states and hypnotic responding (including hypnotic analgesia) are frequently accompanied by an increase in the theta band power and changes in the gamma activity [14, 33]. These oscillations are thought to play a critical role in both recording and recall of declarative memory and emotional limbic circuits and are possibly the mechanistic link between theta (and perhaps gamma) oscillations and hypnosis. Theta oscillations, which are concomitant with the changes in gamma activity, may underlie and facilitate certain hypnotic responses. These findings appear to have important implications for understanding the effects of hypnosis as well as for enhancing the response to hypnotic treatments [33].

In addition to its contribution to validating and defining the state of trance, neuroscience has enabled differentiation between the altered states of consciousness and the ordinary states of consciousness. Bispectral electro-encephalographic analysis, a sophisticated and complex version of spectral analysis, has proved to be effective in differentiating between the subjects that are awake and the ones that are in trance, based on the bispectral (BIS) index [28].

Neuro-imaging studies. Several studies involving neuro-imaging (fMRI and PET) [28, 34-39] have contributed to creating a map of Regions of Interest (ROI) in the brain during 'neutral' or 'default' hypnosis (i.e., hypnosis in the absence of any specific suggestion), including the occipital cortex (the part of the brain involved in visualization processing, which is crucial for the induction and the experience of hypnosis), thalamus, anterior cingulate cortex (ACC), inferior parietal cortex, precuneus (part of the brain that normally mediates imagery and self-awareness) [36], and dorsolateral prefrontal cortex. Perhaps, soon the researchers would be able to sketch a 'Neurosignature' (functional neuro-anatomy) of hypnosis. Furthermore, findings of certain neuro-imaging studies suggest a potential anatomical (morphological and volumetric) basis for hypnotizability, linking variations in the rostrum of the corpus callosum to differences in the attentional and inhibitory processes [40].

4. Mechanisms underlying Hypnotic Analgesia

Hypnotic analgesia represents a significant paradigm of the manner in which neurophysiological and neuropsychological research has contributed decisively to a better understanding of the mechanisms underlying the multidimensional pain control in trance. Given the complex multidimensional nature of the pain experience, it is probable that hypnotic analgesia involves multiple mechanisms for pain modulation.

There is strong evidence suggesting a broader conceptual scheme, postulating that dynamically distributed processing in large-scale networks, possibly operating in parallel, might be integrating and causing modulation at different neural levels and sites of the pain experience.

The combination of all evidence suggests that the concurrent activation of this network of central and peripheral neural structures might constitute the "neurosignature" of the hypnotic pain modulation.

The research on the neurophysiological mechanisms underlying hypnotic analgesia has focused mainly on the peripheral and spinal mechanisms of nociception. However, the activation of these mechanisms is neither necessary nor sufficient to produce the perception of pain [41]. Pain is perceived when complex integrated cortical and subcortical (supraspinal) systems are engaged, with or without the presence of nociception, and it is possible to relieve the pain by disengaging

or interrupting these systems. As a consequence, the main mechanism underlying pain relief by means of hypnosis is a top–down rather than a bottom–up mechanism [34].

Although a number of supraspinal sites have been reported to be involved in the perception of pain, the most consistent areas identified across different imaging studies are the thalamus, the primary and the secondary somatosensory cortex (S1 and S2), the anterior cingulate cortex, the insula, and the prefrontal cortex [41, 42].

4.1 Supraspinal Mechanisms

EEG–ERP Studies. Evidence that the differences in attention levels may account for hypnotic depth and individual differences in hypnotizability has been provided with traditional EEG rhythms, event-related potentials, and 40 Hz and gamma EEG activity [18, 28, 33]. The alteration in stimulus perception may be a secondary effect with respect to the allocation of attentional resources.

There is increasing research demonstrating that the magnitudes of different brain oscillation patterns are associated with the response to hypnotic inductions and suggestions [33]. It has also been demonstrated that hypnosis is associated more with theta oscillations, while hypnotic responding has been demonstrated to be associated with changes in the patterns of gamma oscillations (with potential increases, decreases, or changes in the timing of gamma oscillations), depending on several factors including the suggestions provided [33].

Laser-evoked potential (LEP) experiments have demonstrated that hypnosis may significantly reduce pain and the LEP N2-P2 complex amplitudes compared to the control condition [43]. These findings corroborate the hypothesis that hypnosis inhibits afferent nociceptive transmission; the physiological mechanism underlying hypnosis may involve the influence of sub-cortical gating processes on the cortical activation, which underlies the decreased subjective pain perception and the LEP modulation reported by the subjects under hypnosis.

Valentini and co-workers [44] studied whether the hypnotic suggestion of sensory and affective hypoalgesia (down condition) or hyperalgesia (up condition) could differentially influence the subjective ratings of laser-induced pain and nociceptive-related brain activity in high and low hypnotically-suggestible individuals. The authors observed a significant hypnotic modulation of pain intensity and unpleasantness in the highly suggestible patients and P2 modulation in the up and down conditions, suggesting a top-down modulatory effect on both evoked and induced cortical brain responses induced by selective nociceptive laser inputs. These studies provided evidence in favor of higher efficacy of hypnotic analgesia in highly hypnotizable subjects in experimental pain, indicating that the “high hypnotizables” might possess an enhanced ability for focused attention (or dis-attention) to information and activity controlled by what is referred to as the pain matrix cerebral areas. The reduction in the N2-P2 complex upon hypnotic induction might have been a result of modulation of pain matrix activity, particularly that of the ACC (the brain area that plays a primary role in generating the vertex complex).

Taken together, these studies suggest that clinical hypnosis could play a key role in maximizing both behavioral and neurophysiological responses, as hypnosis is a cognitive phenomenon that affects central nociceptive processing. Furthermore, these studies are supportive of greater cognitive flexibility (*i.e.,* the subjective capacity to shift from one “state” to another) of the high hypnotizables compared to the low hypnotizables [28].

Neuro-imaging studies. Neuro-imaging techniques have contributed in a decisive manner to reveal the putative mechanisms of cognitive modulation of pain, including hypnotic analgesia. In a pioneer study using SPECT, De Benedittis & Longostrevi [45] observed a significant decrease in regional cerebral blood flow (rCBF) in the primary sensorimotor cortex (S1) during suggestions of hypnotic analgesia only in the highly hypnotizable subjects, which was possibly associated with selective neural inhibition.

The turning point in the field of neuro-imaging studies on hypnotic analgesia is represented by the pivotal studies conducted using PET by a Canadian team led by Pierre Rainville. The first one among these studies [46] demonstrated that hypnotic manipulation of the degree of negative affective resonance (unpleasantness) elicited by a nociceptive stimulation in a group of volunteers concomitantly induced corresponding changes in the activities of the brain structures (such as increased/reduced activation of the Anterior Cingulate Cortex, ACC) involved in the coding of motivational-affective component of pain. No change was observed in the activity of the primary sensorimotor cortex (S1), which is involved in the processing of sensory-discriminative component of the nociceptive stimulus. The extraordinary selectivity of hypnotic suggestion to differentially manipulate the two main components of the painful experience was documented in a pioneer study, which reported a marked linear correlation between the intensity of negative affective resonance, as suggested in the hypnosis, and the level of ACC activation. The study was followed by other research works by the same group as well as by Belgian researchers [38, 47], which corroborated and extended the results of the afore-stated study, suggesting that the ability of hypnosis to differentially modulate the different aspects of pain perception is not rigid, structural, and unidirectional, and rather dynamic and dependent on the structure and formulation of the hypnotic suggestions.

Brain imaging studies have also revealed increased activity in several regions of prefrontal cortices and the brain stem during hypnotic analgesia [38, 48]. Furthermore, increased connectivity between the ACC and the mesencephalon was observed in the peri-aqueductal grey (PAG) region [49]. This activation was consistent with the putative activation of the descending pathways involved in pain regulation.

In an fMRI study, painful stimulation in the normal alert state resulted in cerebral activation in a network encompassing cortical and subcortical areas of the brain (i.e., the ACC, premotor, dorsolateral, prefrontal, primary somatosensory and bilateral insular cortices, thalamus, bilateral striatum and brainstem, and the what is referred to as the Pain Matrix), while the same stimuli perceived under hypnosis failed to elicit any cerebral activation [30].

A review of functional neuro-imaging studies on pain perception during hypnosis [35, 50] indicated that hypnosis-induced modifications in pain perception are associated with functional changes in several ROIs, including the cingulate (mainly ACC) as well as the prefrontal, insular, and pregenual cortices, the thalamus, and the striatum. The ACC appears to be the key target in the process of reducing pain perception, regardless of the nociceptive stimulus applied, emphasizing the critical role of ACC in hypnosis-induced modification in the sensory, affective, behavioral, and cognitive aspects of nociception.

According to the theories of hypnosis, one characteristic of the hypnotic procedures is the inhibition of afferent nociceptive transmission. This inhibition may be explained by the dramatic decrease observed in the activity within the thalamus under hypnosis [49]. The thalamus has also been demonstrated to correlate with the pain perception threshold, while the activation of the

midline area (i.e., the posterior cingulate cortex) correlates with the intensity of stimulation and ACC with the unpleasantness of the stimulation [30].

It is becoming increasingly clear that hypnosis is able to effectively modulate not just the motivational-affective component of pain, rather also the sensory-discriminative one (which is further directly linked to the intensity of the nociceptive stimulation), although to a lesser extent. These findings confirm the great cognitive-perceptual flexibility mediated by trance, and would certainly exert a significant impact in the clinical context. The hypnotic modulation in pain intensity causes changes in pain-related activity mainly in the primary somatosensory cortex (S1), while the modulation of pain unpleasantness induces changes mainly in the anterior cingulate cortex (ACC), with the anterior (mid) cingulate cortex possibly modulating both sensory and affective components of pain [38, 51].

4.2 Spinal Mechanisms

Hypnotic analgesia may also be dependent on the activation of the descending inhibitory systems that specifically modulate the spinal transmission of the nociceptive input [52]. The involvement of these systems during hypnotic suggestions of analgesia was demonstrated in a few electrophysiological studies that reported that hypnosis leading to a significant reduction in the amplitude of the nociceptive flexion reflex (R-III), which is believed to be linearly correlated to the intensity of perceived pain [53, 54], and the effect was proportional to the extent of hypnotic suggestibility. There is limited knowledge regarding the details of these mechanisms, with the exception of the modification in synaptic transmission in spinal reflex pathways by descending signals from the brain, which is thought to be an important factor [18, 41, 55].

4.3 Autonomic and Peripheral Mechanisms

There is increasing evidence that in addition to spinal and supraspinal mechanisms, hypnosis also modulates the activity of the autonomic nervous system (ANS) and possibly the peripheral nervous system (PNS) as well. The sympatho-vagal interaction of the ANS during trance was investigated for the first time by De Benedittis *et al.* [56] through the spectral analysis of the heart rate variability signal (RR interval). The authors demonstrated that hypnosis modulates the RR interval by shifting the balance of the sympatho-vagal interaction toward an increased parasympathetic output, concomitant with a reduction in the sympathetic tone. The effect correlated positively with hypnotic susceptibility.

It has also been demonstrated [57] that the heat pain threshold assessed with thermal stimuli is significantly elevated during hypnosis, suggesting that hypnosis may down-regulate the neuronal inflow from the stimulation of A delta and C fibres. A recent study [58] assessed whether a focal glove hypnotic hand anesthesia could induce thermal changes within the area of hypnotic protection. There was a statistically significant difference in the temperature variation induced by the analgesic glove within the hand, wrist, and distal forearm on the glove side, compared to the proximal forearm and control side. Hypnotic glove analgesia provided significant changes in skin temperature within the protected areas.

In summary, the current evidence strongly supports the existence of multiple hierarchical pain-control systems during hypnotic suggestions of analgesia at different levels and sites within the nervous system [18, 23]. At the peripheral level, hypnosis may modulate the nociceptive input

by down-regulating the stimulation of A delta and C fibers and reducing the sympathetic arousal, which is relevant for inducing and maintaining certain chronic pain states. At the spinal level, hypnosis probably activates the descending inhibitory systems by reducing the nociceptive R-III reflex, parallel to self-reported reduction in pain. At the supraspinal cortical level, neuro-imaging and electrophysiological studies have demonstrated the ability of hypnotic suggestions of analgesia to directly and selectively modulate both sensory and affective dimensions of pain perception (the latter exhibiting greater significant reduction compared to pain). Furthermore, the highly hypnotizable subjects possess stronger attentional filtering abilities compared to the low hypnotizable subjects, and this greater cognitive flexibility might result in better focusing and diverting attention from the nociceptive stimulus as well as in better ignoring the irrelevant stimuli in the environment.

Neuropsychological mechanisms underlying hypnotic analgesia are possibly diverse, and include factors related to the reinterpretation of the meanings associated with pain as well as the factors related to the reduced pain intensity; the latter may result either from dissociative mechanisms or from the mechanisms associated with focusing on the alternative or reduced sensations. Certain factors, in turn, are accompanied by modulation at cortical levels, such as in the case of modulation in the activity within the ACC and not in the S1 cortex during the reinterpretation of meanings. Other factors relate to the endogenous circuitry that descends to the brain stem and spinal levels, inhibiting nociceptive transmission within the cells of origin of the ascending pathways and modulating motor and autonomic responses [59].

Taken together, these data support the notion that cognitive (hypnotic) modulation of pain causes dramatic alterations in the cortical Pain Matrix [18, 23]. This complex network may represent the 'Neurosignature' of the hypnotic modulation of pain (De Benedittis, 2003)[18]. However, hypnosis is not a panacea and is unlikely to serve as a stand-alone therapy in the treatment of a variety of chronic pain syndromes, including inflammatory and neuropathic pain. Given the multifactorial nature of chronic pain, a multimodal approach, which includes hypnosis as well as pharmacotherapy (such as NSAID, tricyclic antidepressants, and antiepileptic drugs), is often the preferred and the most appropriate treatment for pain control [22, 23].

4.4 *Hypnosis Modulates Empathy for Pain*

Brain responses to pain experienced by oneself vs. pain viewed in other people indicate consistent overlap in the pain processing network, particularly the anterior insula, thereby supporting the view that pain empathy relies partly on the neural processes engaged by self-nociception [60].

A recent study demonstrated that inducing analgesia through hypnosis leads to decreased responses to both self and vicarious experience of pain [60]. The activations in the right anterior insula and amygdala were markedly reduced when the participants received painful thermal stimuli following hypnotic analgesia on their hand, and also when they viewed pictures of others' hands in pain. Hypnotic modulation of pain responses was associated with differential recruitment of right prefrontal regions involved in selective attention and inhibitory control. These findings provided renewed support to the notion that self-nociception is involved during empathy for pain and demonstrated the potential of using hypnotic procedures for modulating higher-level emotional and social processes [60].

5. Conclusions

One of the oldest medical applications of hypnosis was pain control, the effectiveness of which, although known for quite some time now, has received indisputable confirmation at the level of evidence-based medicine quite recently. Increasing evidence has been suggesting that hypnosis could be effective in the down-modulation of pain sensation in both acute and chronic pain states. Hypnotic analgesia represents a significant paradigm of the manner in which neurophysiological and neuropsychological research has decisively contributed to a better understanding of the mechanisms underlying the multidimensional pain control in the state of trance.

Recent studies on hypnotic analgesia are rather convergent and strongly supportive of multiple hierarchical pain control systems during hypnotic suggestions of analgesia at different levels and sites within the nervous system, thereby providing a cognitive modulation of the Pain Matrix.

Author Contributions

GDB wrote the manuscript and reviewed the final manuscript.

Competing Interests

The Author has declared that no competing interests exist.

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Project Report

Feeling Safe during Intensive Care: Protocol of a Pilot Study on Therapeutic Suggestions of Safety under Hypnosis in Patients with Non-Invasive Ventilation

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Abstract

Patients in the intensive care unit are confronted with an extreme situation that may cause stress and anxiety. The negative experiences may cause patients to suffer for the long-term after leaving the intensive care unit. One such stressor in the intensive care unit is non-invasive ventilation. Positive therapeutic suggestions under hypnosis can help patients in intensive care to enhance their well-being by helping them to deal with specific stress like being ventilated. The aim of our study is to assess the effects of therapeutic suggestions of safety under hypnosis in patients on non-invasive ventilation during intensive care. We present a pre-post study design to evaluate the effects of standardized safety suggestions under hypnosis carried out in a face-to-face setting. We include non-invasively ventilated patients treated in the intensive care unit who must be able communicate and be oriented

toward all dimensions, i.e., person, place, time, and particularly, situation. Patients rate their subjective feelings of valence, arousal, anxiety, as well as the aversiveness of the breathing mask, before and after receiving therapeutic suggestions of safety under hypnosis. We further record physiological parameters like heart rate, blood pressure, breathing rate, and blood oxygen level before, during, and after providing the suggestions under hypnosis. We test the effectiveness of therapeutic suggestions of safety under hypnosis in non-invasively ventilated patients during treatment in the intensive care unit. Psychological interventions such as positive suggestions under hypnosis can help to reduce acute mental distress. Patients in intensive care are in an extreme situation accompanied by stress and anxiety and often suffer from negative long-term complications; therefore, our study addresses an existential need in critical care. We thus provide evidence that positive suggestions under hypnosis increase psychological well-being and reduce the impact of stressors, such as being ventilated in the intensive care unit.

Keywords
Intensive care unit; emotional well-being; non-invasive ventilation; safe place imagination; physiological parameters; therapeutic suggestions; hypnosis

1. Introduction

A patient in the intensive care unit often undergoes negative experiences like pain, fear of death, being dependent on strangers, and being in an unfamiliar environment that is incomprehensible [1]. Patients in the intensive care unit are thus in an extreme situation that causes symptoms of stress, anxiety, and depression [2]. Negative experiences in the intensive care unit can often lead to long-term negative consequences [3]. One of the specific stressors in the intensive care unit, often caused by medical treatment, is non-invasive mechanical ventilation, wherein the breathing mask is positioned over the patient's nose and mouth with considerable pressure. Non-invasive ventilation primarily supports breathing, but many patients perceive the breathing mask as very uncomfortable, threatening, and stressful [4]. Altogether, patients in the intensive care unit are confronted with a generally threatening situation and are additionally exposed to specific stressors like non-invasive ventilation. Figure 1 illustrates the patient's situation in the intensive care unit with non-invasive ventilation.

Figure 1 Illustration of a patient with non-invasive ventilation in the intensive care unit. Drawn by Sophie Elschner, https://sophssketchpad.wordpress.com/

The suggestion of a safe place is commonly made to reduce anxiety and stress [5]. Participants are told to imagine that they are in a safe place where they feel protected and calm. Evidence from hypnosis studies shows that being in a hypnotic state enhances the effects of suggestions [6]. Suggestions also work better when patients are highly suggestible. While suggestibility is a stable trait with considerable retest reliability [7], there are specific circumstances that increase suggestibility. For example, suggestibility increases in highly threatening and stressful situations [8]. As we indicated before, being in the intensive care unit is a highly threatening and stressful situation; therefore, we predict that these suggestions work very well in the intensive care unit. To achieve better results, we decided to present the suggestions after inducing a hypnotic state [6] and tested whether an intervention increases participants' general well-being and reduces the aversiveness of non-invasive ventilation. Developing such an intervention helps to improve patients' well-being immediately and prevents negative long-term consequences.

Therapeutic suggestions have positive effects on patients in the intensive care unit [9]. Previous studies demonstrated that after receiving positive therapeutic suggestions, patients could leave the intensive care unit sooner and got independent of mechanical ventilation faster [10, 11]. Moreover, patients took lower doses of benzodiazepines and opioids when they received positive therapeutic suggestions [12]. However, the existing studies focused primarily on objective medical recordings. In our study, we focus on subjective psychological outcomes like a decrease in anxiety and aversiveness ratings of the breathing mask.

We developed a suggestion text that addresses two issues. First, we include the suggestion of a safe place to induce a feeling of general well-being. Maslow [13] significantly pointed out that the need for safety is existential; therefore, we aimed at increasing the feeling of safety via our suggestion of a safe place during hypnosis. Second, we address the sensations accompanied by

non-invasive ventilation and suggest the comfort and helpfulness of the ventilation mask. We use hypnotic suggestions to increase immediate well-being and post-hypnotic suggestions to reduce the aversiveness of the breathing mask in future treatment.

In a pilot trial using a pre-post design, we measure the effectiveness of therapeutic suggestions of safety during hypnosis in non-invasively ventilated patients. To measure the effectiveness, we use subjective ratings of valence, arousal, anxiety, and aversiveness of the breathing mask. We also record physiological responses during the intervention.

2. Materials and Methods

2.1 Study Design and Setting

This study uses a pre-post design to evaluate the effects of intervention, including therapeutic suggestions of safety during hypnosis. Patients are recruited at the Jena University Hospital, Germany, and are contacted bed-side while being treated in the intensive care unit. The intervention is delivered by students supervised by the first author of this manuscript, who is trained in hypnosis and is a member of the Milton Erickson Society for Clinical Hypnosis.

2.2 Eligibility Criteria

We include adult (18+ years) patients who are treated in the intensive care unit and undergo non-invasive ventilation. As we want patients to indicate their subjective ratings, we only include patients who are able to communicate and who are fully oriented, as assessed via the Glasgow Coma Scale [14]. We select patients with a Glasgow Coma Scale score of at least 14. We exclude patients who get non-invasive ventilation for the first time as they cannot rate the aversiveness of the breathing mask before the intervention and patients who do not understand German or who are deaf.

2.3 Procedure

Before starting with our intervention, we ask patients about their current mood using the valence and arousal scales of the Self-Assessment Manikin [15]. We also measure their current state of anxiety using the Faces Anxiety Scale [16]. To assess the aversiveness of the breathing mask, we use a visual analog scale ranging from 9 (unpleasant and disturbing) to 1 (pleasant and supporting). We select patients who have problems with non-invasive ventilation, as indicated by an aversiveness pre-score of at least 3. To measure the physiological responses to our intervention, we use physiological parameters recorded in the intensive care unit by default, including heart rate, blood pressure, breathing rate, and blood oxygen level. To assess the timing of our intervention, we record a video with a monitor showing the patient's physiological responses and the voice of the hypnotist providing the intervention.

After the breathing mask is applied, we start with the intervention. The whole intervention takes nearly 15 min. Accordingly, our intervention targets non-invasive ventilation periods of about 15 min. First, we induce hypnosis. As there are several possible disturbing factors in the intensive care unit like people walking around and talking, unknown odors, and beeping noises from monitors, we include them in the hypnosis induction. For example, we tell patients that the beeping sounds indicate the presence of people around who take good care so that the patients

can relax completely. We tell patients to focus on their breathing and how the breathing mask helps them to breathe. At the end of the hypnosis induction, we count from one to ten and tell patients that with every number, they get deeper into the hypnotic state. Then, we suggest that the participants are at a safe place. We invite the patients to imagine a place where they had been earlier and felt well and safe. Next, we count from one to ten and tell the patients that they feel safer with every number. We then provide the post-hypnotic suggestion that the breathing mask feels helpful and that in the future, whenever they feel the pressure of the breathing mask again, they will experience the same feeling of safety like they are currently experiencing. This helps patients to transfer the feeling of safety in their daily treatment. Finally, we lead patients out of the hypnotic state by counting from ten to one and tell patients that with every number, they get back slowly into a normal waking state. To assess the effect of the intervention, we again ask the patients about their current state of valence and arousal, using the scale of Self-Assessment Manikin [15] and their current state of anxiety, using the Faces Anxiety Scale [16]. The patients rate the aversiveness of the breathing mask again on a visual analog scale ranging from 1 to 9.

2.4 Outcomes

Primary outcomes are patients' valence and arousal ratings, measured via the Self-Assessment Manikin [15] and patients' anxiety ratings, measured via the Faces Anxiety Scale [16]. Secondary outcomes are breathing mask aversiveness assessed via a visual analog scale and the physiological parameters, including heart rate, blood pressure, breathing rate, and blood oxygen level.

2.5 Sample Size

We estimated the effect size for the effect of hypnotic suggestions on subjective experiences in clinical settings based on a meta-analysis by Tefikow et al. [17] as Cohen's d = 0.5. We computed the necessary sample size to detect an effect of this size in a within-subjects design with alpha = 0.05 and statistical power of 0.9 using the program G*power [18]. The computed sample size was 36, so we plan to test 40 participants to account for possible drop-outs.

2.6 Data Analysis

Primary and secondary outcomes will be analyzed by statistically comparing pre- and post-measures. To analyze the physiological responses to our intervention, we will use the video that we recorded during the intervention and set event markers to assess how specific parts of the text affected patients' physiological parameters. Pre-post effects will be computed as standardized mean differences (Cohen´s *d*) with 95% confidence intervals.

2.7 Ethical Considerations

All eligible participants are informed verbally about the study aims, content, procedure, and duration. Participation is voluntary at any time, and the participants were informed about the same and the choice to interrupt or prematurely terminate study participation without giving reasons. We obtained ethical approval for our study from the ethics committee of the Friedrich-Schiller University, Jena, Germany (#2019–1463).

3. Expected Results

We expect more positive valence ratings and a decline in arousal ratings after the intervention. Further, we predict that anxiety ratings and aversiveness ratings of the breathing mask significantly decrease after the intervention. Considering the physiological parameters, we predict that heart rate, blood pressure, and breathing rate decrease due to the intervention. Overall, we expect that after the intervention, patients show better compliance, perceive the breathing mask as less disturbing, and show less anxiety on being ventilated.

4. Discussion

This study aims to provide the first evidence of a treatment approach particularly designed for patients experiencing stress during non-invasive mechanical ventilation in intensive care. Non-invasive ventilation is one of many stressors in intensive care because of the pressure of the breathing mask and the perceived lack of control, causing feelings of helplessness, anxiety, and discomfort [1, 2, 4]. We provide here an intervention using hypnosis that may help to increase patients' general well-being and also specifically help in improving the perception of non-invasive mechanical ventilation.

Our study is a pilot trial to assess the applicability and to provide the first evidence on treatment effects, and randomized-controlled studies will be needed in the future to test the efficacy of the intervention against a suitable control group in a sufficiently sized sample of patients. Our study is the first attempt to focus on patients' subjective well-being besides the objective medical parameters in a largely technological setting of intensive care. In order to prevent acute anxiety and stress as well as negative long-term consequences, it is necessary to focus on the psychological well-being of the patient in the intensive care unit. Therefore, our study addresses an existential need in critical care.

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Author Contributions

All authors wrote the paper.

Competing Interests

The authors have declared that no competing interests exist.

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Review

Recent Insight on How the Neuroscientific Approach Helps Clinicians

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Abstract

Hypnosis is a modified state of consciousness widely used to decrease pain perception in research protocols and clinical practice. In recent decades, hypnosis has been increasingly proposed to patients to re-engage their resources and capacities to modulate pain and emotional distress and to improve their treatment and recovery of well-being. Neuroimaging research helps clinicians to understand better how hypnosis works in terms of brain modulation. Hypnotic suggestions dramatically influence the self and environmental consciousness networks as well as the attentional and somatosensorial networks. This explains why the subjects feel disengaged from their external surroundings combined with the modification of sensations related to their body and spontaneous thoughts. In this review, we aim to articulate the clinical and neuroimaging findings related to hypnosis in the context of perception of external (pain) stimuli. We intend to shed light on several

mechanisms related to this specific modified state of consciousness that will help in designing randomized and controlled studies in the future.

Keywords
Hypnosis; fMRI; EEG; pain; clinical application

Recent Insight on How the Neuroscientific Approach Helps Clinicians

Hypnosis is a therapeutic technique and an active experience focused on the abilities of the patient. Hypnosis has three main components—absorption, dissociation, and suggestibility—that go beyond simple relaxation, coping strategies, or placebo effects [1]. It includes cognitive and behavioral components that allow patients to use their mind to influence their body sensations [2, 3]. Absorption, dissociation, and suggestibility form the basis for hypnotizability, i.e. the capacity of the patient to be immersed in a hypnotic environment. The therapist may suggest this environment, but a patient may also experience it during self-hypnosis without therapeutic intervention. Precisely, hypnotizability is defined as an individual's ability to experience suggested alterations in physiology, sensations, emotions, thoughts, or behavior during hypnosis [4]. In this article, we review the evidence of brain activity modulation during hypnosis and the growing interest of clinical studies interesting hypnosis to improv conditions of patients.

1. Hypnosis, a Non-Ordinary State of Consciousness

During hypnosis, people may experience a range of phenomena, including increased absorption and dissociation, as well as decreased self-agency and self-monitoring, reduced spontaneous thoughts, and a suspension of space and time orientation. In previous studies, we observed that participants reported greater dissociation and absorption and reduced spontaneous thoughts during hypnosis, when compared to normal wakefulness and mental imagery [5, 6]. Although hypnosis does not have a specific neural correlate, we can quantify its influences on brain activity in different ways [7]. First, the neural activity of the two main consciousness networks, self/internal and environmental/external, markedly changes during hypnosis. During the ordinary conscious state, there is a negative correlation between environmental and self-awareness subjective rate; additionally, there is brain activation related to these two types of awareness [8]. On the contrary, during hypnosis, subjects reported higher scores for self-awareness and lower scores for environmental awareness (Figure 1) [6]. Concerning neuroimaging, the neural counterpart of subjective modulation of feelings during hypnosis is still controversial and discussed among researchers. There is reduced functional connectivity in the external control network during hypnosis, linked to environmental awareness [5, 9]; however, modulation of the self/internal control network is less clear. Some authors have found reduced connectivity in the posterior midline and parahippocampal structures of the default mode network (DMN) involved in self-related processing, combined with increased connectivity in its lateral parietal and middle frontal cortex areas [5]. Others have reported increased activity in posterior regions of the DMN as well as decreased activity in its anterior areas [10, 11]. Finally, some have shown reduced connectivity in DMN and increased activity in attentional/extrinsic systems in lateral prefrontal

regions [12, 13]. Thus, there is a lack of clarity regarding the modulation of resting-state networks during hypnosis. Despite this, we can assume that hypnosis modifies the connection that an individual has with himself and all the surrounding components, by modulating self and environment awareness subjective and neural responses.

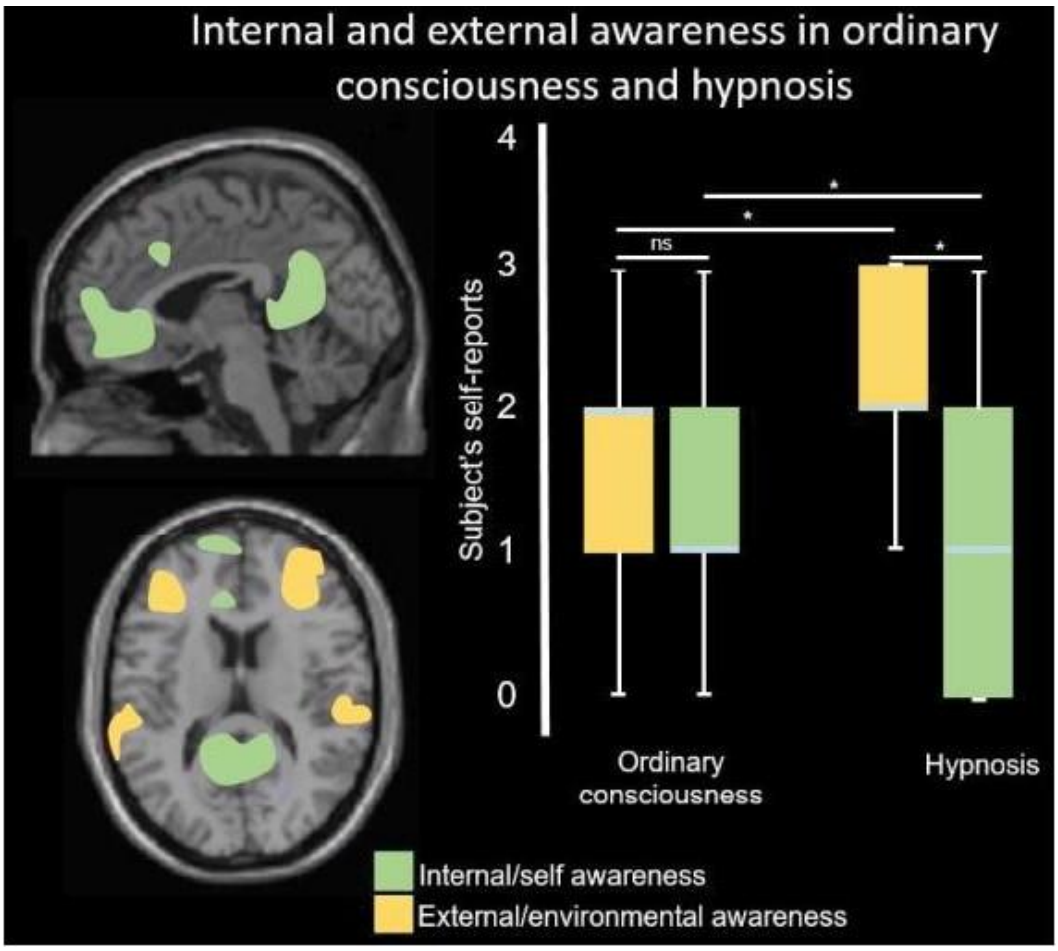

Figure 1 Neural correlates of the two components of consciousness, internal/self-awareness in green and external/environmental awareness in yellow, during the ordinary state of consciousness. The graph illustrates reports of subjects for internal/self and external/environmental awareness during ordinary consciousness and hypnotic states (bars represent medians). *: significant at $p < 0.001$, ns: not significant. This figure was adapted from Demertzi et al. and Vanhaudenhuyse et al. [6, 8].

Researchers have used functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and event-related potential (ERP) studies to decode cognitive processes under hypnosis. EEG reports are inconsistent, making it difficult to conclude a single EEG signature of hypnosis (EEG rythms in ordinary consciousness are illustrated in Figure 2). Some studies reported an increase in alpha rhythms and theta activity, while others have found a decrease in theta activity during hypnosis (for a review, see [14]). An EEG case study on a highly hypnotizable subject reported specific decreases in beta, delta, and gamma amplitudes. This indicates increased independence of brain processes to maintain a state of alertness. The same study also reported an increase in theta and alpha amplitudes, mostly in occipital areas, reflecting the intensification of attentional

processes [14]. The authors hypothesized that the subject could be in a relaxed state during hypnosis, along with a state that facilitated information processing. Others reported an increase in alpha activity, consistent with enhanced relaxation, and a reduction in visual activity, specific to the hypnotic state [15]. Some studies demonstrated a reduction in the ERP response during the hypnotic procedure, suggesting diminution of perception of stimuli, whereas other studies failed to detect such changes in ERP responses [1, 16].

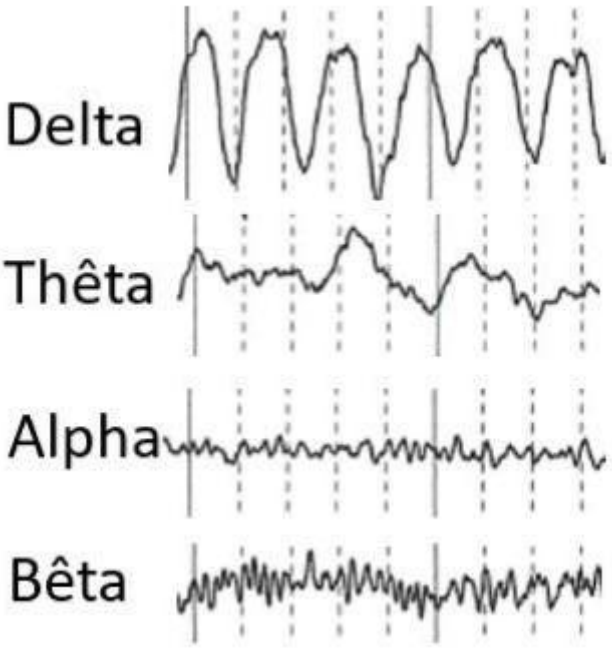

Figure 2 Illustrative examples of EEG rhythms.

The efforts to understand hypnotic phenomena usually contrast with the responses across the levels of hypnotic susceptibility, also called hypnotizability. Hypnotizability is the individual's ability to experience suggested alterations in physiology, sensations, emotions, thoughts, or behavior during hypnosis [17]. It ranges from low to high, depending on the recruitment of attentional networks [18]. It is usually assessed by a protocol encompassing induction and suggestion, followed by evaluation of the number of suggestions an individual successfully experiences and reports after the hypnotic induction procedure [19]. Recently, we reported that it is possible to identify low and highly hypnotizable subjects, without any specific suggestion (i.e., neutral hypnosis). We achieved this by considering the dissociation score in the same way that is categorized by a traditional standardized scale [20]. Some authors demonstrated that training in self-hypnosis, relaxation, or neurofeedback improves the level of hypnotizability [21]. Structural MRI studies have revealed anatomical differences in brain structure size in frontal areas between low and highly hypnotizable subjects [22, 23]. Additionally, they revealed a larger rostrum of the corpus callosum in highly hypnotizable subjects than in subjects with low hypnotizability [24]. The corpus callosum is involved in the allocation of attention and transfer of information between prefrontal cortices. Therefore, the authors suggested that highly hypnotizable subjects might have more effective frontal attentional systems that implement control, monitor performance, and inhibit unwanted stimuli from conscious awareness [24]. However, this claim needs to be

confirmed by other studies. One study reported greater grey matter volume in the medial frontal cortex and anterior cingulate cortex (ACC) combined with lower connectivity in the DMN during hypnosis. They hypothesized these to facilitate greater hypnotic depth [23]. In addition to these structural findings, a functional MRI study revealed differential processing between low and highly hypnotizable subjects. First, in contrast to the low hypnotizable subjects, those with high hypnotizability seemed to have greater functional connectivity between the left dorsolateral prefrontal cortex and the salience network; the former is involved in executive control processing, and the latter is involved in detecting, integrating, and filtering relevant somatic and emotional information [25]. However, this study lacks congruence in coupling executive and salience networks with structural correspondences in highly hypnotizable subjects [25]. Hypnotizability is positively correlated with functional connectivity between the posterior cingulate cortex and precuneus, and both the lateral visual network and the left frontoparietal network [22]. A positive correlation also exists between the executive control network and the right postcentral parietal cortex [22]. A negative correlation exists between the right frontoparietal network and the right lateral thalamus [22]. Other studies showed that the highly hypnotizable subjects recruited more of their right inferior frontal gyrus, whereas the low hypnotizable subjects recruited of their parietal cortex and ACC, during selective attention conditions (even outside of hypnosis). These regions are more connected to the DMN in highly hypnotizable subjects [18]. Based on these results, the authors hypothesized a close dialogue between internally and externally driven processes that may permit higher flexibility in attention and underlie a greater ability to dissociate in those individuals. Finally, Egner et al. displayed that highly hypnotizable subjects are characterized by an increased ACC activation during a congruent/incongruent attentional task, after a hypnotic induction [26]. They suggested that these results indicated an alteration in the attentional efficiency of their subjects as compared to baseline and low hypnotizable subjects.

Studies have revealed higher theta power in highly hypnotizable subjects, especially in the frontal and temporal areas [15, 27] as well as in the left parietal and occipital regions [28]. Also, highly hypnotizable subjects showed a significant difference in the EEG phase synchronization in the delta, theta, and beta bands (mostly in the frontal lobe), compared to medium or low hypnotizable subjects [29]. Mismatch negativity (MMN) is a negative component of ERP elicited by any change or 'mismatch' in the sequence of monotonous auditory stimuli in inattentive subjects. Studies have used MMN to evaluate the attention deficit toward auditory stimuli during hypnosis. MMN was larger in hypnosis compared to the baseline condition, reflecting enhancement of pre-attentive processing related to hypnosis condition [30, 31]. However, it was also larger in subjects with low hypnotizability, suggesting that MMN could not be attributed to distinctive hypnotic processes, despite its relation to the hypnosis condition [30]. These results can be discussed with the findings where MMN amplitude decreased only in the highly hypnotizable subjects during amusia hypnotic suggestions (i.e., inability to recognize melodies or rhythms), whereas subjects with low hypnotizability displayed no difference [32]. Others found no evidence for the effect of hypnosis on MMN amplitude in highly hypnotizable subjects [33]. The hypnotic suggestion of alexia (i.e., incapacity to read, as measured with a Stroop task) modulated the late positive complex amplitude. This amplitude was greater for congruent conditions (e.g., the word "yellow" inked in yellow) than incongruent conditions (e.g., the word "blue" inked in green) in subjects with high hypnotizability [34]. Altogether, these results show that hypnosis somehow modulates attentive auditory and visual mechanisms. However, some discrepancies appear

between studies, and we need to interpret the results carefully since the number of subjects included is limited. Finally, the application of low frequency repetitive transcranial magnetic stimulation (rTMS) to the left dorsolateral prefrontal cortex enhanced subjective response to hypnotic suggestions, supporting theories postulating that diminished function in the frontal cortex is related to hypnotic response [35].

Theories about hypnosis are usually related to top-down processes and self-related mechanisms of modulation. Landry, Lifshitz, and Raz [36] proposed a meta-analysis that details processes related to these theories and gives a unique explanation of hypnosis brain mechanisms that remain challenging. However, most studies reported the involvement of the insula, ACC (involved in the salience network), prefrontal, posterior parietal areas (involved in the central executive network), medial prefrontal and lateral parietal cortices, midline structures, and parahippocampal areas (involved in the DMN). According to the authors, modulation of these brain areas is related to several processes observed during hypnosis—(a) focused attention on suggestions and absorption possibly allowing subjects to develop vivid imaginary experiences, (b) modification of sense of control related to automaticity, (c) integration of internal and external information resulting in modulation of self and environmental awareness, and (d) decrease of mind-wandering.

2. Hypnosis in Medicine and Surgery: the Origins of Interest in a Neuroscientific Approach

2.1 Hypnosis as a Support for Sedation

The development of hypnosis as a scientific endeavor has occurred within the last two centuries. The documented use of hypnosis as an adjunct to surgery dates back to the 1830s; Jules Cloquet performed a mastectomy, and John Elliotson performed major surgical procedures with hypnosis as the only anesthetic technique. James Esdaile, a famous surgeon, worked in India and published more than 300 major surgical cases under hypnosis. He observed that the use of "mesmerism anesthesia" decreased surgical shock, improved morbidity, and decreased the mortality rate during surgery from 40% to merely 5% [37]. The medical establishment showed a great deal of hostility toward this promising surgical approach, censuring it. Almost simultaneous to Esdaile's reports, the discovery of ether in 1846 and chloroform in 1847 suppressed the interest in psychological mechanisms of pain reduction as well as in utilizing the patient's abilities as an influencing factor in recovery. Hypnosis subsequently became discredited, whereas inhaled anesthetic agents were rapidly adopted. During the 19th century, Carpenter and Tuke were among the first to draw attention to the mind's ability to interact with the body and to alter perceptions and feelings. Likewise, Moll and Forel argued that hypnosis had important medical and therapeutic applications [38]. Since the end of World War II, interest in the clinical application of hypnosis has been waxing and waning. It was used sporadically as a complementary technique rather than an alternative to general anesthesia. Anesthesiologists paid little attention to hypnosis until 1955, when the British Medical Association accepted hypnosis in the management of acute pain [39].

More recently, there is a renewed interest in hypnosis due to the trend toward greater prominence of conscious sedation during surgery. Several studies have described the effects of hypnosis during surgery. It may be used more often in conjunction with local anesthesia and analgesics. The usefulness of hypnosis in the relief of pain was demonstrated early in the 19th century before the introduction of chemical anesthetics. Major operations, often limb

amputations, were performed painlessly with "a mesmeric trance" as the only anesthetic; the term "hypnosis" was introduced later [37]. Since 1992, hypnosedation has been used to perform surgeries in Liège, Belgium. Hypnosedation is a technique combining hypnosis with light conscious intravenous sedation and local anesthetic drug [40]. The University Hospital of Liège was a pioneer in elaborating retrospective and prospective randomized studies comparing general anesthesia and hypnosedation in a surgical setting [40–46]. Firstly, it is important to note that hypnosis should be considered as a tool to be used with discrimination in surgical settings, only when circumstances are appropriate. The exclusion criteria for hypnosedation are psychopathology, deafness, and allergies to local anesthetics. Adherence and motivation of the patient, surgeon, and all the medical staff present during the surgery are also of the highest importance for this procedure. Hypnosedation can be used in various situations—thyroid surgery, endovascular procedures, breast and prostate biopsy, colectomy, hysteroscopic placement of implants for sterilization, tooth extraction, skin tumor removal, childbirth, glioma surgery, and burn dressing changes [9]. This technique is associated with improved peri- and post-operative comfort as well as with better conditions during the performance of surgery compared to general anesthesia. Studies revealed that hypnosedation is associated with reduced anxiety, emotional distress, pain, and nausea, as well as diminished intraoperative requirements for anxiolytic and analgesic drugs. Some authors also demonstrated a faster recovery with a significant decrease in the delay before restarting professional activity [42]. A recent study highlighted that prostate cancer patients receiving brachytherapy under hypnosedation reported reduced need for medication, shorter duration of urinary catheter use, and quicker recovery compared to patients receiving the therapy under general anesthesia [47]. In addition, a non-randomized study showed the potential benefits of hypnosedation on post-mastectomy chronic pain [48]. Meta-analysis highlighted several benefits of hypnosis in surgery. It was an effective adjunctive technique for a wide variety of surgical procedures. The patients in hypnosis groups had better outcomes than other patients. There were no differences between the methods of hypnotic induction. Positive effects were observed for emotional distress and medication consumption [49, 50]. In addition, a hypnotic suggestion for pain relief was equally effective in reducing pain in both, clinical and experimental setups. Therefore, it may be an effective and safe alternative to pharmacological intervention [51, 52]. Finally, a recent meta-analysis highlighted the analgesic effect of hypnosis for acute pain perception, efficacy modulation due to the subject's hypnotic suggestibility as well as the use of direct analgesic suggestion. It also revealed that hypnotic intervention could deliver meaningful pain relief for most people and may be an effective and safe alternative to pharmacological intervention [52].

2.2 Hypnosis during Childbirth and Labor

The history of hypnosis in the clinical setting is notable for its early adoption in procedures relating to childbirth. The 20th century witnessed several such case reports in Europe, peaking in the 1950s. In this context, hypnotic suggestions focused on increasing feelings of safety, relaxation, and comfort, reframing the experience from one of pain to one of achievement, and potentially developing sensations of anesthesia such as numbing [53]. However, improvements in pharmacological analgesia in obstetric care in the 1960s led to the decline of hypnosis. Fortunately, in the past decades, various complementary medicines, including hypnosis, have gained renewed

popularity for assisting women during labor and childbirth [54]. Hypnosis assisted women in coping with physical and psychological symptoms during pregnancy, labor, and the postpartum period. In particular, it can lead to decreased nausea and hyperemesis gravidarum, reduced epidural and surgical intervention, pain relief, shorter length of labor, increased postpartum psychological well-being, and decreased postpartum depression [55]. A randomized controlled study conducted on over 1000 women demonstrated a significantly better childbirth experience, including decreased pain, in women who learned self-hypnosis compared to groups undergoing relaxation and standard care [56]. During pregnancy, hypnosis aided to reduce stress, anxiety, depressive symptoms, and nausea and vomiting [55, 57, 58]. These studies highlight that non-pharmacological approaches, such as hypnosis, can facilitate enhanced feelings of satisfaction, competence, and control in women. A meta-analysis of randomized trials with a total of 2954 women showed that hypnosis may reduce the overall use of analgesia during labor, but not epidural use. Also, it did not find clear differences between women using hypnosis and those who did not with respect to satisfaction with pain relief and a sense of coping with labor or birth [54].

2.3 Hypnosis to Relieve Pain in Severely Burned Patients

Hypnosis has also significantly benefited patients with severe burns in the alleviation of pain and anxiety, particularly during care procedures (i.e., removal of dressings, washing, debridement, and application of new dressings) [59]. While pharmacological approaches are recommended as a first-line treatment for procedural pain, studies reported that some patients did not benefit from medication or still experienced significant pain despite medication use [60]. Studies demonstrated that pain and anxiety perception decreased during dressing changes when hypnosis was used in adult and pediatric patients [61, 62]. A recent randomized, double-blind, controlled study evaluated the efficacy of hypnosis in significantly reducing the quality of background pain (i.e., burning or throbbing discomforts which affect patients daily while resting) and pain anxiety (i.e., pain-related anticipatory anxiety) in burned patients [63]. When integrated into their pain management procedures, hypnosis also improved opioid efficacy and wound outcomes of burned patients, while reducing hospital costs [64]. In addition, the integration of this technique in care significantly reduced the stress of nurses, when facing patients who are in pain, disoriented, agitated, and anxious during post-burn care [65].

2.4 Hypnosis to Manage Chronic Pain

Hypnosis may be effective in reducing short- and long-term headaches in migraine sufferers [66]. In addition, self-hypnosis combined with self-care activities may benefit chronic pain patients, in a variety of biological, psychological, and social dimensions. When compared with physiotherapy or psychoeducation treatments, six sessions of self-hypnosis/self-care treatment decreased pain intensity, pain interference, anxiety, and depression with an improved quality of life [67]. Self-hypnosis/self-care intervention in chronic pain patients led to significant modifications in coping strategies due to the observed benefits [68]. A meta-analysis focused on hypnosis effect in fibromyalgia (6 controlled trials; 239 patients) concluded that hypnosis is effective in relieving both pain and sleep problems [69]. Another meta-analysis (12 clinical studies; 669 patients) revealed that hypnosis is moderately more efficacious than standard care or psychological intervention, specifically for adult patients not suffering from headaches [70].

2.5 Hypnosis in Oncology

In 2017, a meta-analysis concluded that hypnosis was not rigorously studied with randomized, controlled trials in oncology [71]. This pushed some researchers to conduct robust studies to assess the potential of hypnosis in this particular clinical context. Initial studies in oncological patients showed that hypnosis is more efficient in relieving pain than other interventions, such as yoga or cognitive-behavioral therapy [72–74]. Hypnosis in oncology has also shown efficacy in helping patients to cope with sleep disturbances and management of stress, anxiety, and grief [75]. Besides, the gender of patients could influence these positive effects, although these observations need to be tested on a larger population [76]. Finally, a recent pilot study demonstrated the feasibility and personal interest in learning self-hypnosis for children with cancer and their parents [77].

2.6 Hypnosis and Dental Care

The field of dentistry showed an increased interest in the hypnosis much later. The technique can be used to reduce anxiety in phobic patients as well as to reduce pain and anxiety during dental surgery. Case reports and controlled studies have displayed several positive effects of hypnosis in dentistry—prevention of avoidance behavior and lack of dental treatment, reduction of extreme fear, anxiety, and pain, reduction in bleeding during tooth extractions, and more effective healing of wounds [78–81].

There are a plethora of clinical reports on the beneficial effects of hypnosis on patients. Despite this, scientists need neurophysiological studies to shed light on the central mechanisms of hypnosis. In the further sections, we summarize the literature to explain how this modified state of consciousness allows individuals to modify their perception of external stimuli.

3. Hypnosis to Alleviate Acute Pain—A Neurological Perspective

Improvements in functional neuroimaging have allowed researchers to articulate objective evidence of hypnotic procedures to reduce pain. Painful stimuli activate several brain regions called the pain matrix—the primary (S1) and secondary (S2) somatosensory cortices, the insular cortex (IC), the ACC, and thalamic nuclei—modulating the perception of pain [82]. There are numerous, widely heterogeneous ways to study pain reduction during hypnosis. Methods used to produce painful simulation include high temperature, laser, and nerve stimulation; methodologies used include positron emission tomography (PET) and fMRI; protocols employed are presence or absence of baseline, a hypnotic suggestion for increased or decreased pain, and mental imagery. Various studies have proven that hypnosis has a direct effect on the pain neuromatrix. Painful stimulation in a normal, alert state resulted in brain activation within a network encompassing cortical and subcortical brain areas, namely, ACC, premotor, dorsolateral, prefrontal, primary somatosensory and bilateral insular cortices, thalamus, bilateral striatum, and brainstem. However, the same painful stimulus perceived under hypnosis failed to elicit any cerebral activation [83]. The modulatory effect of hypnosis was shown to be mediated by an increased modulation of the ACC and a cortical and subcortical network, encompassing prefrontal/superior frontal gyrus, insular, and pregenual cortices, pre-SMA, thalami, striatum and brainstem in the context of hypnosis [84–87] (Figure 3). In addition, there exists a hypnosis-related increase in functional connectivity

between the primary somatosensory cortex (S1) and the anterior insular and prefrontal cortices [83]. Other studies reported that only specific suggestions of increased or decreased unpleasantness changed the pain ratings, in association with modulation of the ACC activity and modulation of pain unpleasantness [86]. A meta-analysis of functional neuroimaging studies of pain perception under hypnosis identified that analgesic suggestion is associated with an increase in the activation of right lateralization in the ACC and insula and a decrease in the midline thalamic nuclei [88]. Using specific hypnotic-focused analgesia (i.e., local analgesia produced during deep hypnosis by focusing attention on a mental image of the absence of pain [89]), a recent study showed that during hypnosis the sensory component of pain (related to S1, S2, insula, and parietal operculum) was reduced more than the affective component (related to ACC, amygdala, hippocampus, hypothalamus and temporal cortex)[89]. Other studies demonstrated additional effects of hypnosis modulation on the affective component of pain. This discrepancy could be explained by the script used for the suggestions of analgesia. Conversely, other studies showed that suggesting painfulness in the absence of actual pain stimulation activates brain areas associated with activation of the brain's pain circuit, similar to real pain stimulation [90, 91].

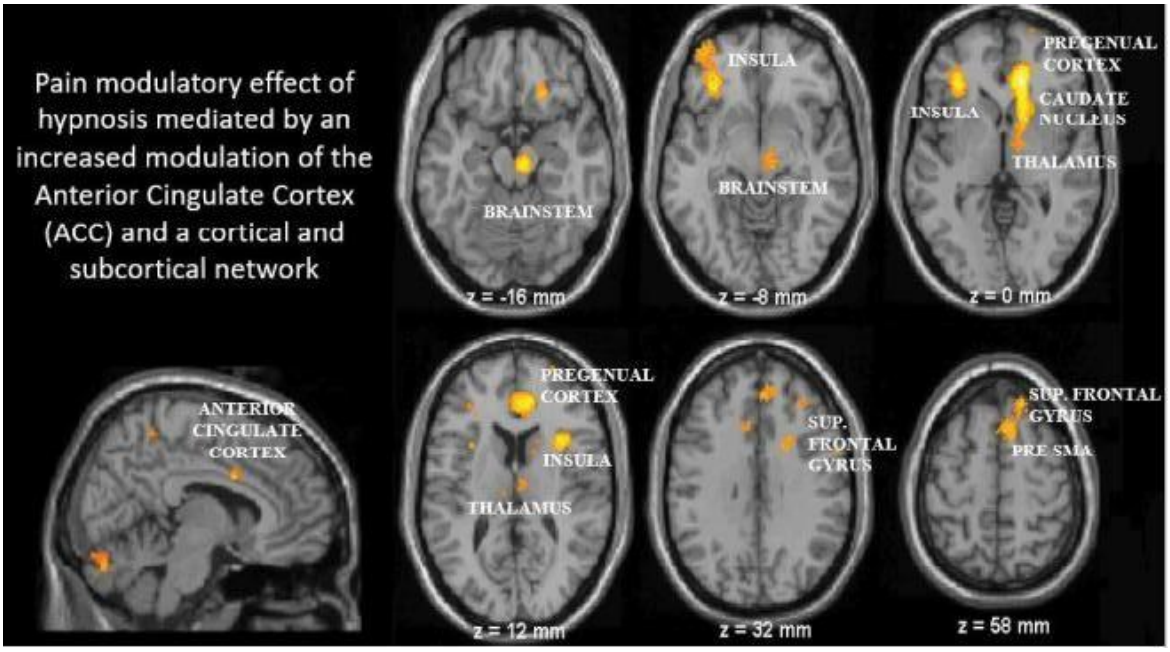

Figure 3 The pain modulatory effect of hypnosis is mediated by an increased modulation of the anterior cingulate cortex and a cortical and subcortical network, encompassing the prefrontal/superior frontal gyrus, insular, and pregenual cortices, pre-supplementary motor area (pre-SMA), thalami, caudate nucleus, and brainstem. This figure was adapted from an earlier study [92].

Pain modulation during hypnosis can be understood concerning the specific role of some brain areas involved in pain perception processing. Firstly, studies have shown that the ACC is related to coding of the intensity of noxious stimulation, opposing pain/avoidance and reward/approach functions, somatosensory processing, fear, and the anticipation of pain [7]. Secondly, there is reported increased functional connectivity during hypnosis between the mid-cingulate cortex, thalamus, and brainstem [87, 93]. This might be related to pain-relevant arousal or attention

mechanisms. Thirdly, the reported decreases in premotor cortex activation in hypnosis suggests that hypnosis may diminish anxiety, defensive, and emotional reactions to pain by reducing activation of both cortical and subcortical areas [94]. Besides, the increased modulation of activity in the insula is related to its role in the pain affect and pain intensity coding [95]. Finally, frontal activity modulation may reflect disruption in the cognitive attentional, appraisal, and memory systems that can influence the perception of environmental stimulation during hypnosis [83, 84].

EEG and ERP studies are key to understand sensorial and pain processing during hypnosis. They allow recording of the fast succession of brain events associated with the administration of sensory stimuli. A study tested whether hypnosis affects the early (sensory processing) or the later (affective integration) stages of sensorial processing. The researchers found reduced activity of the early (N20) and the late (P100, P150, P250) components in brain areas including S1 (N20), S2 (P100), right anterior insula (P150), and cingulate cortex (P150/P250) [96]. They suggested that hypnosis modulation of pain perception is reflected in both, somatosensorial processing with decreases in N20 (i.e., first stages of pain cerebral processing) and affective and conscious processing with decreases in P150 (related to somatosensory conscious perception), P100 (prerequisite for consciousness) and P250 (later stage of somatosensory perception associated with the affective integration of the stimulation). Other studies also reported a decrease in amplitude for the P250 component during hypnosis and painful stimulation [97]. Another study showed that a hypoalgesic hypnotic suggestion induced a decrease in amplitude in highly hypnotizable subjects. Similarly, it reported an increase in amplitude by a hyperalgesic suggestion of both, N140 (mainly in left frontal and frontocentral areas) and P200 (left frontocentral, central, and bilateral centroparietal and parietal areas) waves [98]. These results could be explained by an enhanced capacity of subjects to focus their attention to form the mental images designed to reduce/amplify pain sensations during hypo/hyperalgesia. Finally, magnetoencephalography (MEG) during hypnosis revealed a reduction of activity in the beta band around 214–413 ms post non-painful stimulus mainly in the right insula, combined with a reduction in the alpha band around 253–500 ms in the left inferior frontal gyrus [99].

Regarding hypnosis for pain modulation, higher hypnotic suggestibility correlated with greater relief from hypnotic intervention. Although, subjects with medium suggestibility also obtained significant relief from hypnosis [100]. We need to note that only 20–30% of individuals score either high or low in hypnotizability [36]. Thus, high hypnotic suggestibility is not necessary for successful hypnotic pain intervention.

Together, these results may indicate that brain modulation reported during hypnosis could reflect an alteration of afferent somatic perceptions in the process of cognitive-based pain control. They also suggest that highly hypnotizable subjects may have a specific capacity to enhance disengagement regarding sensorial information.

4. Neuroimaging to Explain the Clinical Benefits in Patients

A growing body of literature is focusing on the brain activity counterparts to clinical reports of patients who benefited from hypnosis. As discussed earlier, patients with different etiologies reported subjective positive effects of hypnosis. PET studies in chronic pain patients under hypnosis reported modulation of activity in the bilateral cingulate gyrus, right thalamus, left inferior parietal cortex, bilateral PCC, anterior cingulate gyrus, and insula [101, 102]. An fMRI study

in fibromyalgia patients highlighted greater activation in the cerebellum, anterior ACC, anterior and posterior insula, and inferior parietal cortex correlating with reported changes in pain after hypnotic suggestions [103]. A similar study in patients with temporomandibular disorder reported activation in the posterior insula related to hypnotic suggestions of pain reduction [104]. With a hypnotic suggestion, pain matrix activation decreased in fibromyalgia patients similar to healthy control subjects [105]. ERP studies illustrated how hypnosis modulates brain function in chronic pain patients. First, in chronic pain patients under hypnosis, the differences in ratings of pain intensity and unpleasantness were accompanied by decreased N2–P2 components [106]. A pilot study in multiple sclerosis patients with chronic pain supported an interest in additional techniques to enhance responses to hypnosis treatment. This was in addition to the enhanced benefits of hypnosis treatments observed with neurofeedback and mindfulness on subjective variables, such as pain intensity, pain interference, pain acceptance, sleep, and depression. Hypnosis, combined with other techniques, impacted the EEG brain responses, mostly delta, theta, beta, and gamma rhythms [107]. Some authors proposed to study electrical brain activity before hypnotic treatment to predict its usefulness in modulating pain in spinal cord injury patients. Theta activity immediately before treatment was positively associated with response to hypnosis, with higher levels of it prospectively predicting subsequent pain reduction with the hypnosis procedure [108]. These results have implications for enhancing response to pain treatment by either better patient/treatment matching or influencing brain activity before treatment.

Few neuroimaging studies have been conducted with other populations of patients. People who suffer from dental phobia display symptoms that make dental treatments difficult or impossible; hypnosis is, therefore, used as an alternative intervention. An fMRI study reported that during hypnosis, dental phobia patients showed a significantly reduced activation in the left amygdala, bilateral ACC, insula, and hippocampus (involved in fear processing) [109]. Researchers observed patients undergoing a mastectomy and sentinel node biopsy with a combination of self-hypnosis and local sedation (i.e., hypnosedation). They reported complex changes in brain electrical activity measured with the bispectral index (BIS) [110] and an increased EEG activity in occipital regions related to visual imagery [111].

5. Conclusion

In the context of clinical practice, there is growing evidence of interest in hypnosis for pain management in various populations of patients. Although higher hypnotic suggestibility correlates with greater pain relief, people with medium suggestibility also manage pain better through hypnosis. Regarding the small proportion of the population (20–30%) considered having low suggestibility, there are no guidelines suggesting a clear strategy to be adopted. In our clinical experience, we never test hypnotizability before practicing hypnosis in either surgical contexts or the management of chronic diseases. Thus, we conclude that even low hypnotizable patients can gain benefits from hypnosis. The specific context of surgery allows anesthesiologists to increase the comfort of patients by administrating intravenous analgesic drugs in addition to hypnosis suggestion. Until now, no one has investigated whether low hypnotizable patients require increased analgesic drugs. However, additional non-pharmacological techniques, such as hypnosis combined with virtual reality, could potentially improve the efficacy of hypnosis for such patients. Studies are needed to validate this hypothesis in clinical practice. Neuroimaging research

drastically increases our understanding of how hypnosis modulates pain and emotional distress in these patients. Hypnosis modifies brain activation as well as brain functional networks. These networks may be involved in self and environmental awareness (DMN and external control network), attentional processing (dorsolateral prefrontal cortex), anxiety processing (amygdala), and sensorial external stimulation (somatosensorial cortices, insula, ACC). These observations may be the first pieces of a rather intricate puzzle of the complex mind-body relationship mechanisms. Through these first studies, hypnosis has acquired a legitimate position in academic and medical fields, as a recognized modified state of consciousness with a specific, complex neural signature. Future research should explore more robust studies designed with randomized and controlled paradigms on larger cohorts to characterize the complexity of this social, cognitive, neurobiological, and interpersonal state of consciousness and its clinical applications.

Finally, a few clinical studies have assessed the effects of the type of hypnotic suggestion on the subjective feelings of individuals. One study reported that hypnosis combined with analgesia suggestion was more effective than hypnosis combined with relaxation suggestions in decreasing pain in 45 chronic pain patients [112]. Globally, positive suggestion to improve comfort leads to decrease in pain [113]. But, we still need comparative studies on large cohorts of patients to clarify which suggestions are more effective than others in the clinical context. Notably, some experimental studies conducted with healthy subjects demonstrated that the type of suggestion could differently affect pain perception [95, 114]. Also, the current research lacks consistent testing of the effects of hypnosis on resting-stage brain networks. Some researchers used pleasant autobiographical memories as a hypnotic suggestion [5, 115], while another used neutral hypnosis [10]. Thus, research in hypnosis lacks rigorous studies using large samples and randomized, controlled designs. Studies of this kind, comparing different types of hypnotic suggestions, would help us understand how different types of suggestions affect the global consciousness status, subjective reports, and pain perception in healthy volunteers and patients.

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Author Contributions

A.V. wrote the manuscript. M-E.F. and A-S.N. reviewed the reviewed the manuscript and contributed to the editing of the manuscript.

Competing Interests

The authors have declared that no competing interests exist.

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Original Research

Hypnotic Responsiveness and Dissociation: A Multi-Variable Analysis

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Abstract

Since Charcot [1], researchers and theorists have associated hypnotic responsiveness with dissociation. However, contemporary researchers have typically not documented impressive or statistically significant correlations between the most commonly used measure of dissociation, the Dissociative Experiences Scale-II [2, 3] and hypnotic responsiveness. We examined the ability of two measures of non-pathological dissociation, which have received scant attention in the hypnosis literature, the Wessex Dissociation Scale (WDS; [4]) and the Dissociative Processes Scale (DPS; [5]), in the context of a broader investigation of predictors of hypnotic responsiveness including expectancies, fantasy-proneness, absorption, and an index of more serious dissociative experiences and symptoms in a sample of undergraduate students. Scales of non-pathological dissociation and most measures of pathological dissociation did not correlate significantly with hypnotic responsiveness; however, stepwise regression analyses predicting HGSHS:A behavioral and subjective scores retained the Detachment factor of the DPS in the final model, along with expectancies and absorption. We present our findings in the context of a broader discussion of dissociation and hypnosis.

Keywords
Hypnosis; dissociation; Wessex Dissociation Scale; Dissociative Processes Scale

1. Introduction

Dissociation has been characterized as a “disruption in the usually integrated functions of consciousness, memory, identity, or perception of the environment” (DSM-5; [6]). Dissociation occurs in everyday life and may be as prosaic as intense absorption in everyday experiences, such as appreciating the beauty of a sunset, or in cases of "highway hypnosis," in which attention is focused, often to the exclusion of one's surroundings and minimal, if any, attention is devoted to behavioral enactments while behaviors unfold in a seemingly automatic fashion [7, 8]. Apart from these normative experiences, dissociation can be manifested in serious dissociative symptoms in dissociative disorders, such as depersonalization/derealization disorder, dissociative amnesia, and dissociative identity disorder (formerly multiple personality disorder).

Since Charcot [1], researchers and theorists have associated dissociation, as a trait-like attribute, with hypnosis, although attempts to predict hypnotic responsiveness based on personality traits have been mostly unsuccessful, and the search for reliable and appreciable correlates of hypnotic suggestibility, including dissociation, has proved elusive [9-12]. Hypnotic suggestibility is a multifaceted construct, which may be affected by numerous individual difference and contextual variables, including the capacity and willingness to use imaginative abilities, personal beliefs and expectations, rapport with the hypnotist, and motivation to respond [13, 14]. Two popular theories of hypnosis -- Hilgard’s [15] neodissociation theory and Woody and Bowers’ [16] dissociated control theory -- assert that hypnotic responding results from a division of consciousness akin to dissociation or a fractionation of cognitive and behavioral systems of control and overall executive control. These theories contend that hypnosis activates dissociative processes that enhance hypnotic responsiveness and imbue them with a sense of nonvolition or lack of personal agency [17-19].

If dissociation lies at the heart of hypnotic responding, then we would expect measures of dissociation and hypnosis to be positively associated. Earlier investigations linked hypnotizability and dissociation within clinical samples [20], including the observation that patients who suffered from dissociative disorders were highly hypnotizable [21, 22]. More recently, Dell [23] has argued that “at the level of diagnostic groups hypnotizability and dissociation are *sometimes* ... robustly related” (p. 68). Vanhaudenhuyse and colleagues [24] reported a modest correlation of r=.39 between performance on the Stanford Hypnotic Susceptibility Scale, Form C (SHSS:C; [25]) and responses to a single question assessing the degree to which participants "...felt a dissociation between your bodily sensation and the actual environment" (p. 30), administered just a few minutes after a “neutral hypnosis” exercise. However, ratings between medium and low suggestible participants did not differ significantly. When well validated self-report inventories of dissociation and standardized assessment of hypnotic ability are employed, researchers typically find small yet sometimes statistically significant correlations between the two constructs [10, 26-28].

Bernstein and Putnam's [2] Dissociative Experiences Scale (DES; and the DES-II, [3]) is the most commonly used measure to assess the frequency of dissociative experiences. The correlation between the DES and hypnotizability typically hovers around *r*=.20 [29-31] and may be affected by the testing context (i.e., whether both scales are completed in the same testing session or in different, purportedly unrelated sessions; [10, 32]), such that the correlation of the DES with measures of hypnotizability decreases to near zero when the measures are administered in independent testing contexts [18]. Given that the DES was originally designed to measure dissociation within clinical samples, it is not surprising that the distribution of scores is often heavily skewed toward the low end in non-clinical samples, which may account, at least in part, for the lack of meaningful association observed between the DES and hypnotizability [30].

With college student samples, DES total scale scores may not capture possible links between non-pathological dissociative tendencies and hypnotic responsiveness. For example, using a 'present state' (vs. trait) measure of non-pathological dissociation, Cleveland and colleagues [33] administered the State Scale of Dissociation (SSD; [34]) before and after a hypnotic induction from the Harvard Group Scale of Hypnotic Susceptibility: Form A [35]. Consistent with their predictions, they observed that "a robust change in state dissociation occurs as a result of the hypnotic process" and argued that their findings "provide support for the existence of a positive relationship between hypnosis and dissociation" (p. 206-207). Maxwell et al. [36] reported that while trait dissociation (DES) was not associated with hypnotic responsiveness, highly suggestible participants reported more state depersonalization than less suggestible participants. Perhaps dissociative *state-like* experiences during hypnosis, which are associated with hypnotic responding, could be explained in terms of eye closure, relaxation, and general detachment from the environment associated with a focus on suggested events, rather than explained by a *trait-like* attribute of dissociation.

Nevertheless, other dissociation scales might exhibit higher correlations between hypnotic responsiveness and dissociation and better reflect the influence of trait-like attributes. Indeed, researchers have developed a number of other scales, such as The Wessex Dissociation Scale (WDS; [4]) and the Dissociative Processes Scale (DPS; [5]), to assess non-pathological variants of dissociation. However, these scales have received scant attention in the context of hypnosis research.

The present study is the first to examine the correlates of these scales with behavioral and subjective responsiveness to a standardized assessment of hypnotic susceptibility, alongside the widely used DES and a measure of more serious dissociative symptoms and experiences, derived from the DES (DES-Taxon scale; [37]). We also explored the relations among factorially derived subscales of these measures, when available, as well as their links with hypnotizability, and expanded our inquiry to encompass interrelations among these measures with absorption, fantasy proneness, and expectancies regarding hypnotic responsiveness. Absorption and fantasy-proneness, like dissociation, typically correlate with hypnotic suggestibility in the range of r = .20 to r = .35 (see [11] for a review), although the link between absorption and hypnotizability decreases when the measures are administered in independent contexts (reviewed in [38]).

An important goal of our research was to determine whether these self-report measures accounted for variance in hypnotic suggestibility beyond that of expectancies, as previous research has documented that expectancies correlate robustly with hypnotic suggestibility (see

[11]). For example, Green and Lynn [39] reported that a 3-item expectancy measure correlated at r = .53 with hypnotizability. The current research examined the correlates of different measures of dissociation with hypnotic responsiveness in tandem with (a) other self-report trait measures (i.e., absorption, fantasy-proneness), which previous research has associated with hypnotizability to a modest extent (see [11]) and (b) with expectancies to determine the variance that these measures alone, and in combination, contribute to responsiveness to hypnotic suggestions. Finally, we examined potential gender differences related to our findings.

2. Method

2.1 Participants

A total of 177 undergraduate students enrolled in introductory psychology classes at The Ohio State University, Lima were invited to participate in a study on "personality and hypnosis." We excluded 5 students who reported that they were hypnotized before and 16 others with significant missing data (e.g., skipped an entire page of the self-report assessment booklet). Final data analyses were based on *N*=156 students who reported that they had not been hypnotized before. Table 1 lists self-reported demographic information describing the sample. All participants signed a consent form. The lead author's local Institutional Review Board approved the study. Participants received four course extra credit points in exchange for their participation.

Table 1 Demographic information.

Sample of Undergraduate Students	*N=156*
Age	
Mean	19.08
SD	2.24
Gender	
Female	81
Male	75
Race	
Caucasian American / "White"	141 (90.4%)
African American / "Black"	6 (3.8%)
Latino American	2 (1.3%)
Asian American	2 (1.3%)
Other	5 (3.2%)
Grade Rank	
Freshman	132 (84.6%)
Sophomore	14 (9.0%)
Junior	7 (4.5%)
(did not report rank)	3 (1.9%)

2.2 Materials

Wessex Dissociation Scale (WDS: [4]). Based on Beck's [40] cognitive theory of personality, the WDS assesses the frequency of "decoupled" mental processes. The 40-item WDS addresses a wider range of less severe symptoms of dissociation than other scales, and, accordingly, "may provide a better reflection of the full spectrum of dissociation than the DES-II" [4]. The authors reported a *r*=.80 and .65 across clinical and non-clinical samples between the WDS and the DES. The authors of the scale also reported positive correlations between scores on the WDS and scales measuring anxiety and somatization. Sample WDS items include: "I find myself unable to think about things no matter how hard I try;" "Unwanted memories come into my head;" and, "My personality is very different in different situations." Participants selected one of six options (ranging from 0 to 5 and anchored with the following terms: *Never, Rarely, Sometimes, Often, Very Often,* or *All the time*). High scores on the WDS indicate greater dissociative experiences. A total scale score reflects the item mean for the entire scale, with higher scores reflecting greater dissociative experiences. Kennedy et al. [4] found high internal consistency across the WDS items (Cronbach alphas of .95 and .90, across clinical and non-clinical samples). Internal consistency values for all measures in the current study are presented in Table 4.

Dissociative Processes Scale (DPS; [5]). The 33-item DPS assesses normal-range dissociative tendencies within non-clinical populations. The items are positively keyed with a response format consisting of the following options**:** 1=*strongly disagree;* 2=*disagree;* 3=*neutral or cannot decide;* 4=*agree;* 5=*strongly agree*. A total scale score is generated by summing across the items. Watson [41] reported a Cronbach alpha of .93 for the total scale score and correlations with the DES around *r*=.60 across two college student samples.

The DPS consists of three factors. The first factor (DPS-F1), *Obliviousness,* consists of 14 items and assesses the inclination to act in mindless and automatic ways and to enter into "naturally-occurring trance states" [41]. Sample items include: "I will walk into a room, and not remember why I went in there"; and, "At times, people have told me that I seemed to be off in a world of my own." The second factor (DPS-F2), *Imagination,* measures absorption, imaginativeness, and fantasizing. Sample items include: "If I want to, I can imagine some things so vividly that they hold my attention like a good movie or book does"; and, "I have an interesting fantasy life." The third factor (DPS-F3), *Detachment,* consists of 6 items and reflects depersonalization and derealization experiences as reflected in the following item: "Sometimes when I am looking in the mirror I feel like I am seeing someone else."

Dissociative Experiences Scale-II (DES and DES-II, [2, 3]). The DES is a widely used questionnaire measuring dissociative experiences in both clinical and non-clinical samples [42]. The DES-II [3] response format requires participants to select one of 11 response options ranging from 0-100, listed in 10-point increments, to reflect the percentage of time that they experience the phenomenon described in each question. The total scale score is the average response across all of the items. Scores above 30 reflect severe dissociative pathology [3]. The scale has adequate temporal stability (e.g., test-retest *r*s =.79 to .84; [3]) and internal consistency statistics (average *r*s=.93; [42]).

Within clinical samples, a 3-factor solution is most commonly observed [43, 44]. Stockdale and colleagues [45] assessed different factor structures across two samples of college students and

concluded that the following 3-factor solution best fit their data: *Absorption* (16 items), *Amnesia* (6 items), and *Depersonalization,* (6 items).

Waller et al. [37] identified an 8-item subset of the DES (i.e., DES-Taxon/DES-T) that distinguished dissociative disordered patients from other patient groups and from non-pathological types of dissociation. Examples of items comprising the DES-Taxon include: "Some people have the experience of feeling that other people, objects, and the world around them are not real. What percentage of time does this happen to you?"; "... hear voices inside their head and tell them to do things or comment on things that they are doing ..."; and, "...find that in one situation they may act so differently compared with another situation that they feel almost as if they were two different people ..." The current study used the DES-II and derived factors based on findings from Stockdale et al. [45], as well as the DES-T scale.

Tellegen Absorption Scale (TAS; [46]). The TAS consists of 34 items measuring imaginative abilities and the tendency to become absorbed in everyday activities (e.g., being deeply moved by a sunset; experiencing thoughts as visual images; becoming so absorbed during a movie or play and feeling as though you are part of the play and not part of the audience). TAS scores range from 0 to 34 reflecting the number of items endorsed. Tellegen [46] reported a test-retest correlation of .91 over the course of one-month and an internal consistency value of .88.

Inventory of Childhood Memories and Imaginings (ICMI; [47]). The ICMI is a widely used measure of fantasy-proneness. The scale consists of 52 items assessing childhood and adult beliefs and imaginings (e.g., vividly re-experiencing sensations in one's imaginations such as the feeling of a gentle breeze; pretending to be someone else; having a past out-of-body experience; having felt, heard, or seen a ghost). ICMI scores range from 0 to 52 reflecting the total number of items endorsed. Scores on the ICMI correlate with the TAS (*r*s=.67 to .81; [48]), and the scale has adequate test-retest reliability statistics (see [49]).

Expectancy Index [39]. Prior to hypnosis, participants responded to the following statements: (1) *I expect that the hypnosis experience will be interesting and enjoyable;* (2) *I think that I will be a good hypnotic subject* (response format of the first two items: 1-*no, not at all,* 4-*somewhat, and* 7-*yes, very much*); and, (3) *Please predict—as best as you can—how many of the 12 suggestions you expect that you will respond to during hypnosis* (participants circled a number corresponding to their prediction). Summing items creates an overall, global index of positive expectancies about being hypnotized. Green and Lynn [39] found that the individual items and the overall index all positively correlated with hypnotic responsiveness.

Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS:A; [35]). The HGSHS:A is a widely used, group administered, 12-item standardized measure of hypnotic suggestibility. The scale begins with a suggestion for participants to close their eyes and to think of their head falling forward, followed by a 15-minute (approximately) eye-closure induction and then ideomotor suggestions for movements (e.g., eye closure, hand lowering, hands moving together), motor-challenge-type suggestions (e.g., inability to bend an outstretched arm, arm immobilization, finger lock, arm rigidity, communication inhibition, eye catalepsy), and cognitive-perceptual suggestions (e.g., hallucinating a buzzing fly, post-hypnotic amnesia, post-hypnotic suggestion to touch ankle). After hypnosis, participants report the degree of overt behavioral responses (i.e., how movements would have been judged by an onlooker) on a scale that can range from 0 to 12 with higher scores indicating greater responsiveness to hypnotic

suggestions. About one hour is needed to administer the hypnosis session and allow time for participants to complete the post-hypnosis response booklet.

The standard response format consists of a dichotomous choice in response to each item: pass (e.g., "My head fell forward at least two inches") or fail (e.g., "My head fell forward less than two inches"). As part of a larger study on the response format of the HGSHS:A, we included a third option to allow participants to indicate that they did not attempt the suggestion and to list reasons as to why (e.g., felt too relaxed; didn't want to attempt). In this study, we classified non-attempts as item failures.

Subjective Involvement/Involuntariness Ratings. After indicating their behavioral response to each HGSHS:A suggestion, participants rated the degree to which their response felt "automatic" or "involuntary." For example, after participants rated whether their head fell at least 2 inches after the 'head falling forward' suggestion, we asked the following question: "To what degree did your head falling forward feel "automatic" or "involuntary" (that is, *as if* it occurred all by itself)?" Similar to the subjective experience scale developed by Bowers [50] and then later expanded to the HGSHS:A by Kirsch, Council, and Wickless [51], our response options ranged from 1 to 5 and included the following anchors: 1=*not at all automatic or involuntary*; 3=*somewhat*; 5=*very much automatic or involuntary.* We summed scores across the 11 HGSHS:A behavioral items to generate an overall subjective involvement score (the HGSHS:A amnesia item was not assessed for involuntariness). If a participant both reported that they did not behaviorally respond to a given item and subsequently left the subjective involvement response blank, then we assigned a value of 1 (lowest rating of subjective involvement) for that item.

2.3 Procedure

We announced the study to prospective participants enrolled in 6 different sections of introductory psychology at The Ohio State University, Lima. Interested students were given a series of questionnaires as part of a "take home" booklet and were instructed to complete the scales and return for a standardized assessment of hypnotic suggestibility scheduled approximately one week later. Students completed the dissociation and personality scales that we listed above, along with additional scales not related to this investigation. The scales relevant to this study were presented in a fixed order and appeared in the following sequence: demographic questions, TAS, ICMI, WDS, DPS, and then the DES-II. Before hypnosis, the experimenter disputed common myths associated with hypnosis (i.e., hypnosis involves a trance state; you could get "stuck" in hypnosis; subjects are unable to resist suggestions) and provided students with an example of something "hypnosis-like" that they might experience during the session (i.e., that if they fully imagined that their foot was attached to a helium filled balloon, then their foot might actually lift off the floor). Immediately prior to the hypnosis session, students completed the expectancy items contained within a response booklet. The HGSHS:A was delivered via audio recording to student groups ranging in size from 9 to 39 participants. Following hypnosis, participants self-reported in the response booklet the extent to which they responded behaviorally to each suggestion and rated how automatic or involuntary their responses felt.

3. Results

Organization of analyses and controlling for Type I error. Based on previous work [12, 39, 52, 53], we predicted that women would score higher than men on the HGSHS:A behavioral and subjective measures, TAS and ICMI total scale scores, and across our expectancy items. We therefore grouped these variables together. Our next set of variables included more pathological measures of dissociation and consisted of total scale scores on the DES-II, each of the DES factors, and the DES-Taxon. Last, we contrasted responses by our female and male participants across our measures of non-pathological dissociation (i.e., the WDS, DPS, and the DPS factors). Because we ran multiple tests within each group of variables, we applied a Bonferroni correction adjusting the critical value of significance to control for Type I error.

Findings. In our first set of independent samples t-tests, we examined mean scores obtained from our female and male participants across the behavioral and subjective indices on the HGSHS:A, total scale scores on the TAS and ICMI, and on our global Expectancy Index. As can be seen in Table 2, female students passed more suggestions on the HGSHS:A (behavioral score), reported greater subjective involvement with the HGSHS:A items (subjective/involuntariness score), and scored higher on the ICMI. In addition, mean scores on the TAS and on our Expectancy Index were consistent with our a priori hypotheses; however, the magnitude of the difference between means did not reach statistical significance given the Bonferonni correction to alpha. Table 2 also lists responses by gender to the three individual expectancy items.

Results from our second set of t-tests did not show any gender-related differences on the DES-II, DES factors, or the DES-Taxon. Across our final set of t-tests, male and female students responded comparably across the WDS, DPS and on two of the three DPS factors. Female students generated higher scores the first DPS factor (DPS-F1, *Obliviousness*), relative to male students (see Table 2).

Given that our female students scored higher on the HGSHS:A – both in terms of behavioral responsiveness and their reported subjective involvement – we examined whether the correlations between our various measures and the HGSHS:A scores differed by gender. We used the Fisher transformation test to convert correlations into Z scores and then contrasted these scores between female and male students. Given a total of 33 comparisons (16 scales by HGSHS:A behavioral and subjective scores; HGSHS:A behavioral and subjective scores with one another), we adopted a $p<.01$ criterion for significance. None of these correlations differed by gender using this criterion (Zs ranged from -1.17 to 2.29; ps ranged from .02 to .94).

We calculated Pearson-Product Moment Correlations across our measures. As can be seen in Table 3, the dissociation scales inter-correlated highly. The WDS and DPS correlated with the DES-II (total scale scores), r=.74 and r=.70, respectively, and the WDS and DPS positively correlated with one another (r=.75). We obtained very small, non-significant, positive rs (i.e., less than .14) between scores on the WDS, DPS and the three DPS factors, and students' behavioral performance on the HGSHS:A. Correlations between these measures and subjective/involuntariness scores on the HGSHS:A also failed to reach significance. Although the DES-II correlations with behavioral and subjective responding were low, they attained statistical significance, r = .19 and r= .16, respectively. Correlations of behavioral and subjective hypnotic responsiveness with absorption were statistically significant (r = .30 and .33, respectively) as were correlations with fantasy-proneness (r = .27 and r = .26, respectively).

Table 2 Mean scores for male and female participants across our measures.

Measure	***Overall M (SD)***	***Males M (SD)***	***Females M (SD)***	***t***	***p***	***Hedges' g***
HGSHS:A (behavioral response)	4.76 (3.06)	4.12 (3.39)	5.35 (2.60)	2.52	.01	.41
HGSHS:A (subjective/involuntariness)	29.59 (10.63)	26.39 (11.25)	32.56 (9.13)	3.74	<.001	.60
TAS	16.88 (5.98)	15.89 (6.13)	17.79 (5.72)	2.00	.05	.32
ICMI	21.23 (7.59)	19.53 (7.36)	22.80 (7.49)	2.74	<.01	.44
Expectancy Index	14.21 (4.30)	13.53 (4.53)	14.84 (4.00)	1.91	.06	.31
Individual Expectancy Items						
Expectancy -item #1 (interesting)	4.97 (1.27)	4.83 (1.33)	5.10 (1.20)	1.34	.18	.21
Expectancy -item #2 (good subject)	3.97 (1.28)	3.95 (1.30)	4.00 (1.26)	0.26	.80	.04
Expectancy -item #3 (estimation)	5.27 (2.83)	4.76 (3.22)	5.74 (2.33)	2.19	.03	.35
	19.22 (14.23)	18.60 (14.28)	19.79 (14.24)	0.52	.60	.08
DES						
DES-F1 (Absorption)	26.17 (16.72)	24.61 (15.87)	27.61 (17.44)	1.12	.26	.18
DES-F2 (Amnesia)	11.37 (13.91)	11.60 (14.31)	11.15 (13.63)	0.20	.84	.03
DES-F3 (Depersonalization)	8.53 (13.58)	9.58 (15.54)	7.55 (11.49)	0.93	.35	.15
DES-Taxon	11.47 (13.51)	12.37 (15.21)	10.63 (11.75)	0.80	.42	.13
	1.25 (0.60)	1.20 (0.59)	1.30 (0.61)	1.07	.29	.17
WDS (Wessex)						
DPS	86.03 (23.43)	82.84 (22.28)	88.98 (24.21)	1.64	.10	.26
DPS-F1 (Obliviousness)	40.79 (11.41)	38.37 (11.39)	43.04 (11.03)	2.60	.01	.42
DPS-F2 (Imagination)	19.88 (6.24)	19.72 (6.05)	20.02 (6.44)	0.30	.76	.05
DPS-F3 (Detachment)	10.03 (4.67)	10.17 (4.46)	9.89 (4.88)	0.38	.70	.06

Note: Within each set of 5 dependent variables, a Bonferroni correction of alpha resulted in a critical value of $p \leq .01$. Because Levene's test for equality of variances was significant for both HGSHS:A indices, the test statistics listed for these two variables were based on *equal variances not assumed.*

Table 3 Correlations between measures.

Measure	1 HGSHS:A (behavioral response	2 HGSHS:A (subjective/involuntariness	3 TAS	4 ICMI	5 DES-II	6 DES-F1 (Absorption)	7 DES-F2 (Amnesia)	8 DES-F3 (Depersonalization)	9 DES-Taxon	10 Wessex Dissociation Scale	11 Dissociative Processes Scale	12 DPS-F1 (Oblivousness)	13 DPS-F2 (Imagination)	14 DPS-F3 (Detachment)	15 Expect Q1 (interesting)	16 Expect Q2 ('good subject')	17 Expect Q3 (estimation)	18 Expect Index
1. HGSHS:A (behavioral response)	-																	
2. HGSHS:A (subjective/ involuntariness)	.81**	-																
3. TAS	.30**	.33**	-															
4. ICMI	.27**	.26**	.63**	-														
5. DES-II	.19*	.16*	.50**	.51**	-													
6. DES-F1 (Absorption)	.24**	.22**	.54**	.55**	.97**	-												
7. DES-F2 (Amnesia)	.12	.06	.31**	.35**	.87**	.75**	-											
8. DES-F3 (Depersonalization)	.03	-.01	.34**	.31**	.82**	.68**	.76**	-										
9. DES-Taxon	.09	.04	.38**	.38**	.91**	.79**	.90**	.92**	-									

10. Wessex Dissociation Scale	.09	.11	.51**	.58**	.74**	.72**	.61**	.63**	.69**	-								
11. Dissociative Processes Scale	.13	.13	.65**	.64**	.70**	.72**	.51**	.54**	.59**	.75**	-							
12. DPS-F1 (Obliviousness)	.12	.13	.49**	.49**	.65**	.69**	.48**	.44**	.52**	.67**	.91**	-						
13. DPS-F2 (Imagination)	.12	.10	.60**	.66**	.49**	.52**	.33**	.34**	.40**	.54**	.82**	.60**	-					
14. DPS-F3 (Detachment)	.01	.10	.56**	.49**	.58**	.52**	.45**	.66**	.61**	.68**	.76**	.54**	.59**	-				
15. Expect-Q#1 (interesting)	.30**	.32**	.22**	.20*	.11	.17*	.03	-.04	.02	.02	.09	.09	.11	-.04	-			
16. Expect-Q#2 ('good subject')	.29**	.22**	.10	.20*	.15	.16*	.13	.09	.12	.01	.10	.08	.08	.12	.52**	-		
17. Expect-Q#3 (estimation)	.32**	.30**	.16*	.09	.17*	.19*	.09	.09	.11	.04	.11	.10	.11	.08	.36**	.40**	-	
18. Expectancy Index	.39**	.36**	.20*	.18*	.19*	.22**	.10	.07	.11	.04	.13	.11	.13	.08	.69**	.72**	.89**	
19. Gender	.20**	.29**	.16*	.22**	.05	.09	-.02	-.07	-.06	.09	.13	.20**	.02	-.03	.11	.02	.17*	.15

Note: Values reflect Pearson Product Moment correlations with the exception of those involving gender (point bi-serial values; gender coded as 1=male, 2=female).

* and ** indicate significant bivariate differences at the $p<.05$ and $p<.01$ levels, respectively.

To examine the ability of our variables, collectively, to predict behavioral and subjective responsiveness on the HGSHS:A, we performed two exploratory multiple regression analyses. First, we conducted a stepwise multiple regression analysis to examine the ability of the following variables to predict overt behavioral responsiveness to the HGSHS:A: TAS, ICMI, DES-II, DES factor scores and the DES-Taxon, WDS and DPS total scale scores, DPS factor scores, the Expectancy Index, and participant's gender. The full model (model 3) consisted of our expectancy index, TAS, and DPS-F3 (Detachment), R2=.232, F (3, 152) = 15.27, p<.001; adjusted R2 = .216. The initial model contained our Expectancy index, R2=.15, p<.001. The addition of TAS scores to Expectancy Index scores (model 2) led to a statistically significant increase in R2 of .051, F (1, 153)=9.79, p=.002. The addition of DPS-F3 (Detachment; model 3) resulted in a significant increase in R2 of .031, F (1,152) =6.10, p=.015.

We conducted a second stepwise multiple regression analysis to estimate *subjective* responses on the HGSHS:A, using the same predictor variables noted above. The full model (model 4) consisted of our Expectancy Index, TAS, gender, and DPS-F3 (*Detachment*), R^2=.273, F(4,151)=14.19, p<.001, adjusted R^2=.254. The initial model contained our Expectancy Index, R^2=.13, p<.001. The second model added scores on the TAS and resulted in a significant increase in R^2 of .071, F(1,153)=13.62, p<.001. The third model included gender and increased R^2 by .042, F(1,152)=8.45, p=.004. The addition of DPS-F3 (*Detachment;* model 4) increased R^2 by .030, F(1,151)=6.13, p=.014.

Finally, we generated Cronbach alphas to determine internal consistency reliability across our measures (see Table 4). Alpha values ranged from .79 to .95, with the exception of our expectancy index (α =.59).

Table 4 Internal consistency reliability statistics across measures.

Measure	Number of Items	Cronbach Alpha
HGSHS:A (behavioral response)*	12	.79
HGSHS:A (subjective/involuntariness)	11	.90
TAS	34	.81
ICMI	52	.85
DES-II	28	.95
DES-F1 (Absorption)	16	.92
DES-F2 (Amnesia)	6	.85
DES-F3 (Depersonalization)	6	.86
DES-Taxon	8	.86
Wessex Dissociation Scale	40	.93
Dissociative Processes Scale	33	.95
DPS-F1 (Obliviousness)	14	.90
DPS-F2 (Imagination)	7	.86
DPS-F3 (Detachment)	6	.88
Expectancy Index	3	.59

* Kudar Richardson (KR-20) value for reliability of dichotomous variables is equal to Cronbach alpha. The reliability for our expectancy index was likely affected by the small number of items comprising the scale.

4. Discussion

Our study provides a comprehensive examination of the link between trait measures of dissociation and hypnotizability in the context of a more encompassing study of the correlates and potential determinants of hypnotic responsiveness. We replicated and extended previous research in important ways.

Perhaps our most noteworthy finding was the general failure to find statistically significant or impressive correlations of measures of dissociation with hypnotic responsiveness. Indeed, across all of our dissociation measures, only the DES-II total scale score (*r*=.19) and one of the three DES factors (*Absorption*, *r*=.24) correlated significantly with behavioral hypnotic suggestibility, and correlations were similarly low with subjective responses to hypnosis (DES-II total score *r*= .16; DES *Absorption* factor *r* = .22). Our low range correlations between the DES-II and behavioral and subjective hypnotic responding were similar in magnitude to those reported in previous studies [11]. Moreover, the WDS and DPS, along with DPS subscale scores, were not reliably associated with hypnotic responding on a statistical basis, with low and non-significant correlations in the range of *r* = .01 to *r* = .13. Importantly, we found only a very weak and nonsignificant correlation (*r* = .09) between hypnotic suggestibility and the DES-T, a measure of serious dissociative symptoms, confirming the failure in the hypnosis literature to find evidence for an association between hypnotic responding and psychopathology.

Given the similar pattern of findings across diverse scales of dissociation, it is sensible to argue that these scales can be used interchangeably in the context of hypnosis research with student populations. Whereas our survey was not designed to rigorously test dissociation-based theories of hypnosis [15, 16], our findings are inconsistent with predictions derived from such theories; specifically, the hypothesis that dissociation, considered as a trait, is a viable predictor of hypnotic responsiveness (see [18] for a review), with the following qualification: Our preliminary finding of a link between the *Detachment* subscale of the DPS and behavioral and subjective scores on the HGSHS:A in our regression analyses suggests that scores on this factor assay something relevant to hypnosis beyond absorption (as measured by the TAS) and a positive expectancy to respond. Although total scale scores on the WDS and the DPS and DPS factor scores did not correlate with hypnotic suggestibility, our regression analyses suggested that the third DPS factor of *Detachment* contributed to the prediction of HGSHS:A behavioral and subjective scores after expectations about being hypnotized and absorption were included.

One possibility is that the propensity toward detachment in everyday life potentiates the tendency toward disrupted metacognition or executive monitoring during hypnosis [18, 54, 55]. Indeed, previous work suggests that highly hypnotizable individuals may experience reduced metacognitive awareness of their behavioral intentions, resulting in an attenuated sense of agency [56, 57]. Although the fact that the zero-order correlation between hypnotic responding and the *Detachment* subscale was not significant (i.e., *r*s=.01 and .10 across behavioral and subjective scores on the HGSHS:A, respectively), we suggest that future research should, nevertheless, more fully explore detachment and deficits in metacognition as potential moderators or mediators of hypnotic responding.

We documented strong support for the convergent validity of measures of dissociation, which exhibited impressive positive intercorrelations. For example, the WDS and DPS correlated with the DES-II, *r*s=.74 and .70, respectively, and the WDS and the DPS correlated at *r* = .75. In fact, the

lowest inter-correlation across total scores on the DES-II, DPS, WDS, and the DES-T was still a substantial *r* = .59 (DES-T and DPS).

Our study also provides supportive psychometric statistics regarding the internal consistency reliability of items comprising the dissociation measures and subscales, which were good to excellent and ranged from α=.85 (DES-F2, *Amnesia*) to .95 (DES-II and DPS total score). Alpha values for the HGSHS: A scores (behavioral and subjective), TAS, and ICMI ranged from α=.79 to .90. We obtained a rather low alpha value for our expectancy index (α =.59); however, this is not overly surprising given that the index consists of only 3 items and alpha values are "strongly affected by the length of the scale" [58]. Nevertheless, we suggest that future research employ expectancy measures with greater internal consistency.

Moreover, we replicated previous research [11, 36, 38, 59, 60] by finding low-to-moderate statistically significant correlations, *r* = .30 and *r* = .27, respectively, of behavioral measures of hypnotizability with absorption (TAS) and fantasy-proneness (ICMI), and correlations in a similar range with subjective measures of hypnotizability (absorption, *r* = .33; fantasy-proneness, *r* = .26). In contrast, we found moderate-to-high correlations of measures of dissociation with measures of fantasy-proneness (range *r* = .31 [DES-F3 *Depersonalization* factor] to *r* = .66 [DPS-F2 *Imagination* factor]), which is consistent with the idea that significant overlap exists between fantasy-proneness and dissociation [61]. Our finding of a high correlation between the measures of absorption and fantasy proneness (*r* = .63) indicates that these constructs map onto a common domain of immersion in imaginative experiences.

In previous work, we have found that female students endorse more favorable views about being hypnotized and scored higher on the HGSHS:A, TAS, and ICMI, relative to male students [12, 39, 52, 53]. Our present findings converge with these earlier observations. More specifically, female students passed more HGSHS:A suggestions, reported greater subjective involvement during hypnosis, and averaged higher scores on the ICMI relative to their male counterparts. The magnitude of the effect sizes associated with gender differences on the HGSHS:A scores and the ICMI ranged from .41 to .60, indicating a small to medium effect. By squaring zero-order correlations, we estimated that gender accounted for small but significant amounts of variance across HGSHS: A behavioral (4%) and subjective (8.5%) scores and on the ICMI (5%). In addition, female students tended to score higher on the TAS and to hold more favorable views about hypnosis, especially their overall estimation of passing suggestions; however, in the current study, the magnitude of these differences between genders did not meet the pre-set criterion for significance.

Total scale scores on the WDS and DPS did not differ between female and male participants, with the exception of the first DPS factor (*Obliviousness*), where gender accounted for 4% of the variance on this subscale. Our female participants scored higher on this factor relative to males, reflecting a greater self-reported rate of mindlessness, automaticity, or even absentmindedness. In contrast, Fernaeus and Ostberg [62] examined absentmindedness among undergraduates attending Stockholm University and failed to find any gender difference. We question whether our finding of female students scoring higher on the DPS *Obliviousness* factor will be replicated, and if so, the extent to which it reflects a true gender difference or reporting bias. More specifically, one could speculate that female participants might be more willing to acknowledge experiences of mindlessness/absentmindedness than males with a more guarded, defensive self-presentation consistent with sociocultural expectations [63].

Although we found that the magnitude of correlations between our various scales did not differ by gender, and gender as a stand-alone variable did not enter as a predictive variable of behavioral scores on the HGSHS:A in our multiple regression analysis, we recommend that researchers analyze for potential gender differences in their data sets. Exploring predictive models of hypnotic susceptibility within a large sample by examining interactions between gender and individual scale scores would be informative and permit more complex models beyond those that linearly add individual scale scores. Indeed, in a previous investigation, we found that predictive models of hypnotizability varied across male and female participants when gender-by-scale interactions were considered [39]. Our current finding that gender contributed to the prediction of HGSHS:A subjective/involuntariness scores further underscores the importance of including gender as a potential moderating variable when examining associations between personality variables and hypnotic responsiveness.

Our exploratory regression analyses should be interpreted with caution given the number of variables in the analyses and our sample size. Tabachnich and Fidel [64] recommend a 40-1 ratio of cases to independent variables. Given a ratio of roughly 15-1 in the current study, we characterize our analyses as exploratory and caution that our results are preliminary. In addition, stepwise regression capitalizes on sample-specific variation, and future investigations with larger samples should consider alternative statistical approaches to derive predictive models driven by theory. Whereas the use of stepwise regression has lost favor among many statisticians, some methodologists still view the technique appropriate for exploratory purposes [65, 66]. Indeed, "An 'atheoretical' use of hierarchical regression may be just as inappropriate to using exploratory-based analyses such as stepwise regression" [67]. We believe that our use of stepwise regression was reasonable in light of the exploratory nature of our investigation of the WDS and DPS, and associated DPS factors, given that these scales have not been fully examined within the context of hypnosis research. Clearly, our findings need to be replicated, particularly those involving the predictive contribution of scores on the DPS *Detachment* factor. If they are, then subsequent investigations based on empirical findings pertaining to non-pathological measures of dissociation could be advanced and tested in a more theory driven manner.

Our study is further limited in that we only included trait measures of dissociation and our participants completed the dissociation measures within the context of a hypnosis study. Future investigations should examine state as well as trait measures of dissociation in terms of accounting for their interrelation in hypnotic contexts and their differential ability to predict hypnotic responsiveness. Given that many hypnotic suggestions call for a present-moment dissociation of behavioral enactment and subjective experience of involuntariness, state measures of dissociation may very well prove to be more robust correlates of hypnotic ability than trait measures [24, 33, 36]. Furthermore, researchers should consider whether the magnitude of correlations are affected by the testing context by administering measures of dissociation both within and outside of the context of hypnosis or if the order of administering scales (e.g., before or after hypnosis) matters.

We acknowledge that undergraduate students' self-reported experiences of dissociation and their responsiveness to a group administered hypnosis scale may not fully capture dissociative or hypnotic phenomena, and that our findings may not generalize to a clinical setting. It is also possible that dissociation and hypnotic responsiveness in our sample are not linked in a straightforward, linear fashion, and that individuals with stronger dissociative tendencies might

experience hypnotic phenomena in a qualitatively distinct manner from those that are less dissociative [7], thereby attenuating correlations between hypnotic suggestibility and dissociation measures across the entire range of hypnotic suggestibility. Moreover, experiential as well as personality differences, such as past experience with trauma, attachment styles, and imaginative abilities, for example, might separately or collectively moderate dissociative experiences within the hypnotic context [68].

Consistent with previous research we reviewed, of all of the variables we examined, the one that numerically correlated most strongly with hypnotic responsiveness was our Expectancy Index and, subsequently, it was the first variable retained in the regression analyses. Indeed, our collective assessment of participants' expectancies that hypnosis would be interesting and enjoyable, they would be a good hypnotic subject, and would pass a number of suggestions, correlated with both behavioral (r = .39) and subjective (r = .36) measures of responsiveness. Correlations between individual items comprising our Expectancy Index and hypnotic responsiveness were also significant, albeit at a slightly lower level than our global expectancy index (rs across the individual expectancy items and behavioral and subjective HGSHS:A responses ranged from .22 to .32). As highlighted by many sociocognitive theorists [69-73], expectancies seem to play a prominent role in determining hypnotic responsiveness. Supporting this assertion, and similar to our findings, Kirsch, Silva, Comey and Reed [74] found that response expectancy correlated more strongly with hypnotic responding than absorption, fantasy-proneness, or personal motivation. Still, scores on our Expectancy Index only accounted for 15% and 13% of the variance in HGSHS:A behavioral and subjective scores, respectively, thereby providing only limited support for a sociocognitive model of hypnosis. Clearly, much more variance remains to be accounted for in future studies. Finally, a virtually unexplored area in hypnosis studies is to determine whether inducing dissociation by means such as mirror gazing, dot staring, ganzfeld setups, virtual reality, and pulsed audio and photic (with due cautions regarding seizures) stimulation [75-77], would increase hypnotic suggestibility, as, to date, little evidence exists to support a robust relation between trait dissociation and hypnotic responsiveness, even across the variety of measures of dissociation we examined.

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Author Contributions

Joseph P. Green: study design and preparation, IRB approval, data analyses and interpretation of results, writing manuscript, responding to reviewers' questions. Steven Jay Lynn: writing and contributing to manuscript, interpretation of results, theoretical knowledge regarding hypnosis, responding to reviewers' questions. Olivia J. Green, Victoria R. Bradford, and Rouhangiz Rasekhy: data collection, data entry, assisting with initial data analyses and interpretation of results, contributed to manuscript.

Competing Interests

The authors have declared that no competing interests exist.

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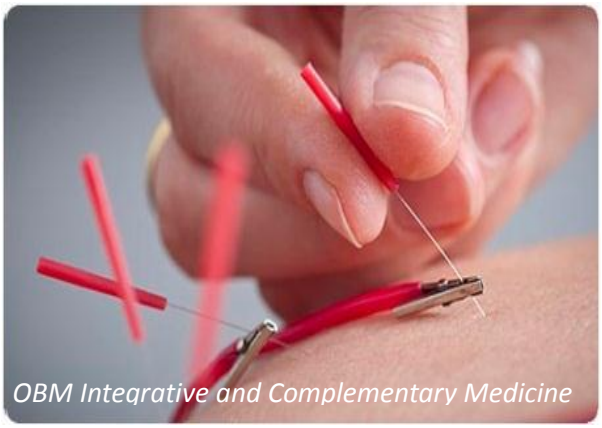

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Review

Hypnosis for Resilience

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Abstract

The topic of resilience is of paramount importance. Although the term resilience was coined in the fields of physics and engineering, its use has spread to the fields of social sciences, biology, psychology, and psychiatry, as well as to the industry. Moreover, the term is now endowed with a wide range of meanings. The topic of resilience plays a central role in all critical life events. It is of paramount importance in medicine as well as in psychology and psychotherapy, where it is involved in both psychiatric disorders and physical diseases, particularly when encountering the specter of chronic pain, suffering, disability, and death. The available data indicate the relevance and effectiveness of hypnosis for resilience in numerous clinical conditions, and propose hypnosis as a candidate for a central role in palliative care. Furthermore, resilience is endowed with deep philosophical implications that are not to be neglected during patient management. Indeed, suffering, including the perception of one's doom as well as the real mystery of life and death, relies closely on philosophical, cultural, and ethnic factors. Eastern, as well as pre-Socratic philosophers,

based their philosophies on an epistemologically sound, non-dualistic paradigm; they profoundly explored the inner–outer world relationship, allowing for so radical a resilience that has no equal in the modern Western culture. Therefore, these philosophies should be re-appraised and properly understood from a metaphilosophical perspective, in order to utilize their wisdom and knowledge in an efficient manner. A few examples of Eastern philosophical concepts drawn from Taoism, Yoga, and Buddhism, as well as those from Heraclitus and Parmenides, which would be potentially useful in patient care, are provided in the present article.

Keywords
Hypnosis; resilience; philosophy; epistemology; palliative care; Taoism; Buddhism; Yoga

1. Introduction

The topic of resilience, owing to its central role in all critical life events, is of paramount importance in the fields of medicine, psychology, and psychotherapy. The term ‘resilience’ was coined for physics, where it indicated an object able to recoil or spring back into shape after bending. In the context of an individual, resilience refers to the capacity to withstand or rapidly recover from difficult conditions such as those related to family and social relationships, financial stressors, workplace, and health issues.

The term resilience was derived from the Latin word *resilire* (which means to bounce), and in its broadest sense, it refers to the capacity of a system to adapt to the changes caused by external agents. The term was initially used in the fields of physics and engineering, and then its usage spread to the other fields such as social sciences, biology, psychology, and psychiatry, as well as to the industry, endowing the term with a wide range of meanings, a few of which are summarized as follows [1, 2]:

a) The capacity to absorb the deformation elastic energy and subsequently regain the initial shape (in materialss science).
b) Recovering the initial homeostasis following a perturbation or reaching a new state of balance through hallostasis (in biology).
c) A dynamic process of psychological adaptation, including both emotional and intellectual aspects as well as their management, in socio-cultural and environmental interactions.
d) Recovery from perturbation. In psychiatry, when dealing with psychopathic patients with no hope for recovery, resilience is limited to the restoration of the previous condition after it has worsened; for example, recovery from a phase of depression in a patient with severe bipolar disorder. Here, a relevant fact is the time of restoration, where resilience is the counterpart of vulnerability, i.e., it may decrease the proneness rather than preventing the susceptibility to psychopathy.
e) Useful resources for the management of change, i.e., self-transformation and enhanced awareness, which enable one to cope with changing living conditions.
f) Steady change of condition, including the amount of stress required to achieve it.

g) Conditioned resilience, yielded by prolonged treatment – e.g., improvement after the administration of psychiatric drugs, the effects of which may be for a limited duration. On the other hand, this could be considered a drug effect rather than actual resilience, unless it also favors a subject's change.
h) Dynamic balance, i.e., the average steady condition compatible with limited disturbances in a relatively steady condition; an example of a dynamic balance between the highs and lows in psychiatry could be borderline personality disorder.

The relevant elements of resilience are: a) threshold and feedback, b) functional redundancy and plasticity, c) management of the adaptation, and d) capacity and awareness. The threshold is defined as the level beyond which the requirement for a change is perceived, while positive or negative feedback may affect the response to critical events, in turn increasing or decreasing it, respectively. Redundancy is largely represented in biological systems and is defined as a property that allows preserving functions following damage. Management of the adaptation may occur through an interactive revision of the hypotheses and feedbacks, rather than simple trials and errors. Furthermore, in the world of business and risk management, resilience may be realized through reactive flexibility, i.e., the capacity to alter one's organization in response to environmental changes, or through proactive robustness, i.e., attempting to prevent crisis or decompensation, or to withstand the change, although possibly accompanied with minor changes or losses [3]. In both psychology and psychiatry, while reactive flexibility allows for second-order changes, the concept of proactive robustness is compatible with first-order changes.

As a matter of the relationship between the individual and the environment – between the inner and outer worlds in their unceasing becoming and transformation – resilience is mainly a cognitive problem, warranting the understanding of the meaning of reality, of what happens in its continuous dynamic change, and of the requirement for updating oneself to adapt to it. Resilience also calls for metacognition to properly understand: a) the meaning, value, and the limits of one's ideas, including the awareness of the mental process es employed to process these ideas; b) the limitations of the adopted *Weltanschauung* (view of the world) and *Zeitgeist* (spirit of times) in which all of us are immersed. In fact, the egocentric perspective of ordinary consciousness is unaware and inclined to naive realism (the belief that senses provide us with a direct awareness of the objects as they really are), where the ego is inclined to perceive the world as constituted of stable, separated objects with an autonomous intrinsic existence. As a consequence, despite being aware of the time stream, the ego is prone to believe that the outer world should remain unchanged and should always fit one's own expectations. This static view also forms the definition of identity, viz. its permanence in a ceaseless one's body and mind transformation, an unsolvable philosophical conundrum [4]. Therefore, any crisis, including the ones occurring in all periods of physiological changes in a lifetime, such as the transition from adolescence to the adult life, and then to aging, the role transitions, disasters, and diseases (with the associated specters of disability and death), becomes a powerful source of distress. This is not a matter of psychotherapy only, and rather, in the context of nature and the meaning of life and its becoming, belongs to philosophy, and, therefore, should be approached as a whole through an integration of both these disciplines.

The whole process of evolution of humankind, including culture, art, science, and technology, is a consequence of the encountered harms and crises. Indeed, fear and distress are powerful stimuli that force one to change, to cope, or to fail, whatever the case may be. Resilience is the virtue of all successful men that have ever lived, including the scientists (one for all, Stephen Hawking) and

the artists (e.g., Beethoven, Chopin, Dostoevskij, Mussorgsky, Ravel, van Gogh, Messiaen) who perceived their diseases and disasters as resources, relentlessly continuing on their journey, providing humanity with beautiful works. An outstanding example is Olivier Messiaen, who was jailed in 1940 by the Nazis in the concentration camp Stalag VIII–A at Görlitz in Silesia. As he himself narrated, his only concern at the moment of his arrest was to get hold of a booklet regarding orchestral scores, a pencil, and a few music papers. When he underwent the check-up and wore the prison jumpsuit, he was terrified of the risk that his belongings were confiscated – the only things, as he stated, that would have assisted him in bearing the hunger and cold that the soldiers themselves would have suffered from. Once there, he came across three other musicians who were playing strings and clarinet, and a malfunctioning piano. In the period of imprisonment, Olivier Messiaen composed the *Quatuor pour la Fin du Temps*, a masterpiece of the 20^{th-}century music, mainly while sitting in a latrine (the only quiet spot in the camp). The quartet was played on January 15, 1941, in a building of the camp, before all the prisoners and soldiers. The following month, Olivier was released, as a non-combatant soldier–musician. His religiosity and genius allowed him to transform an awful tragedy into a masterpiece. A common characteristic of all genius people in all the fields of human knowledge is the capacity to relentlessly work for moving on irrespective of the misfortunes, illnesses, and sufferings they may encounter, while the common man remains trapped within his limited horizon and ultimately collapses [5].

2. Disease, Death, and Resilience

Culture, the resulting *Weltanschauung* and *Zeitgeist* are at the base of the definition and the perceived relevance of all problems, including the terrific concepts of time and death. Indeed, both *Weltanschauung* and *Zeitgeist* are characterized by the incapacity of rational thought to be able to grasp their nature and meaning, despite the fact that time is now measured with incredibly high precision. Reflection on its nature has raised unsolvable aporias (logical contradictions) for over two millennia, and even in relativistic and quantum physics, its meaning and reality are under continuing debate [6-8].

It is noteworthy that the Chinese concept of time is considerably different from the Western one, the latter having been introduced in China at the end of 19th century with a neologism. In Taoism, time is conceived as an unceasing renewal, duration, and opportunity – a concept grasped in the West by Bergson's philosophy of time. In Taoism, time – just as anything else – is a manifestation of Tao, which is characterized by the dynamic alternation and reciprocal generation of the two opposite although complementary poles, the *Yin* and the *Yang*. Accordingly, in Chinese language, verbs do not have past and future tenses, as the reality and the nature of existence is conceived as a stream, in which everything is transforming in a dynamic, immanent present [9, 10]. This is also the reason for the absence of opposition between life and death, and as a consequence, the lack of soteriological doctrines, in the Chinese culture. Indeed, this clearly demonstrates that resilience in front of death – a human problem par excellence and the greatest source of anguish among humans – is essentially a matter of philosophy, and the causes for suffering rely closely on the adopted *Weltanschauung*. Similarly, Buddha was right when he stated that suffering stems from the five *skhanda* (the components of ordinary consciousness), while Epictetus, a Roman stoic philosopher of the first century A.C., stated that men do not fear things and rather the opinion they have of them [11].

Among all the sources of distress, death represents the greatest one, the mother of all the problems. In the clinical setting, the fear of diseases, pain, suffering, disability, and death is the main cause of anxiety disorders and depression. It is noteworthy that dental anxiety and phobia [which may also include symptoms of post-traumatic stress disorder (PTSD)] are significantly correlated to previous bad experiences associated with medicine and/or dentistry [12]. This may also justify the fear associated with all invasive procedures and medical therapies (such as chemotherapy and radiotherapy for cancer). Therefore, a bad doctor-patient relationship might be a cause of severe psychological disorders, turning the caregiver figure into a torturer.

Death has been the unsolved philosophical dilemma for ages, particularly in the West, and at the same time, the most powerful factor supporting both spiritual and material development of humankind. If mankind had been as resilient as not fearing death at all or anything else that could happen, perhaps there would not have been such advancements in science and technology, both of which stem from the will of having power and control on all possible harms [13]. Indeed, such an apparently unattainable level of resilience is that reached by the Taoist *great man*, as defined by Zhuāngzǐ [6, 7, 14-16]. The Western concept of time, with its rational, mathematical partition (past, present, and future), is the basis for profound anguish of the Western culture, which lies in the belief that everything is doomed to become nothing [17]. The resulting existential dilemma has led to huge religious, philosophical, and scientific developments, as analyzed by the Terror Management Theory and debated in contemporary philosophy between presentism and eternalism [18]. Nevertheless, the life-death problem remains unsolved so far, and the present time, ruled by a materialist monist perspective, is constitutionally unable to properly encounter this problem and accept the mystery associated with it.

According to Emanuele Severino, the Western culture is imbued with nihilism, which stems from the parricide of Parmenides by Plato and Aristotle and is marked by the idea that everything is doomed to become nothing– a questionable, ill-founded concept worth being deeply re-appraised [17, 19]. According to Parmenides, the being

> *"is, and that it is impossible for anything not to be. The other, namely, that which is not, and that something need not be, that, I tell you, is a completely untrustworthy path. For you cannot know what is not, that is impossible, nor can you utter it; for that can be thought and that can be is the same thing" (Perí Phýseōs, II, III).*

In other words, *ex nihilo nihil*, i.e., from nihil, nothing can arise. Nihilism stems from Plato's conception of the world of ideas, where a concept of nihil may exist. However, it is an abstract positive concept of a negative fact which is self-contradictory, because, by definition, nihil cannot exist. As a consequence, Parmenides' parricide led to incorrectly considering phenomenal appearance for "being" and what disappears for nihil, a view similar to naive realism and disproved by modern physics as well. Indeed, energy cannot be destroyed, can change the form, while the matter is just a concentration of energy (according to the famous Einstein formula, $E = mC^2 \rightarrow m = E/C^2$). Therefore, even matter cannot turn into nothing. Furthermore, in quantum physics, matter is no longer considered the primary manifestation of the world and is rather thought to have manifested as a secondary product from quantum vacuum, rendering the materialist stance based on the classical concept of matter obsolete [8, 20]. It is noteworthy that the reciprocal transformation between energy (yang) and matter (yin) had already been acutely defined by Taoism over two thousand years ago. In line with Taoism and Parmenides's thought, Hippocrates,

the great father of medicine, stated in *De Diaeta* (I, 4, 9) that:

> *"Nothing arises from nothing, rather everything changes due to mixture and separation. The men incorrectly think that things arise from the Hades and go back to the Hades, and therefore believe their eyes rather than reason. What is living cannot die, nor is it possible that what is not may begin to be".*

In summary, the great wisdom of both Eastern philosophies and the Western pre-Socratic *physicoi* (philosopher-physicists) and physicians established that life is an inseparable life–death whole, i.e., death is nothing more than a transformation of life and an essential part of it, despite resembling the awful, irreconcilable opposite of this from the illusory, naive, egocentric perspective of ordinary consciousness. In this context, it is worth highlighting that the paradigms of Heraclitus, Parmenides, and Hippocrates were similar to that of Taoism [21], and the best way to translate the original Parmenides' concept of being into Chinese is, indeed, the term Tao [4]. Despite appearing as a metaphysical problem unworthy of attention from modern medical science, it has relevant epistemological implications in the science of consciousness as well as in the definition of the mind-brain–world relationship. The ancient thought also has greater compatibility with quantum physics compared to the classical Western post-Aristotelian thought (for a detailed analysis, see [7]), and the former is of paramount importance in therapy for improving resilience.

In the modern era, which is ruled by positivism and materialism, terminal illness and death have been reduced to a conventional matter of biological mechanisms, their technical management, and the political debate on their bio-ethical implications and resource availability. This inclination is paralleled by the neglect of death in everyday life, which is a defense mechanism that leads to an implicit illusion (or delusion) of immortality coupled to almost obsessive attention to health and physical efficiency. The ostensible obscenity of death and its neglect has been well-defined by Gorer as *the pornography of death* [22]. Death being an essential part of life rather than its opposite, the tragedy stems from the refusal to acknowledge it, engendered by the deceitful egocentric perspective: as Freud wisely stated paraphrasing a famous Latin motto on the war, *si vis vitam para mortem* (i.e., if you wish life, set up your death).

One must be aware that the adopted scientific concepts of health, normality, and disease are conventional and statistical in nature; although pragmatically useful, they are weaker than commonly believed and may turn against each other. According to Woodruff et al. [23], the disease may be defined as:

> *"any condition associated with discomfort, pain, disability, death, or increased liability to these states, regarded by the physicians and the public as properly the responsibility of the medical profession, may be considered a disease".*

When considering the fact that we are all going to die one day, health may be paradoxically defined as an asymptomatic illness that would inescapably lead one to death, thereby fulfilling the above-stated definition of disease. The only difference between health and disease is the presence of symptoms and the possibility of diagnosis. Furthermore, suffering and pain may evoke in one, the awareness of one's actual existential condition. According to Le Breton, pain is not a plain symptom of disease, and is rather an incision of the sacred, ripping one from oneself and leading the one to confront one's limitations, the transience of life, and its cost. Pain obliges to metaphysics [24, 25].

If the above discussion is correct, the problems of life, disease, pain, suffering, and death are far from being a simple matter of medical definition from a narrow perspective of a positivist; these

problems warrant a psychological and philosophical approach, with philosophy deserving a certain important place in both psychotherapy and hypnosis as well as in the patient-doctor relationship.

3. Hypnosis for Resilience

Resilience may be regarded as the key player in psychotherapy as well as the remedy for all sources of distress in both medicine and everyday life. This is the reason why the XIII Congress of the European Society of Hypnosis (held in Sorrento, Italy on October 21-25, 2014) was devoted to "Hypnosis and Resilience".

Hypnosis may effectively assist in restructuring patient's problems, an objective that David Spiegel has well-defined as "Trance-formation" [26]. Unlike psychotherapies which rely mainly on the retrospective analysis of the causes of disorders and their rational interpretation (such as psychoanalysis), hypnosis may additionally allow for direct experience in the "here and now" of the patient requirements and what they are seeking for through imagination and plastic monoideism [27-29]. Therefore, hypnosis may behave as a sort of simulator – a tool being increasingly employed in the training of pilots, surgeons, anesthetists, and all the professionals who require developing certain special skills.

Imagination has been understated or even disparaged by the century-old rationalist stance of Western culture. In fact, hypnosis was totally dismissed by the prominent panel of experts convened by King Louis XVI in France as "nothing but heated imagination" [30]. In early 20th century, imagination was incorrectly considered a feature of the less-developed brain of children, primitive people, and inferior races, while conceptual thought was regarded as a privilege of the civilized, Western "superior" man – a sort of collective delusion of self-importance which led to the opprobrious consequences of colonialism and the ideologies of early 20th century. In that positivist climate, Freud himself considered the visual images reported by his patients as related to their neurosis, which had to be replaced with a verbally-mediated rational analysis [31].

However, imagination is a powerful mind faculty that the great artists and scientists are endowed with. For instance, Nikola Tesla reported his incredible eidetic imagery in his autobiography, which allowed him to see with his mind eye all his inventions in complete detail, and even evaluate them prior to constructing them [32]. Albert Einstein, the icon of 20th century science, was a scientist-philosopher who was endowed with a vivid imagination. In an interview to the Sunday Evening Post in October 26, 1929, he stated:

> *"I'm enough of an artist to draw freely on my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world"* [33].

The above-stated facts clearly demonstrate the relevance of imagination for knowledge and the century-old underestimation of imagination by the rationalistic Western culture. In the same years, young Milton Erickson, under complete paralysis following a severe case of polio, invented and taught himself a unique method of rehabilitation, playing mental games with himself, intensely wishing for and imagining playing outside, as well as watching his baby sister who was only learning to walk at that time.

The role and power of imagination have been recognized only recently in neuropsychology. Mental imagery (the "mind eye") is a multifaceted psychological construct that exhibits conceptual and neurobiological overlaps with related cognitive processes, such as attention, memory, and

actual perception. Spatial imagery is associated with complex brain activation, including activations in the dorsolateral prefrontal cortex, visual cortex, middle frontal gyrus, premotor cortex, and parahippocampal gyrus [34]. Motor imagery facilitates motor performance, by training the associated brain areas and improving the association between process and actions, with the training exerting a long-lasting effect on metacognition [35]. These data also lead to a renewed interest in the potential use of motor imagery in rehabilitation [36-38], confirming the exceptional intuitions of the 17-year-old Milton Erickson one hundred years ago. Hypnosis enhances motor imagery by improving concentration and the connection between sensory information and motor output [39]. This is consistent with the relationship between hypnotic ability and the enhanced functional connectivity between the left dorsolateral prefrontal cortex (belonging to the executive control network) and the salience network (including anterior cingulate cortex, insula, amygdala, and ventral striatum), which allows the somatic, autonomic, and emotional information to be evaluated and integrated [40].

All these data suggest the relevance and effectiveness of hypnosis, with its plastic imagery, in both medical and psychological disorders. The neuropsychological components of the hypnotic simulator – a sort of mental lab – might allow one to virtually perform tasks, process information through a different perspective, and restructure one's problems with higher efficiency with respect to ordinary consciousness and a limited rational interpretation. This may occur without requiring a retrospective analysis of the distressing events of the past and would guide the patient in the present toward the future, updating his/her model of the world. The rational interpretation of past events, despite being undoubtedly useful, may not be sufficient for bringing a change; several patients have reported that it allowed them to understand the origin of their symptoms, although they anyway failed to overcome their limitations and recover.

According to Bandler & Grinder [41], several patients are self-limiting because of their previous experiences and the resulting model of the world that they have developed, which prevented them from viewing and adopting new options and possibilities. This belongs to the physiology of life; even the oddest behavior, when observed from inside the subject's world, might turn out to be understandable and coherent with the subject's experience and adopted model. If so, an enlargement of patient's model, which would enable him/her to discover new paths and adopt new options and behavior, allows mitigating or even completely resolving the problem, rendering the previous limited behavior unnecessary. The updating and enlargement of the model is an issue of paramount importance in itself for the whole life. Bertrand Russell introduced an outstanding concept of Self enlargement, which encompassed philosophy, science, and psychology [4, 42]:

> *"All acquisition of knowledge is an enlargement of the Self… This enlargement of Self is not obtained when, considering the Self as it is, one attempts to demonstrate that the world is so similar to this Self that the knowledge of it is possible without any admission of what appears alien… Knowledge is a form of union of the Self and the not-Self; similar to all kinds of union, it is impaired by dominion, and consequently, by any attempt to force the universe into conformity with what one finds in oneself. This view… is untrue... What it refers to as knowledge is not a union with the not-Self, but a set of prejudices, habits, and desires, constructing an impenetrable veil between oneself and the world beyond. The man who has no tincture of philosophy goes through life imprisoned in the prejudices derived from common sense, from the habitual beliefs of his age*

> *or his nation, and from the convictions which have grown in his mind without the co-operation or consent of deliberate reason".*

Therefore, an approach centered on the contemplation of the world beyond one's limited perspective, *Weltanschauung* and *Zeitgeist* in the "here and now" may strongly assist in developing resilience. This is not just useful for psychotherapy, rather is also an essential general rule in all the fields of human knowledge, including science, philosophy, and religion.

As far as therapy is concerned, resilience may be regarded as a relevant general component of the treatment, capable of enhancing coping irrespective of the causes of distress. At the same time, resilience removes the risk of possible retraumatization implied in the retrospective analysis of the distressing events.

Bandler and Grinder's model, as well as the psychoanalytic perspective, is compatible with the Solms and Panksepp's neuro-psycho-evolutionary approach, envisioning the evolution from an unconscious life to the first appearance of consciousness up to the development of the highest expression of the Self from a dual-aspect monist perspective [43, 44]. According to Solms and Panksepp's theory, emotions are dependent on the neurodynamics of the innate brain primary circuits yielding an anoetic form of consciousness, the neuro-anatomical base of which belongs to deep brain structures (including the brainstem, hypothalamus, central thalamic nuclei, and limbic circuits). Higher-order, noetic components of consciousness and awareness, as well as the autonoetic, autoreflective ones have their neuro-correlates in more rostral structures, the cerebral hemispheres. The ultimate result of this complex caudo–rostral circuitry is the bidirectional interplay between the anoetic and noetic components, which causes the present experiences to be affected by the past ones and the effects of past experiences to be consequently altered by the autoreflective processes of the present. The latter explains why it is possible to resolve the problems rooted in the past by working in the present to enlarge the patient's model, perspective, and the Self.

The outstanding properties of hypnosis allow it to a relevant tool in palliative care, where it may play a central role in enhancing coping and resilience. Here, resilience is used in its widest sense as the capacity to cope with all the adverse events and all the causes of suffering and pain; for instance, resilience here may also include hypnotic analgesia, which is not in itself a matter of resilience although it may improve resilience by means of enhancing one's ability to control pain. Hypnosis may be used beneficially in all the aspects of palliative care [45-47], including:

1. The management of anxiety, depression, and pain [48-50].
2. The peri-operative period of surgery and invasive procedures, where hypnosis may assist in relieving pre-operative anxiety and concern, improve wellbeing and collaboration, and enhance the stability of cardiorespiratory parameters). It may also improve post-operative wellbeing and wound recovery and may decrease the requirement for the intake of pain killers. It may even be successfully used as the only anesthesia in selected patients [51–54].
3. Physical symptoms, spontaneous or yielded by drug side effects, such as nausea and vomiting, diarrhea, flashes, insomnia, fatigue, and dyspnea [55]. It is noteworthy that most of the afore-stated symptoms could be caused or enhanced as a result of the nocebo effect, i.e., these could be psychosomatic in nature. For instance, a strong nocebo effect was reported in patients belonging to the placebo group in an RCT on cancer-related fatigue (including 79% insomnia and 38% nausea) [56]. In this context, hypnosis holds a great potential to assist in relieving the physical symptoms in patients even in severe pathologies

such as cancer, where the psychosomatic components of suffering have greater relevance than previously believed.

The above-stated indications of hypnosis include a wealth of possible, specific suggestions and metaphors, a detailed description of which is far beyond the scope of the objectives of the present article. All these indications converge on the suggestion that resilience should be regarded as the key player in the whole management, which extends from the first diagnosis of chronic progressive disease all the way up to its terminal state. Hypnosis may assist in better confrontation overall and improve coping and resilience; this would be achieved through ego strengthening, mindfulness, usage of metaphors that assist in mitigating disturbing ideas, negative emotions, and any other causes of worry, and including the philosophical implications discussed above.

4. Relevant Clues from Eastern Philosophies

The above-discussed philosophical implications should not be regarded as abstract speculations. Rather, they are concrete, pragmatic reflections to be considered in clinical practice when dealing with distress, suffering, disease, and death. The modern medicine, with its governing mechanist–reductionist approach, has cured diseases rather than the patients, neglecting all the relevant subjective factors as if the mind would have no role to play in both health and disease, a fact that has huge epistemological implications [7, 21, 57]. Indeed, its paradigm is metaphysical in nature, stemming from the mathematical apriorism of Galileo and the *original sin of Galilean Sciences,* i.e., the compromise with the Church and Inquisition (which claim an exclusive competence on the soul), the genius of Descartes promoted through its radical dualism. Therefore, the novel sciences were epistemologically ill-founded as these were a consequence of political friction, which caused their field of interest to be forcibly limited to the Cartesian *res extensa,* and in medicine, to the *earthen body machine*. As a consequence, the observer was removed from the observed facts in the illusion of the neutrality of the former, and maintained so, until the revolution started in the 20th century by quantum physics. Owing to its neglect of the consciousness and subjectivity, the positivist–materialist perspective governing medical science has been constitutionally unsuitable for properly understanding and managing the subjective phenomena, including pain and suffering.

Unlike the modern Western culture, Eastern philosophies have developed a profound knowledge regarding the inner world and its relationship with the external reality using a non-dualistic perspective. It is noteworthy that according to the etymology of the term *Yoga*, a word that stems from the Sanskrit term *yujir* (*binding together or joining*), it indicates the reunion of mind and body, I and the non-I (i.e., mind–body–world), a state in which all the ostensibly opposite and incompatible phenomena are dissolved in an inseparable whole. Taoism and pre-Socratic philosophers, as well as Hippocrates, held the *coniunctio oppositorum*, i.e., convergence and reciprocal generation of the opposites. Over 2,000 years ago, Buddhism had already recognized and deeply analyzed the illusory stance of the Ego, the existence of the unconscious, the limitations of conceptual thought, the relevance of empathy and compassion, and the path of liberation from all the attachments and sorrows [14]. Together, all these belief systems established the path to wisdom and enlightenment, enabling one to live well, die well, and remain in a state of unshakable resilience, rather than seeking power from an egocentric utilitarian perspective. Therefore, according to the previously adopted approach to defining the Self [4], resilience may be better understood from a metaphilosophical perspective, by moving beyond the

limited ethnocentric modern Western perspective and the positivist inclination to consider its concepts and findings as universal.

The discussion on metaphilosophical criteria and their application in the analysis of Eastern culture is far beyond the limited scope of an article (for further details, see [9, 58-62]). Therefore, the present article would just outline a few clues drawn from Buddhism and Taoism, in order to better understand their relevance in regard to resilience. The relevance of Eastern philosophy is also closely associated with the huge historical, procedural, and neuropsychological links between hypnosis and meditation [14, 16, 63-65], which have recently led to the introduction of what is referred to as mindful hypnosis [66, 67]. Indeed, mindfulness meditation, which should be regarded as the best technique of Western meditation, is basically an adaptation of *Vipassanā* meditation, while *Śamatha* meditation (meditation of the dwelling calm) is associated with hypnotic absorption and neutral hypnosis. Similar to hypnosis, *dhāranā* (the induction of yoga meditation) is based on focused attention and deep relaxation, while *dhyāna* (the meditative state) could be translated as meditative absorption and contemplation, which may engender a flow of images. Similarly, Buddhist meditation involves a detached observation of one's states and mental objects, and letting them go.

Eastern philosophers, unlike the Western ones, have unvaryingly merged theoretical philosophy and practical philosophy as a whole, devoting themselves to self-knowledge and the path for emancipation, i.e., liberation from all the attachments and conditioning, up to the level of wisdom, saintliness, and enlightenment. All the Eastern philosophies included meditation as an essential practice for reaching a complete metacognitive awareness and to get rid of *Māyā*– the mask of illusion of the ordinary consciousness (i.e., the flawed naive realism and what Kant referred to as the *unavoidable natural illusion* [4, 57, 68]). Moreover, meditation, which allows for the subject's empowerment, may also serve as a healing technique.

As stated above, hypnosis has strong links to Eastern meditation [14, 16, 63-65]. In fact, the first mesmerists were deeply interested in the Eastern philosophies and healing practices, which they considered similar to their own discipline and claimed that Mesmer had only provided a scientific interpretation for these. In the early 19th century, *The Zoist*, a journal on mesmerism, published several articles on Indian practices; hypnosis was also compared to Taoist practices and Yoga meditation (also referred to as *hibernation*), and was considered as an *ecstatic or Mesmeric condition* [16, 65]. Neutral hypnosis may also favor intense experiences similar to those achieved with meditation and the ones associated with mystic and near-death experiences, such as "*having no thoughts*, *being one with everything*, *increased meaningfulness, letting things happen, and merging with pure light or energy*", among others [69-71].

Buddhism originated as a consequence of a pragmatic observation of reality, i.e., the universal presence of pain and suffering in the world. As Siddharta Gautama stated:

> *«Birth is pain, aging is pain; illness is pain; death is pain; attaching to what is displeasing is pain; separating from what is dear is pain; not obtaining what is wished for is pain. In brief, the five skhanda [the clusters of consciousness; author's note], which are the basis of the attachment to existence, are pain» (Saṃyutta Nikāya, 56, 11*).

This apparently pessimistic cosmic view of pain is the starting point of the path to the most radical liberation from suffering, according to the *Four Noble Truths (Majjhima Nikaya* 26, *Ariyapariyesana Sutta: The Noble Search*). Therefore, both the stepping stone and the endpoint of

Buddhism are akin to the essence of medicine and psychology, rendering Siddhartha Gautama the greatest psychotherapist in the history of humankind. The surprisingly modern viewpoint of Siddhartha Gautama recognized that the origin of suffering lies in the ordinary consciousness and ego. In brief, the path to liberation from suffering warrants overcoming the narrow limits and flaws along the path toward wisdom, a fact which also engenders the most radical resilience.

It is similar to Taoism. As Lǎozǐ stated, "the sage men are self-aware and not self-absorbed; self-respect is not self-importance" [72]. Zhuāngzǐ defined the problem as follows:

> *"The perfect man has no self (Chapter 1)… Do not let your outward stance affect your inner self, nor allow your inner self to be drawn out (Chapter 4)... One who seeks fame and thereby loses his real self is no gentleman (Chapter 6)… The mean or petty person is willing to risk his very body for gain. The scholar risks his own self for fame… All of these different types, with differing claims to fame, have damaged their innate nature and risked their lives in the same way (Chapter 8)… Everyone in the world appears to be concerned only with his own self. This implies the whole world is full of anxiety (Chapter 14)"* [4, 15].

The above-stated *trait d'union* between meditation and hypnosis allows certain valuable Eastern concepts to be exploitable in hypnotherapy; they include certain concepts from pre-Socratic philosophers, which share the non-dualistic paradigm of Taoism, based on the *coniunctio oppositorum*. Therefore, it would be worth outlining a few of these concepts prior to concluding the present article, which may assist in contributing to hypnotic suggestions and metaphors and/or could be included in the philosophical reflection outside the formal hypnotic sessions.

4.1 Taoism & Pre-Socratic Philosophy

As stated earlier, the concept of Tao has an equivalent in the Parmenides' concept of being, while the *Yin–Yang* polarity appears tantamount to the Parmenides' *light and dark night* [4], as stated in the *Perì Phýseos* (VIII, 51-6):

> *"Henceforth, learn the opinions of mortals, listening to the deceptive ordering of my words. Mortals have settled in their minds, to speak of two forms, one of which they should have left out, and that is where they deviate from the truth. They have assigned an opposite to each, marked distinct from one another".*

If the separation of the opposites is deceitful, the belief based on this separateness is a source of suffering, which leads one to anxiety in an endless attempt to escape from what is rejected or feared. Heraclitus, who properly described the dynamic course of events (also similar to the *Yin–Yang*), wisely demonstrated how deceitful the ontological separation of the opposites is:

> *"Opposition unites. From what draws apart, emerges the most beautiful harmony. All the things occur by means of strife (DK 22B9)… Men do not know how something that is at variance agrees with itself. It is an attunement of opposite tensions, similar to that of the bow and the lyre (DK 22B52)… It is the same thing in us that is quick and dead, awake and asleep, young and old; the formerare shifted and become the latter, and the latter in turn are shifted and become the former (DK 22B89)... For god, all things are fair and good and just men suppose that certain things are unjust, while the others are just (DK*

> *22B103)… The disease makes health sweet and good; hunger, satiety; toil, rest (DK 22B112)".*

When one completely understands that the opposites are not different, irreconcilable entities and rather just the complementary attributes of an inseparable deeper unit, the apparent bad part may be integrated in the whole along with the good one, and may be better accepted, despite remaining unpleasant; its intrinsic dynamics also emphasize its transience, both representing essential steps toward resilience. Indeed, nothing could be perceived and known without its opposite, not even pleasure without pain and good without evil. This was the initial condition of young Siddhartha Gautama, a crowned prince kept in the dark regarding the distressing events of life (disease, aging, and death), who began waking up when he realized the universal presence of pain in the world, and ultimately established the Buddhist way of liberation from it.

A further useful clue for resilience is provided by an ancient Chinese saying– "If you have a problem and there is a solution, what are you worried about? If you have a problem and there is no solution, what are you worried about?" The detached equanimity of the great Taoist man and his apparently unattainable resilience has been correctly defined by Zhuāngzǐ as follows [73, 74]:

> *"The titles and honors of this world are of no interest to him, nor is he concerned at the disgrace of punishments. He knows that there is no distinction between right and wrong, or between great and little. I have heard it been said that 'the Tao man earns no reputation, perfect Virtue is not followed, the great man is self-less'. In perfection, this is the path he follows… The perfect man is a pure spirit… He does not feel the heat of burning deserts or the cold of the vast waters. He is not frightened by the lightning which is capable of splitting open mountains, or by the storm capable of whipping up the seas... Neither death nor life concerns him; how could gain and loss disturb him? (Chapter 16)".*

This absolute resilience also includes a non-spilt view of life and death in line with both Hippocrates and Heraclitus thoughts:

> *"Life follows death and death is the forerunner of life. Who can know their ways? Human life begins with the original breath; when it comes together, there is life, and when it is dispersed, there is death. As death and life are together in all this, which one of them should be termed as bad? All the forms of life are one, yet we regard some as beautiful, as they are spiritual and wonderful; others we count as ugly, as they are diseased and rotting. But the diseased and the rotting could become spiritual and wonderful, and the spiritual and the wonderful could become diseased and rotting. It is said that 'all that is under Heaven is one breath'. The sages always comprehend such unity (Chapter 22)".*

These sentences, the wisdom of which is unquestionable, illustrate the mystery of life and death in a blissful manner, including their inseparability, and ultimately, the ontological inexistence of death, which is just a part of the dynamic process of life transformation. Death remains a tragedy for the ego; getting rid of the narrow, illusory perspective of the ego and contemplating the whole world as a ceaseless transformation of the "breath" (the Greek *psyché*, blow, energy), allows to view death to be not as bad as it appears from an egocentric, nihilistic, materialist perspective.

4.2 Patañjali's Yoga-Sūtra

Niroḍha and the *internal witness* are the two key concepts of Patañjali's *Yoga-sūtra*, and the former allows disclosing the latter [75]. The term *niroḍha* indicates an insight into the pure consciousness, which is void of any content (lying beyond perception, concepts, and any category of the mind). The ordinary consciousness is inclined to self-identification with mental objects (the inputs received from the outer and inner worlds) crossing one's mind, leading one to assume these and the related experiences as parts of oneself. The truth, however, is that the mind is their master and host; in itself, it is the pure awareness of the agent, the witness who observes phenomena and may choose to remain detached and untroubled.

Metaphorically (and this may be a hypnotic approach to assist the patient in understanding it), the flow of ordinary consciousness could be compared to an exposed film, where the images are the flow of experience, while *niroḍha* could be recognized as that unexposed subtle stripe between subsequent images (their support), of which one is usually unaware [16]. Therefore, *niroḍha* is a meaningful step toward metacognition, which allows reaching a higher level of awareness and stability in encountering life's experiences. The internal witness is the detached neutral subject consisting of pure awareness, which enables one to control the activity of the ordinary consciousness, and recognize the nature of the mental objects and subsequently let them flow away without being conditioned by them; this was stated clearly by Patañjali in the following words:

> "1.3. Yoga is the control (*niroḍha*) of the modifications of the wave-vortex of mind activity (*cittavṛtti*).
> 1.4. Then, the Seer abides in Itself, resting in its own True Nature, which is referred to as Self realization (*tada drashtuh svarupe avasthanam*).
> 4.5 While the activities of the emergent mind fields may be diverse, the one mind is the director of the many (*pravritti bhede prayojakam chittam ekam anekesam*)."

This wise analysis of the human mind by Patañjali is outstandingly profound and in perfect agreement with the concept of enlargement and complete realization of the Self [4].

4.3 Buddhism

Buddhism aims for a radical liberation from pain and suffering (*dukkha*), and the two key concepts of *anicca* and *śūnyatā* (the impermanence and the vacuity of reality, respectively) form its core. According to Buddhism, the world is not constituted of independent, separated "things" endowed with an intrinsic autonomous existence, and are rather interrelated transient events, the phenomenal appearance of which is the consequence of a co-creation of reality (unattainable in itself) and the human way of perceiving and coding it. Furthermore, Buddhism does not admit the existence of an Ego as a reified substance. Rather, the ego is conceived as a functional aggregate at the superficial layer of the empirical mind directed toward the outer world.

Buddhism, with its view of the world as constituted of interrelated events being in perfect agreement with quantum physics, is epistemologically sound and surprisingly modern [7, 20]. The relationship between the mind and the world described in Buddhism is consistent with the Pooper and Eccles' theory of the three worlds, a modified version of which is held by the author of the present article [7, 57, 76]. Furthermore, the nature of *dukkha* described in Buddhism is consistent

with the present definition of pain in medicine, viz. a matter of experience rather than a plain epiphenomenon of stimulation of pain pathways in the nervous system [77-79]. This is equivalent to saying "no experience, no pain", a fact implying that pain could be well-managed by altering the experience. This definition is compatible with the observed outstanding analgesic effects of hypnosis, and exposes the self-contradictory overriding attitude of conventional medicine to rely just on drugs, which stems from its materialist–reductionist stance. A relevant aspect in the psychological management of suffering and pain (besides the hypnotic suggestions which are aimed at directly increasing the pain threshold [80]) is detachment from all the sources of sorrow by adopting a neutral, non-judgmental disposition. As emphasized by Siddhartha himself, suffering is closely related to the mismatch between what happens and what was expected:

> *«Birth is pain; aging is pain; illness is pain; death is pain; attaching to what is displeasing is pain; separating from what is dear is pain; not obtaining what is wished for is pain. In brief, the five skhanda [the clusters of consciousness], which are the basis for attachment to existence, are pain» (Saṃyutta Nikāya, 56.11).*

Certainly, accepting does not necessarily imply approving or adopting a passive fatalist behavior. Rather, according to the Chinese saying stated earlier, acceptance allows for better coping with the life events, moving on to resolve problems when possible, and coming to terms with what is inescapable.

The proper approach to be followed is described well by the motto–"One must never mourn a paradise lost, rather live well even in hell". Paradise and hell are neither physical nor metaphysical places; they are just conditions of the mind. This is why, at first glance, the Indian concepts of *samsāra* (the world of becoming and suffering) and *nirvāṇa* (extinguishment) may appear as the irreconcilable opposites to the Western reader, similar to the concept of heaven and hell, which is rather not true. The Western reader may become disappointed upon discovering that *samsāra* is *nirvāṇa* and *nirvāṇa* is *samsara,* the two different perspectives of human consciousness. *Samsāra* is the common inclination to focus on what is going awry, on what has been lost, thereby perceiving and depicting the outer world as hell. *Nirvāṇa*, being a non-judgmental stance, is to perceive everything (both good and bad things) without focusing on what has been lost, allowing for a fresh open-minded starting point that assists in discovering that good things are inseparably intermingled with the displeasing ones. For instance, the same beautiful sunset may be inspiring to an open mind that is ready to contemplate it, while it would be not be perceived as or deemed irrelevant by a worried mind that is focused on its own ordeal. Therefore, as Buddha stated, the source of suffering is in the ego and the ordinary consciousness, which have a narrow perspective.

The philosophical issues discussed above may appear odd or irrelevant to the modern view ruled by the clear-cut rationality of positive sciences. However, these philosophies are the expression of the several-thousand-year old thoughts of the great sage men, which should be reappraised and properly understood. Indeed, these thoughts belong to what Karl Jaspers referred to as the axial period (around 500 B.C., in the spiritual process extending from 800 B.C. to 200 B.C.) [81]:

> *"The most extraordinary events are concentrated in this period. Confucius and Lao-Tse were living in China, and all the schools of Chinese philosophy came into being... India produced the Upanishads and the Buddha, and similar to China, ran the whole gamut of philosophical possibilities down to sceptiscism, materialism, sophism, and nihilism in Iran, Zarathustra taught a challenging view of the world,*

> *as a struggle between good and evil; in Palestine, the prophets made their appearance… Greece witnessed the appearance of Homer, and of the philosophers Parmenides, Heraclitus, and Plato… Everything implied by these names developed during these few centuries, almost simultaneously in China, India, and the west, without any one of these regions knowing the others. What is new about this age is that man became conscious of the Being as a whole, of himself and his limitations. He experiences the terror of the world and his own powerlessness. He asks radical questions. Face to face with the void, he strived for liberation and redemption. By consciously recognizing his limits, he set for himself his highest goals. He experienced absoluteness in the depths of selfhood and in the lucidity of transcendence... Consciousness became, once again, conscious of itself; thinking became its own object... Spiritual conflicts arose… The most contradictory possibilities were essayed. Discussions…and the division of the spiritual realm into opposites… created unrest and movement, to the extent of spiritual chaos. As a result of this process, hitherto unconsciously accepted ideas, customs, and conditions were subjected to examination, were questioned, and liquidated. Everything was swept into the vortex."*

In this inevitable process of reappraisal of the ancient thought, one must refrain from inadvertently adopting the ordinary ethnocentric, chronocentric, and egocentric Western perspective, which is conditioned by the axioms and theories adopted in the present *Zeitgeist* and the related traps of logic. In this context, it is worth emphasizing that science must not be confused with a narrow, acritical adoption of a given paradigm and set of [undemonstrated] axioms, the nature of which is metaphysical in nature – a fact which led Husserl to define the objectivism of positive sciences as a transcendental naivety worth of reappraisal [82]. Indeed, any rational discipline is based on undemonstrated axioms, and despite being valuable, remains *dóxa* (relative knowledge, opinion); Aristotle himself warned of the necessity of constantly wondering regarding the truthfulness of such axioms (*Metaphysics* 1005b, 1-5).

Author Contribution

The author is responsible for the entire process of writing up, revising, and approving the final version of this manuscript.

Competing Interests

The author has declared that no competing interests exist.

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Editorial

Hypnosis: From Neural Mechanisms to Clinical Practice

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Hypnosis is the oldest psychotherapy and is one of the oldest and most popularly-practiced methods for control of pain and other stress-related chronic disorders. The chequered history shows unsurpassed adaptive power of hypnosis, enabling it to survive till date [1].

Though having witnessed variations over centuries, the current interest in hypnosis has become stronger; hypnosis has emerged both as a useful topic for scientific research and an effective technique in clinical applications and therapeutic interventions.

Hypnosis has remained poorly understood for long primarily due to lack of knowledge about objective neurobiological markers of trance state, but continuous advances in neuroscience in past several decades, largely due to the introduction and refinement of sophisticated electrophysiological and neuroimaging techniques, have opened up a "bridge of knowledge" between the classic neurophysiological studies and psychophysiological studies of cognitive, emotional, and sensory systems [1]. Still many of the basic questions regarding hypnosis remain unanswered.

The Society of Psychological Hypnosis, Division 30 of the American Psychological Association, has defined hypnosis as "a state of consciousness involving focused attention and reduced peripheral awareness characterized by an enhanced capacity for response to suggestion" [2].

Of late, hypnosis has gained huge popularity in the health care and education sectors [3]. However, the exact role of hypnosis remains incompletely explored, and the mechanisms of its precise neural, biophysical, biochemical, and neurochemical actions remain inadequately understood. This Special Issue addresses some of the crucial questions relating to the neural mechanisms of hypnosis and improves understanding of hypnotic practices.

Thirteen acclaimed researchers and clinicians from all over the world were invited to present their perspectives, research findings, and recommendations for future work. The articles in this issue offer critical analysis, cutting edge research, clinical perspectives, and directions for future research and clinical practice. Through focusing on experimental research, this issue will prove extremely insightful for the clinicians, researchers, academicians, and medical scientists, thereby filling the gap between basic research and clinical practice, offering amply-useful therapeutic interventions.

In taking stock, Green *et al.* [4] (*this issue*) critically discuss the historical link between hypnotic responsiveness and dissociation. The Authors utilize scales of non-pathological dissociation and of pathological dissociation, failing to find any significant correlation with hypnotic responsiveness. In contrast, expectancies were the most influential in terms of variance accounted for in predicting hypnotizability.

Low-to-moderate statistically significant correlations were found between behavioral measures of hypnotizability with absorption and fantasy-proneness, with moderate-to-high correlations of measures of dissociation with measures of fantasy-proneness, suggesting that these constructs map on to a common domain of immersion in imaginative experiences.

It is of paramount importance to fill the gap between basic research and clinical practice. Vanhaudenhuyse et al. [5] *(this issue*) investigates how neuroimaging studies help clinicians to better understand the mechanisms of hypnosis in terms of brain modulation, especially of pain. Hypnotic suggestions dramatically influence not only the primary consciousness and self-consciousness networks but also the attentional and somatosensorial networks. Resultantly, the subjects feel disengaged from their external stimuli combined with the modification of sensations related to their body, their affective resonance, and cognitive appraisal.

Schmidt et al. [6] (*this issue*) propose an innovative application of hypnotic procedural techniques in clinical practice. An important stressor and source of chronic suffering in the intensive care unit is non-invasive ventilation. Positive therapeutic suggestions under hypnosis can help patients in intensive care units to enhance their well-being by helping them deal with specific stressors like being ventilated. The authors set up a clinical design to assess the effects and safety of standardized therapeutic suggestions under hypnosis in patients on non-invasive ventilation during intensive care.

Relieving pain is one of the oldest and most important applications of hypnosis [7], however, mechanism of relieving pain remains largely unexplored. In the neurophysiological context, De Benedittis [8] (*this issue*) reviewed recent evidence supporting the notion how hypnotic suggestions of analgesia can modulate pain processing at multiple hierarchical levels and sites within the central nervous system (CNS). Hypnotic suggestions of analgesia could directly modulate both sensory and affective dimensions of pain perception, with the affective dimension registering more significant reduction compared to the sensory one. Moreover, highly hypnotizable subjects possessed stronger attentional filtering abilities and greater cognitive

flexibility in comparison to the low hypnotizable subjects, thus allowing diversion of attention from the nociceptive stimulus as well as better ignoring the irrelevant stimuli in the environments.

Flynn [9] (*this issue*) provides a review of theories and biomedical paradigms of pain, including the biopsychosocial model that takes into account biological, psychological, and social factors that modulate the pain experience. He argued that it might be useful for clinicians who practice hypnotherapy to understand pain paradigms. As key brain areas involved in the processing of pain have been shown to be influenced by hypnosis and hypnotic analgesia, an experienced therapist who wishes to obtain optimal results with their pain patients/clients should include these targets in their treatment approach [10]. Biopsychosocial models emphasize the key role of psychological processes in the physical experience of pain, such as Fear-Avoidance and Fear-of-Pain [11]. A moderate- to- large positive association between pain-related fear and disability was observed, suggesting that pain-related fear may be considered an important risk factor for pain-related disability with implications in the treatment of pain [12]. Understanding and targeting these psychological variables may empower clinicians practicing hypnotherapy in tailoring suggestions specific to their pain patients to derive optimal results.

There is increasing evidence demonstrating that hypnosis can be effective in down-modulation of pain sensation in both acute and chronic pain states [13]. A summary of the recent systematic reviews would help better understand the quality of evidence regarding the efficacy of hypnosis, and provide the right direction for future research. Pathak et al. [14] (*this issue*) conducted a scoping review of systematic reviews and meta-analyses on the efficacy of hypnosis for the management of clinical pain conditions and concluded that there was low-quality evidence for beneficial effects of hypnosis in the management of procedural pain, headache, and pain associated with breast cancer care. Hypnosis may be an effective treatment for a variety of clinical pain conditions; its efficacy for clinical pain treatment is yet to be ascertained in large trials. Improvement of clinical designs and recommended guidelines are needed to avoid the methodological shortcomings of previously published trials.

Modern research does not offer due weight to the topic of the subjective experience in hypnosis. Hypnotizability scales focus mostly on behavioral responses, not on the subjective experience of the trance state. However, the brain/mind interface can better be explored by taking into account the first-person self-report and trying to link together behavioral, neurophysiological, and subjective experiences. Pekala & Creegan [15] (*this issue*) introduce noetic qEEG analysis as a neurophenomenological method to quantify the mind during hypnosis in a reliable and valid manner. The differences in qEEG results may relate to differences in noetic experience under hypnosis and possibly altered states of consciousness.

Hypnosis offers effective treatment in disorders involving the autonomic nervous system (ANS). However, studies investigating the nature of its effect on the ANS have reported contradictory results**.** Kasos et al. [16] *(this issue)* investigate the effects of hypnosis on electrodermal activity (EDA) to objectively assess the activity of the sympathetic branch of the ANS. Their findings show that sympathetic arousal is bilaterally reduced during hypnosis induction, which is persistent across different levels of hypnotizability. At the same time, lateral differences define unique EDA patterns in the induction phase, characterizing high, medium, and low hypnotizability. These findings confirm with those in previous studies that highlighted the reduction in the sympathetic tone under hypnosis by means of heart-rate variability power spectrum analysis (HRV) [17].

Although significant research has been done to evaluate the neurobiological aspects underlying the phenomenon of consciousness, there is a lack of information regarding the effect of clinical and sociodemographic variables relating to altered states of consciousness and hypnosis. Ciaramella [18] *(this issue)* investigates clinical and sociodemographic factors on three hundred and forty-nine subjects from the general population in a single session. The age of the subjects was observed to be a negative predictor of hypnoidal state, intended to be a general measure of trance. Age also contributes to changing the phenomenology of consciousness, predicting greater vividness of imagery, reduction in time sense, fear, arousal, anger, negative affect, and perception. Female subjects were found to be more hypnotizable than the male subjects as they experienced a reduced memory of suggestions and an increase in the depth of trance. Subjects with a history of psychological trauma were found more prone to have reduced memory of suggestions than the normal ones. The subjective experience of a trance state results from a combination of several individual predisposing traits and variables that are contextual to a specific situation and influence the quality of sensation, emotion, volition, and thought, which are fundamental for an appropriate response to suggestions.

According to Casula [19] (*this issue)*, 'therapist's focused attention, open awareness, and kind intention are basic ingredients for creating a relationship of trust with the subject from the very first session. When the attention of a non-judgmental therapist is centered on how the subjects express themselves and what contents they propose, the subjects rely more on the competent care of the therapist. The author emphasized that to empower patients, it is essential to accept their vulnerabilities, awaken hidden resources, and pursue realistic therapeutic goals. In this manner, each session focuses on the perceptual, cognitive, emotional, and behavioral changes that the subject can make during the session and implement after the session by themselves. Some clinical cases have outlined the significance of this empathic and interactional approach.

Resilience—the capacity of a system to adapt to the changes caused by external agents/factors—may be regarded as the key player in psychotherapy as well as the remedy for all sources of distress in both medicine and psychological disorders. Facco [20] *(this issue)* explores the potential of hypnotherapy to promote and enhance resilience by empowering patients to better cope with adverse events and with precipitating sources of suffering and pain and emphasizes the role of both Eastern and pre-Socratic philosophy in exploring the inner-outer world relationship, thereby allowing a deep resilience. The counterpart of resilience in modern Western culture is still to be explored.

Moss [21] *(this issue)* focuses on integrative medicine that attends the psychosocial dimensions of chronic lifestyle-based disorders comprehensively and seems to offer better promise for the patients, clinicians, and researchers. Despite being evidence-based, person-centered, and attuned to subjective and comprehensive dimensions of a human being, hypnosis currently receives relatively less attention in integrative medicine, and it remains untapped despite the availability of many effective clinical protocols for a wide range of medical conditions. The author introduces and discusses emerging paradigms in integrative healthcare in order to improve educational preparation for hypnosis practitioners to comply with these paradigms.

Hypnotizability is a psychophysiological trait associated with several patterns, including the level of functional, neuroanatomical equivalence between imagery and perception. This pattern is stronger in easily hypnotizable subjects (highs) than in low hypnotizable subjects (lows).

Ruggirello et al. [22], (*this issue*) explored the correlation between electroencephalogram (EEG) of imagined arm/hand movements (MI) and actual movements performed in the absence of suggestions (M) and in the presence of suggestions of arm/hand anesthesia (MA) in easily and low hypnotizable subjects. *Highs* reported better imagery during MI, greater perceived influence of the suggestion of anesthesia during MA, and lower cognitive efforts than the *lows* for both the tasks. As revealed in previous studies, the spectral analysis did not reveal significant restructuring of the cortical activity during tasks in *highs*, whereas *lows* showed cortical changes during MI and MA indicating that they were able to mentally simulate movements and accept suggestions for anesthesia during voluntary movement, despite having low hypnotizability scores.

Nowadays, hypnosis is increasingly being recognized by the international scientific community not only as an effective clinical intervention to control several psychosomatic disorders but also as a valid and flexible physiological tool to explore the central and peripheral nervous system. This appears to be a real Copernican revolution in the field [1, 13].

This special issue compiles landmark studies and traces the evolution of hypnosis and charts its future therapeutic potential as well. It is hoped that the compendium of articles in this issue may raise more questions than answers, stimulating critical thinking, research at the leading edge of the fascinating and intriguing domain of hypnosis.

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The future of hypnosis depends greatly on the capacity of hypnosis researchers and clinicians to integrate hypnosis research and practice in broader areas of medicine, psychology and psychotherapy by building bridges of understanding.

Author Contributions

GDB wrote the manuscript and reviewed the final manuscript.

Competing Interests

The author has declared that no competing interests exist.

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