The Neurological Underpinnings of Hypnosis and its Clinical Applications

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Abstract

The brain is so complex that it is almost impossible to select one variable as the reason for a specific observation. This paper will discuss the neurological basis of hypnosis, and how hypnosis has made unique contributions to the refinement and development of cognitive neuroscience. In addition, hypnosis has been proven to cure many psychological and neurologically based diseases. Due to in-depth study of the neurological underpinnings of hypnosis, much advancement has been made in elucidating the relationship between the complex neural circuitry of the brain, its direct correlation to consciousness, and both the efferent and afferent neurological systems. New neuroimaging techniques, such as fMRI and other brain scanning methods such as Electroencephalography (EEG) and positron emission tomography (PET), have made it possible to localize task related regionally specific brain activity and cognitive mental state, which allows researchers to scientifically examine and construe the many obscure theories surrounding the phenomenon of hypnosis.

Introduction

Modern views on the experience of hypnosis are largely dominated by the belief that the "hypnotist" possesses the ability to generate a "sleep-like state" within the individual being hypnotized. It is then presumed that the hypnotist possesses a supernatural control over the person's mind, causing him to behave in an irrational manner. In actuality, hypnosis is a highly complicated component of neuroscience related to the intrinsic workings of the human brain. Neurobiologically, the induction of a hypnotic trance can be viewed as an alternate state of consciousness due to the modulation of brain activity critically related to areas in the brain that oversee the regulation of the conscious state of being (Kihlstrom, 2013). Hypnosis is also characterized as an increase in mental relaxation and mental absorption mainly related to changes in the anterior cingulate cortex (ACC), various areas of the prefrontal cortex and frontal lobes, cortical and sub-cortical areas, the ponto-mesencephalic brainstem, and changes of regional cerebral blood flow (rCBF) in these areas (Rainville et al., 2002). Contemporary scientific theories of hypnosis emphasize changes in the engagement or disengagement of specific neurocognitive processes, and their effect on performance and psychophysiological activity such as executive control and attention. Additionally, there are individual psychological characteristics, partially relating to genetic brain structure, predicting hypnotic susceptibility. Moreover, scientific experiments have proven that hypnosis can be effective as an analgesic. Hypnosis can reduce acute pain associated with invasive medical procedures, burn care pain, labor pain, as well as reduce chemotherapy side affects. Hypnosis can also decrease chronic pain such headaches, backaches, and fibromyalgia. The study of hypnosis and its clinical applications is an ever-evolving field that can greatly advance the understanding of the conscious versus the subconscious mind and the complex structure of the human brain.

History of Hypnosis

In the 1770's Anton Mesmer wrote his doctoral thesis titled: 'De influxu planetarum in corpus humanum' (On the Influence of the Planets on the Human Body), in which he revisited the ancient belief that the solar system emits invisible rays that affect our bodies. Mesmer called this idea the "animal magnetism" effect. He practiced his healing through animal magnetism, capturing the "magnetic fluid" through pieces of iron and conductive metals that he fixed upon the diseased areas on the patients´ bodies. He concluded that one could attain "magnetic" effects through the laying of hands, or even simply by speaking to the patient. His teaching became known as mesmerism. This theory was accepted until the mid-1800's. James Braid disproved this idea of mesmerism in 1840 (Gauld, 1992). Braid demonstrated, through various experiments, that hypnosis was nothing more than a fixation of attention rather than an occult shadow of mesmerism. Braid concluded that there is a biological and physical basis to what was previously known as "mesmerism", and coined the term "hypnosis", which comes from the Greek word "Hypnos", which means sleep (due to the trance-like state of the subject). Subsequently, many famous psychologists such as Milton Erickson, who introduced the Neuro-Linguistic Programming via hypnosis, used hypnosis to cure clients of psychological ailments (Gauld, 1992). The trance-like state of hypnosis is now known to be a reflection of biological circuitry and a form of focused attention as proposed by Braid. The future of hypnosis will be to uncover fully all the underlying neurological components of hypnosis and discover its many clinical applications.

Materials and Methods

In researching the neurological underpinnings of hypnosis and its clinical advantages, many articles and journals were compiled to properly explore and present this topic. References were obtained through PubMed, and Touro College's Database, in addition to Google scholar and EBSCO multisearch. Key words, such as; hypnosis, hypnotic susceptibility, clinical benefits of hypnosis, and hypnotic analgesia were used to find pertaining articles that are cited throughout this paper.

Contemporary rendition of hypnosis

Succeeding the Braidian definition of hypnosis, researchers argued regarding the exact definition of hypnosis and its causes. Hypnosis refers to a change in mental activity following an induction, which usually results in increased attention,

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dissociation, and an increased absorption in pertaining stimuli (Spiegel, 2007). Typical hypnosis includes alterations in sensory experiences, motor control, and even amnesia. During a hypnotic induction, specific neural synaptic circuits are activated to express one's character, and personality in relation with his/her character traits specifically portrayed during hypnosis. Herbert Spiegel (2007), an American psychiatrist who popularized hypnosis as a treatment for pain and other disorders, identified three characteristics of hypnotized individuals:

1. Dissociation is the conscious versus unconscious separation of memory, perception, and motor response from one's main awareness. The capacity to dissociate is biologically determined and is reflected in the Eye Roll (ER) movements controlled by the external ocular muscles (as explained below).

2. Absorption is the decrease in peripheral awareness to facilitate greater focal attention. The intensity and duration of this absorption is influenced by bio-psychological components of intelligence and motivation. Absorption is diminished by attention deficit disorders, impaired concentration, and some medications.

3. Suggestibility is characterized by how prone an individual is to accept new information as fact with a relative suspension of critical judgment.

Rainville et al. (2002) described hypnosis as a state of mental relaxation and mental absorption, which are both associated with the instructions used to induce a hypnotic state. Hypnotic relaxation results from the direct instruction to relax prior to a hypnotic induction, which leads to positive bodily feeling, drowsiness and mental ease. Mental absorption, otherwise known as fixed attention, as "total attention that fully engages one's representational resources and results in imperviousness to distracting events" (Rainville et al., 2002).

Individuals who were hypnotized reported having been in an altered state of consciousness, describing this state as an increase in mental relaxation, automatic response, slight disorientation of time, increased imagery, focused attention, dissociation of irrelevant stimuli, and a disorientation toward their sense of self (Oakley and Halligan, 2009).

Hypnosis susceptibility

Hypnotic susceptibility is unique to each individual. Some people are easily hypnotizable while others are virtually unaffected by hypnotic induction. Hypnotic suggestibility scales are the primary way to measure hypnotic susceptibility. Two such scales include the Stanford Hypnotic Susceptibility Scale (SHSS) and the Harvard Group Scale of Hypnotic Susceptibility (HGSHS). These tests are constructed for standardized group administration and are scored by self-report. They consist of a recorded verbatim hypnotic induction, which is scored according to how similar the subjects responses are in relation to previously measured highly susceptible individuals. There are many other ways to measure hypnotic susceptibility, but these two scales are most commonly used in scientific experiments.

Hypnosis is thought to be a state of fixed attention and absorption. It can therefore be postulated that that the individuals who have the highest score in hypnotic susceptibility are more able to focus intently on one specific stimulus, disregarding other competing "noise"(Galbraith et al., 1970). There is much controversy as to whether or not hypnotic susceptibility depends on the individual's ability to selectively attend to the hypnotist's instructions, or whether it has to do with the ability to shut off distracting stimuli, creating a mental state where the subject is more able to capture the hypnotist's commands. A study was done to measure hypnotic susceptibility via an electroencephalogram (EEG). Subjects were asked to focus intently on a dim light. The EEG showed that those who scored highest on hypnotic susceptibility were more able to fix their attention on the dim light, which directly led to their ability to ignore all other stimuli (Galbraith et al., 1970). This discovery discounts the findings that hypnosis is an inhibitory response and lends credence to the fact that hypnosis is a result of fixed attention.

To further research this phenomenon, a case study was done to determine the differences in cortical activity in "high" and "low" individuals (in regard to hypnotic susceptibility). The EEG showed greater theta activity (4-8 Hz) in highly susceptible individuals in the anterior frontal cortex, as well as in the occipital cortices. Theta waves in the frontal lobes and occipital cortices are associated with vivid visualizations, and great imagination. This shows a pattern of EEG dimensionality more consistent with imagery processes, which are controlled by various parts of the frontal, occipital and parietal regions of the brain. Low susceptible individuals exhibited a pattern more consistent with cognitive activity such as mental math (Blai et al., 1998). This study was done in conjunction with another study involving neuropsychological tests. These tests were administered to both "high" and "low" individuals. The tests were selected to examine potential differences in tasks using the prefrontal cortex, as well as verbal and visual-spatial modalities. The WCST (Wisconsin Card Sort Test) tests the ability to detect relevant information by dissociating the irrelevant. Overall, a faster performance was observed in the highly susceptible individuals, which indicated that highly suggestive participants are more flexible in their ability to shift cognitive sets, which is consistent with the results of the EEG (shifting cognitive sets more easily insinuates a greater imaginative ability) (Blai et al., 1998).

In 1992, Herbert Spiegel presented three different personality styles based on the way an individual related to the self and to the world. Those who score high on hypnotic ability tend to be more trusting, have a higher degree of malleability, and an extreme propensity to dissociate. This lends to total absorption with a complete abandonment of peripheral awareness. Those who are not susceptible tend to place logic at highest priority and have a limited experience of dissociation, having constant peripheral awareness. Those in midrange exhibit trends toward oscillating between relative periods of action and inaction. They tend to fluctuate between feeling and thinking and have a moderate ability to express dissociation.

In a study conducted by Herbert Spiegel in 2006, the measure of what was referred to the "eye roll" determined hypnotic susceptibility. This proved that there was a discernable biological component in the ability to experience a hypnotic state. The eye roll is the distance between the lower eyelid and the bottom of the cornea. Spiegel hypothesized that hypnotic susceptibility was based on the amount of sclera seen in the eye while hypnotized. Consequently, experiments showed that his hypothesis was correct. When he asked his patients to look up during the induction phase of hypnosis, he found that if the eye roll was so high that nothing but the sclera was showing, that individual has a higher neurological capacity for dissociation and focused attention, thereby having the potential to be highly hypnotizable. This is attributed to the basic biological circuitry of the brain unique to each individual. This complex circuitry involves spinal cord pathways, the trigeminal nerve that includes the ocular motor muscles (which explains the ER phenomena), as well as the vagus complex and many other nuclei and neural circuits. Conversely, if little sclera is seen between the lower lid and the cornea, that individual has a lower biological dissociative ability and is therefore only capable of low hypnotic capacity. This study was further proven in conjunction with the Hypnotic induction profile, which provides an assessment for mental concentration, the ability to internalize new ideas, disassociation, and the capacity to experience sensory alteration. This proves that the ER can be regarded as a surface indicator of underlying synaptic circuitry.

To enable those who have low hypnotic susceptibility to benefit from hypnotherapy, studies have been done to determine whether hypnotic susceptibility can be increased. A study done by Kinny and Sachs (1974) demonstrated that hypnotic susceptibility could indeed be increased in some individuals. Additionally, this experiment determined whether the permutation in hypnotic susceptibility is attributed to actual cognitive and perceptual changes or to a response alteration due to expected behaviors. The experiment included training that was found to improve hypnotic susceptibility in past experiments. Participants were taught how to imagine certain sensations so acutely until the perception of the sensory explanation was perceived as being genuine. The goal of this learning process was to teach participants how to feel the sensation that was imagined, in addition to blocking out other competing variables. Therefore, it can be inferred that the more imaginative a person is, the more susceptible they are to hypnosis. The SHSS was given after each training session to measure the progress of the participants. The result of this experiment proved to be exceedingly intriguing. Overall there was an increase in hypnotic susceptibility among most of the subjects. Researchers postulate that the reason for this change can be attributed to three variables: learning, attitude and motivation. This can essentially be positively correlated to the learning process of all other skills. Subjects practiced attending to specific sensations and blocking out others. Moreover, subjects were allowed to advance at their own pace to ensure optimal results. There were also changes in the attitude previously attributed to hypnosis. Many subjects were originally skeptical regarding the legitimacy of hypnosis. Once they accepted the fact, for example, that their hand could be lowered involuntarily, they were more willing to capitulate to the hypnotic induction. Subjects then reported that they were better able to concentrate, and believed that they had greater autonomy over their actions during hypnosis. The subjects who originally portrayed controlling, rigid and/or fearful personalities failed to show large improvements in their ability to be hypnotized. They were afraid of losing control and were concerned that their mind would betray them during the hypnotic stage (Kinny and Sachs, 1974). Furthermore, hypnotic susceptibility has been shown to be a stable trait due to studies that tested the hypnotic susceptibility of the same individuals at different ages. Therefore, it can be deduced that hypnotic susceptibility can be attributed to personality traits that are inherent in each individual, which also control their ability to imagine, focus attention, and absorb internal stimuli.

Neurological underpinnings of hypnosis

There is much controversy regarding the neurological basis of hypnosis. This is attributed to the fact that much remains unknown regarding the various structures and networks present in the brain. Although many studies show conflicting results, there are some conclusions that can be deduced from the many studies that examined this topic. The following comprehensive study was done by Rainville et al. in 1999 and was later repeated in 2002, attaining similar results. Therefore, it can be assumed that the information presented in these studies can be considered rather factual, as opposed too purely theoretical. The effects of hypnosis on regional cerebral blood flow (rCBF) were measured using positron emission tomography (PET), which gauges the rCBF in the brain. "Pure" hypnosis (hypnosis without suggestion) was accompanied by a considerable increase in rCBF in the following regions: the occipital region, the right anterior cingulate cortex, and bilaterally in the inferior frontal gyri. Decreases in rCBF were found in the right inferior parietal lobe, the posterior cingulate gyrus, and the left precuneus. Hypnosis with suggestion showed additional increases in rCBF in the frontal cortices, chiefly in the left side of the brain (Rainville et al., 1999). This is attributed to the fact that the proposal for an altered perception reflects the verbal arbitration of suggestion and top-down processing involved in the reinterpretation of the perceptual experience (Kihlstrom, 2013). An increase in delta rhythms shown in the EEG performed along with the PET, supports the theory that hypnosis reflects an altered state of consciousness which is associated with decreased arousal. Moreover, findings show a great increase in occipital rCBF, which supports the theory that hypnosis facilitates visual imagery.

rCBF differences in "pure" hypnosis

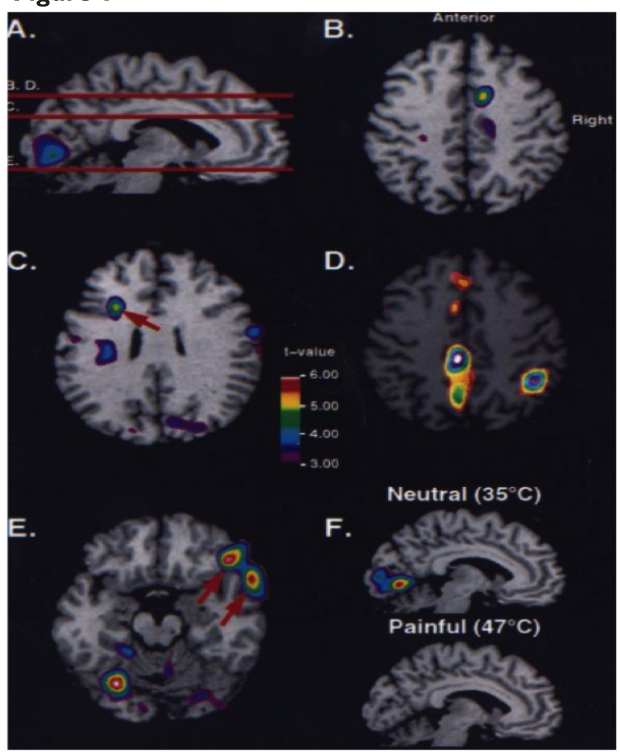
Hypnotic induced relaxation showed a wide-spread increase in rCBF bilaterally in the occipital lobes (Figure 1). Interestingly, comparable effects have been reported during visual imagery. In this study, subjects were not encouraged to engage in imaginative thinking, but spontaneous visual imagery was reported in many subjects. This phenomenon could be attributed to the establishment of deep relaxation, which has been proven to facilitate visual imagery processes (Brann et al., 2012). Other areas associated with an increase in rCBF included: the inferior frontal gyri, which are associated with prepotent responses, and the right anterior cingulate cortex (ACC), as seen in Figure 1. The ACC is an area in the brain that is connected to functions related to conscious experiences and the emotional interpretation of pain. Greater rCBF in the ACC was present in more emotionally aware females (Lane et al., 1998). Many studies have found that the ACC is involved in functions such as anticipation tasks, attention, and motivation (Bush et al., 1999). Moreover, focus of attention is associated with the anterior cingulate gyrus, which is consistent with the definition of hypnosis as being a state of focal attention and increased concentration.

Decreases in rCBF were associated with the inferior parietal lobule, which involves language and mathematical operations. It is remarkable to note that individuals with low hypnotic susceptibility tend to exhibit a greater preference to cognitive activities such as mental math (as aforementioned). Specific parts of the posterior parietal cortex also showed a significant decrease in rCBF (Figure 1). The posterior parietal cortex attends to processes involving spatial attention, orientation to external stimuli, and self-representation. A decrease in rCBF in this area reflects the decreased orientation to extrapersonal and somatic stimuli observed in individuals under hypnotic influence. Additional decreases in rCBF were found in the medial precuneus, which is involved in self-processing operations, and is part of the network of the neural correlates of self-consciousness and self-related mental representation (Cavanna and Trimble, 2006). A reduction in rCBF was observed in the left posterior cingulate gyrus, which has been proven to become deactivated during effortless mind wandering, while controlled awareness corresponded to activation in the posterior cingulate (Garrison et al., 2013), the left medial superior frontal gyrus, which is involved in self -awareness in conjunction with sensory system, and left posterior middle temporal gyrus, whose function remains unknown (Rainville et al., 1999).

rCBF differences in suggestion related hypnosis

Increases in rCBF were seen predominantly within the medial superior and left dorsolateral regions of the frontal lobes, in addition to the right dorsolateral frontal lobule (Figure 2). This can reflect the verbal mediation of hypnotic suggestions, working memory processing, and top-down mechanisms involved in the reinterpretation of the sensory experience sometimes used

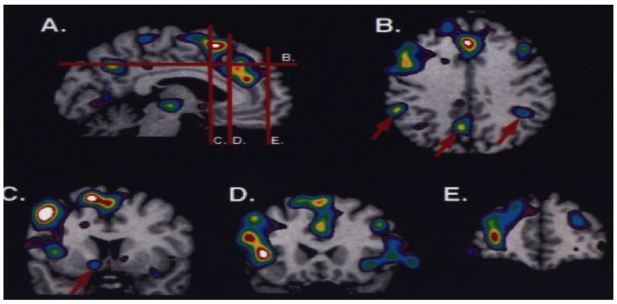
Figure 1



Statistical (t) maps of hypnosis-related increases in rCBF, across stimulation conditions, in occipital (A), right anterior cingulate (B), left frontal (arrow in C), right frontal and right temporal cortices (arrows in E). Decreases in blood flow were found in right lateral and medial posterior parietal cortices (D). When analyzed separately in each stimulation condition, the hypnosis-related increase in occipital rCBF was observed mainly in the neutral stimulation condition, as shown in F. (Rainville et al., 1999).

in the induction of hypnosis. Similar effects have been found in subjects who were asked to listen and list words that include verbal lexical-sematic processing (Oakley and Halligan, 2009).

Figure 2



Statistical (t) maps of suggestion-related changes in rCBF show increases in medial (A) and dorsolateral frontal cortices (C, D, and E), and in medial and lateral posterior parietal cortices (arrows in B). Arrow in D shows significant subcortical increase in left nucleus accumbens. (Rainville et al., 1999).

Therefore, it was postulated that the left anterior lobes are largely involved in the internally generated reinterpretation of stimuli, which can lead to an alteration in perception known to affect hypnotized individuals (Rainville et al., 2002). Significant increases were also seen in the left medial parietal and bilateral posterior parietal cortices (Figure 2). This can be attributed to the specific content of the suggestion, which may cause specific somatic interpretation of perception. Decreases were found in the right uncus, bilateral in posterior orbitofrontal regions, and the left lateral cerebellum (Rainville et al., 1999).

Hypnotically induced changes in neural oscillations as measured by EEG

When searching for neurological changes in the brain due to hypnosis, Electroencephalography (EEG) can directly measure the electrical activation of the various parts of the brain. An EEG records the frequency (measured in Hz) and amplitude (measured in microvolts) of waves produced by electrical brain activity. Four simple periodic rhythms are recorded in the EEG: alpha, beta, delta, and theta. These rhythms are associated with the frequency of the waves. Alpha waves are typically 8-13 Hz. Alpha rhythms are usually prominent in adults who are awake, but in a very relaxed state (e.g. eyes closed). These alpha waves diminish when subjects tune into external stimuli and are usually observed to be of the greatest amplitude in the parietal and occipital regions of the cerebral cortex. In contrast, Beta rhythms (13-30 Hz) occur in individuals who are attentive to external stimuli, or who exhibit specific mental stimulation. In essence, Beta waves represent the arousal of the cerebral cortex to higher degrees of alertness and attention. Delta waves (1-5 Hz) are generated in deep meditation, and suspend external awareness. It has been proven that healing and regeneration occur in this state as well. Theta waves (4-8 Hz) are low-frequency rhythms that are dominant in deep meditative sleep. Senses in this state ignore external stimuli and focus on the subconscious. Vivid imagination beyond normal conscious awareness is present in this stage as well (Lee et al., 2007). Not surprisingly, these rhythms directly correspond to the EEG brain waves associated with different stages in hypnosis.

A case study was done to determine whether an EEG during "pure" hypnosis (hypnosis without suggestion) would differ from a normal non-hypnotic EEG. Pure hypnosis can be categorized as a state of heightened attention and increased alertness, reflected in neuronal activation (Rainville et al., 1999). These neural changes account for the susceptibility to suggestion after a hypnotic induction. This study concluded that hypnosis affected all of the EEG electrodes. Occipital and frontal EEG channels were most affected by hypnosis. There was up to an 89% increase in Spectral Pattern (SP) from baseline to hypnotic state in the frontal lobes. Right parietal and mid-frontal EEG channels increased 11%. Comparative analysis demonstrated that hypnotic conditions caused a large increase in delta, beta, and theta rhythmic segments in various areas of the brain when compared to the non-hypnotic state EEG. Although all EEG channels were affected by hypnosis, the prefrontal cortex (Fp1 and Fp2 electrodes) and the right occipital electrode (O2) showed the greatest percentage increase (Fingelkurtz et al., 2007). This data is consistent with the knowledge that many neural changes in these areas occur during hypnosis. Hypnosis increased beta activity and decreased delta activity in the frontal lobes. This is an interesting phenomenon, for delta rhythms should increase during hypnosis while beta rhythms should technically decrease when measured in accordance to the mental states that they represent. However, it can be inferred that the EEG measured hypnotic state after induction, which can account for the increase in beta waves due to heightened attention, while an increase in delta waves may have been observed during the induction, but decreased thereafter. A majority of beta rhythmic conditions appeared in the EEG only after the induction of hypnosis. This unique composition in brain oscillation in the prefrontal cortex during hypnosis reinforces the premise that this area is of major import in the hypnotic state (Fingelkurts et al., 2007). In addition, these findings disprove previous views that hypnosis constitutes a sleep-like state. This study further demonstrates that in actuality, hypnosis is a state of increased alertness and heightened attention to internal stimuli, as proven by the increase in beta waves. Moreover, this confirms the theory that the frontal lobes are extensively involved in attention networks.

To further elucidate the notion that suggestion for specific perception under hypnotic induction facilitates the same response in cortical activity as reality, a study was done by Kosslyn et al. (2000) in which color perception in the brain was recorded. A grey-scale image was shown to hypnotically induce participants with a suggestion to perceive a colored image. There was modulation of activity in the fusiform gyrus that is responsible for color processing in the brain, thereby proving that when hypnotically induced, the brain interprets perception as authenticity.

Hypnotic Analgesia

The mechanism through which hypnosis reduces pain is still quite obscure; however, there is a plethora of scientific evidence proving the effectiveness of pain amelioration via hypnosis. Pain is a spinal nociceptive reflex. Once the nociceptive signal reaches the brain, a sensory and affective discriminative neural network acts to facilitate the conscious perception of pain (Perl, 2011). Structures in the brain that compromise these networks include the primary and secondary somatosensory cortices (S1 and S2), thalamus, insula, and the ACC (Rainville, 1998). Hypnotic analgesia is thought to be attention based in that incoming stimuli are inhibited while awareness is simultaneously deployed elsewhere (Eimer, 2000). The inhibition of afferent nociceptors can be attributed to the decrease in thalmic activity when hypnotically induced (Faymonville et al., 2003). Miron, Ducanan, and Bushnell (1989) conducted a study in which subjects were instructed to attend to a painful stimulus or divide their attention between the painful stimulus and a visual stimulus. Pain reduction was reported in subjects who were asked to divide their attention between two simultaneous stimuli. These results support the hypothesis that when faced with competing processes, attention is directed to other processes, thereby inhibiting the conscious perception of pain. This process depends on a supervisory attention control system that operates to relocate thalamocortical activities. Incoming painful stimuli are suppressed at cortical levels and do not enter conscious awareness, thereby reducing the degree of perceived pain by invoking physiological inhibitory processes of the brain (Faymonville et al., 2003).

Although most studies attribute the reduction in pain to cortical activity, a study was conducted to monitor nociception at the spinal cord level and how it is affected by hypnosis. A study done in 1998 demonstrated that a suggestion for analgesia directly correlates with the spinal nociceptive (R-III) reflex. Subjects showed strong inhibition of the R-III reflex at the spinal cord level in response to hypnotic induction (Danziger et al., 1998). These results are rather intriguing because they introduce a new aspect of hypnosis, independent of the cognitive model. There is no recorded scientific basis for these findings, but they do insinuate that there may be mechanisms in the peripheral nervous system that are directly influenced by hypnosis.

There has been much research as to whether hypnotic analgesia affects the sensory or affective processing of pain. Researchers speculated that hypnosis has a greater affect on the affective system because that system has a greater cognitive evaluation, while the sensory system is modulated by nociceptive inputs from the peripheral nervous system. Studies have shown that both are affected by hypnosis. Hypnotic analgesia produces both a modulation of pain effect by producing changes in the anterior cingulate cortex, and inhibition of afferent nociceptive signals arriving at the somatosensory cortex. Hypnotic suggestion for altering pain unpleasantness affected rCBF flow to the ACC, but not to the S1 Cortex, proving the role of the ACC in pain affect. Suggestion for modulating pain intensity affected rCBF mainly in the S1 and S2 cortices and had little affect on the ACC. These results are consistent with the role of the somatosensory cortex in the sensory dimensions of pain. Interestingly, the context of the suggestion that facilitated the analgesia determined to what degree the affective and sensory systems were affected (Rainville, 1998).

Researchers at the University of Iowa conducted a case study in 2004 to determine the difference in pain perception in hypnotically induced individuals. fMRI (functional magnetic resonance imaging) was used to measure brain activity. A painful thermal stimulus was applied to the participants' left hand. The subjects were then hypnotized, and their brain activity was recorded by the fMRI. The hypnotic state was then broken and the procedure was repeated. Hypnosis was successful in reducing perceived pain in all of the individuals. Participants reported a significant pain reduction or feeling no pain. The fMRI reported decreased activity in the primary sensory cortex, which is involved in pain perception. Increased activation was seen in the basal ganglia and the anterior cingulate cortex. The increase in brain activity in these two regions could be attributed to their involvement in the inhibition pathway that blocks pain signals from reaching higher cortical areas responsible for pain perception (Schulz-Stübner et al., 2004).

The induction of hypnotic analgesia, simply known as the reduction of pain via hypnosis, can offer amelioration of pain intensity and offer an alternative to drugs that have various negative side effects. By utilizing direct suggestion such as suggesting numbness (glove anesthesia), direct suggestion for turning down pain, physical dissociation from painful areas of the body, pain relief imagery, or cognitive reframing while in an hypnotic state, pain reduction is possible (Eimer, 2000).

A study was conducted to ascertain whether pain modulation requires a hypnotic suggestion for pain reduction, or if pure hypnosis affects the ratings for pain unpleasantness. Participants were expected to submerge their left hand in painfully hot water (470C) during pure hypnosis and then again in response to a suggestion for pain reduction while hypnotized. The relationship between pain effect and cerebral activity was recorded via PET. An increase in rCBF was seen in the insular cortex, where a person imagines pain while looking at painful images and feels sensation of pain and its intensity. Increases were also found in the ACC, which mediates affective response to noxious stimuli, and the primary and secondary somatosensory cortical areas (S1 and S2), which are believed to involve the sensory discriminating processing of pain. Comparing hypnosis related changes in rCBF in neutral and painful stimuli conditions tested the effect of hypnotism on pain reduction. A strong lateralization increase in rCBF in the right ACC has been shown in conjunction with the experimental painful stimuli. Furthermore, although pain and hypnosis related ACC sites were anatomically close within broadmann area 24 (which is part of the cingulate gyrus), the pain related peak was medial along the cingulate gyrus and the hypnosis related peak was more lateralized in the cingulate sulcus. Occipital rCBF was less when a pain modulatin suggestion was proposed in relation to occipital rCBF without suggestion. Additionally the amount of pain reduction and pain unpleasantness was directly correlated with the participant's level of hypnotic susceptibility (Rainville et al., 1999).

Hypnosis in treating acute pain

Acute pain is defined as pain that gradually resolves as the injured tissue heals. Many studies have been done to uncover the effects of hypnosis on the reduction of acute pain. A study was performed in 1991 to determine the effects of hypnosis in treating invasive medical procedure pain. This study compared participants who received pre-surgery hypnosis prior to angioplasty surgery with participants who received standard care. The hypnotically induced patients showed a 25% increase in the amount of time they allowed the cardiologist to keep the balloon catheter inflated, and showed a substantial reduction in opioid analgesics that are vital during the procedure. The hypnotically induced group also showed a significant decrease in catecholamine blood levels relative to the control group (Weinstein and Au, 1991). Another study done in 1996 produced similar results. Sixteen patients received hypnosis with a suggestion for relaxation and pain relief imagery while fourteen patients were treated with the standard procedure. Hypnotized patients reported less pain, used less pain medication, and showed more physiological stability during the diagnostic arteriogram procedure. No statistically significant differences in heart rate or blood pressure were recorded (Lang et al., 2000).

Bone marrow transplant patients often receive supralethal doses of chemotherapy prior to the procedure. This treatment often results in severe nausea, pain from oral mucositis, and vomiting. Patients were hypnotically induced and were given suggestion for pain control and relaxation. Most patients reported a significant reduction in pain; however, no significant differences emerged regarding nausea and vomiting (Syrjala et al., 1992). Burn care patients who were treated with hypnosis reported a reduction in burn-related pain and even facilitated wound healing (Patterson et al., 2003). Additionally, burn patients who received hypnosis used significantly less analgesic drugs than the control group (Wakeman and Kaplan, 1978). Labor pain is also a good candidate for hypnosis. There have been many clinical benefits recorded in using hypnosis to reduce labor pains. Women who were given sessions of posthypnotic suggestions for pain relief and relaxation during labor showed shorter stage 1 labor and reported less labor pain (Davidson, 1962). Freeman et al. (1986) conducted another study in which women received hypnosis before labor. Hypnosis involved suggestion for pain relief and for transferring anesthesia from the hand to the abdomen. No differences were reported in pain relief during labor; however, highly susceptible individuals reported that hypnosis helped reduce their anxiety during labor, thereby helping them cope effectively with the pain.

Hypnosis in treating chronic pain

Chronic pain is defined as pain that persists beyond the healing time needed for a specific injury. Many psychological factors, such as patient coping responses, patient cognition, and environmental factors play an important role in the expression and experience of chronic pain, while acute pain is directly related to the injury itself. Therefore, different techniques in hypnosis must be used in the treatment of chronic pain as opposed to acute pain. The difficulty in treating chronic pain with hypnosis can be maintaining reduced pain awareness for an extended period of time (Patterson et al., 2003). Many studies have been performed to determine the effectiveness of hypnosis on headaches, fibromyalgia, and back pain. Other etiologies of chronic pain have not been extensively researched. Hypnosis treatment was given to 47 subjects suffering from migraine headaches. The control groups consisted of participants who were not given any treatment as well as subjects who were given prochlorperazine. Suggestion was given for visual imagery techniques, pain reduction, and for the aversion to migraine headaches. The patients who received hypnotherapy reported fewer headaches per month, a higher frequency for remission, and fewer Grade 4 headaches (Anderson et al., 1975). Hypnosis was also proven to be more effective than physical therapy in the treatment of fibromyalgia. Muscle pain, fatigue, and sleep disturbances caused by fibromyalgia were improved via hypnosis (Haanan et al., 1991). Back pain was also shown to improve when treated with hypnosis. A study done among 22 patients suffering from spinal cord injury related pain showed an 86% decrease in pain following a hypnotic induction (Jensen et al., 2001).

Conclusion

Although there is still much obscurity surrounding the intriguing phenomena of hypnosis, much research has been done to elucidate the underlying mechanisms and benefits of this remarkable phenomenon. Hypnosis has matured to become both a worthwhile treatment option for many medical conditions as well as a significant research tool in the quest to understand human cognition. The actual benefits of hypnosis can be seen through various experiments, both cognitively and clinically, disputing researchers who term hypnosis as being one giant placebo effect. The clinical applications of hypnosis are numerous, and more study is being done to discover viable hypnotic treatments for various illnesses. By understanding of the neurophysiological mechanisms underlying the hypnotic modulation of conscious experience, and its specific patterns of cerebral activation, one can appreciate, and potentially benefit, from the many advantages of hypnosis both in research and in practice.

References

Anderson, J. A., M. A. Basker, and R. Dalton. "Migraine and hypnotherapy." International Journal of Clinical and Experimental Hypnosis 23 (1975): 48-58. Print.

Blai, A., W. Ray, D. Aikins, J. Coyle, and E. Bjick (1998): Understanding hypnosis and hypnotic susceptibility from a Psychophysiological perspective. On-line Proceedings of the 5th Internet World Congress on Biomedical Sciences '98 at McMaster University, Canada.

Brann, Les, Jacky Owens, and Ann Williamson. The Handbook of Contemporary Clinical Hypnosis: Theory and Practice. N.p.: John Wiley & Sons, 2012. Print.

Bush, G., P. Luu, and M. I. Posner. "Cognitive and emotional influences in anterior cingulate cortex." Trends in Cognitive Neuroscience 4 (2000): 215-22. Print.

Cavanna, Andrea E., and Michael R. Trimble. "The precuneus: a review of its functional anatomy and behavioural correlates." Brain: A Journal of Neurology 129 (2006): 564-583. Web. 22 June 2015.

Danziger, N, E. Fourier, D. Bouhassira, D Michaud, and T De Broucker. "Different strategies of modulation can be operative during hypnotic analgesia: A neurological study." Pain 75 (1998): 85-92. Print.

Davidson, J. "An Assessment of the Value of Hypnosis in Pregnancy and Labor." British Medical Journal 2 (1962): 951-52. Print.

Eimer, Bruce N. "Clinical Applications of Hypnosis for Brief and Efficient Pain Management Psychotherapy." American Journal of Clinical Hypnosis 43 (2000): 17-40. Print.

Faymonville, M. E., Roediger, L., Fiore, G. D., Delgueldre, C., Phillips, C., Lamy, M., Luxen, A., Maquet, P., Laureys, S. "Increased cerebral functional connectivity underlying the antinociceptive effects of hypnosis." Cognitive Brain Research 17 (2003): 255-262.

Fingelkurts, Alexander A., Andrew A. Fingelkurts, Sakari Kallio, and Antti Revonsuo. "Hypnosis Induces a Changed Composition of Brain Oscillations in EEG: A Case Study." Contemporary Hypnosis 24 (2007): 3-18. Print.

Freeman, R. M., A. J. Macaulay, L. Eve, G. V. Chaimberlain, and A. V. Bhat. "Randomized trial of self-hypnosis for analgesia in labour." British Medical Journal (Clinical Research Ed.) 292 (1986): 657-58. Print.

Galbraith, Gary C., Perry London, Morris p. Leibovitz, Leslie M. Cooper, and Joseph T. Hart. "EEG and Hypnotic Susceptibility." Journal of Comparative and Physiological Psychology 72.1 (1970): 125-31. Print.

Garrison, K. A., J. F. Santoyo, J. H. Davis, T A. Thornhill, and C. E. Kerr. "Effortless awareness; using realtime neuro-feedback to investigate correlates of posterior cingulate cortex activity in mediator;s self report." Frontiers in Human Neuroscience 7 (2013): 440. Print.

Gauld, Alan. A History of Hypnotism. New York: Cambridge University Press, 1992. Print.

Haanen, H. C., H. T. Hoenderdos, L. K. Van Romunde, W. C. Hop, and C. Mallee. "Controlled trail of hypnotherapy in the treatment of refractory fibromyalgia." Journal of Rheumatology 18 (1991): 72-75. Print.

Jensen, M., J. Barber, R. Avery-Willaims, L. Flores, and M. Brown. "The effect of hypnosis suggestion on spinal cord injury pain." Journal of Back and Musculoskeletal Rehabilitation 14 (2001): 3-10. Print.

Kihlstrom, John F. "Neuro-hypnostism: Prospects for hypnosis and neuroscience." Cortex 49 (2013): 365-74. Print.

Kinney, Jill M., and Lewis B. Sachs. "Increasing Hypnotic Susceptibility." Journal of Abnormal Psychology 83 (1974): 145-50. Print.

Kosslyn, S. M., Thompson W., Costantini-Ferrando M., Alpert N., Spiegel D. "Hypnotic visual illusion alters color processing in the brain." American Journal of Psychiatry 157 (2000): 1279-84. Print.

Lane, R D., E. M. Reiman, B Axelrod, G. E. Schwartz, and A Holmes. "Neural correlates of levels of emotional awareness. Evidence of an interaction between emotion and attention in the anterior cingulate Cortex." Journal of Cognitive Neuroscience 10 (1998): 525-35. Print.

Lang, E.V., Benotsch, E. G., Fick, L. J., Lutgendorf, S., Berbaum, M. L., Berbaum, K. S., Logan, H., Spiegel, D. (2000). Adjunctive non-pharmacological analgesia for invasive medical procedures: a randomised trial. The Lancet, 355, 1486-1490.

Lee, J-S, D Spiegel, S. B. Kim, and B. H. Yang. "Fractal analysis of EEG in hypnosis and its relationship with hypnotizability." Journal of Clinical and Experimental Hypnosis 55 (2007): 14-31. Print.

Miron, D, G H. Ducanan, and M C. Bushnell. "Effects of attention on the intensity and unpleasantness of thermal Pain." Pain 39 (1989): 345-352. Print.

Oakley, David A., and Peter W. Halligan. "Hypnotic suggestion and cognitive neuroscience." Trends in Cognitive Neuroscience" 13 (2009): 264-270. Web. 22 June 2015.

Patterson, David R., and Mark P. Jensen. "Hypnosis and Clinical Pain." Psychological Bulletin 129 (2003): 495-521. Print.

Perl, Edward R. "Pain Mechanisms: A commentary on concepts and Issues." Prog Neurobiol. 94 (2011): 20-38. Print.

Rainville, Pierre. "Brain Imaging Studies of the Hypnotic Modulation of Pain Sensation and Pain Affect" (1998): On-line Proceedings of the 5th Internet World Congress on Biomedical Sciences '98 at McMaster University, Canada.

Rainville, Pierre, Robert K. Hofbauer, Gary H. Duncan, Catherine M. Bushnell, and Donald D. Price. "Cerebral Mechanisms of Hypnotic Induction and Suggestion." Journal of Cognitive Neuroscience 11 (1999): 110-25. Print.

Rainville, Pierre, Robert K. Houfbauer, Catherine Bushnell, Gary H. Duncan, and Donald d. Price. "Hypnosis Modulates Activity in Brain Structures Involved in the Regulation of Consciousness." Journal of Cognitive Neuroscience 14 (2002): 887-901. Print.

Spiegel, Herbert. "The Neural Trance: A New Look at Hypnosis." Intl. Journal of Clinical and Experimental Hypnosis 55 (2007): 387-410. Print.

Spiegel, Herbert. "An eye-roll test for hypnotic susceptibility." The American Journal of Clinical Hypnosis 15 (2006): 25-29. Print.

Syrjala, K. L., C. Cummings, and G.W. Donaldson. "Hypnosis or cognitive behavioral training for the reduction of pain and nausea during cancer treatment." Pain 48 (1992): 137-46. Print.

Schulz-Stübner, Sebastian, Timo Krings, Ingo Meister, Stefen Rex, and Armin Thron. "Clinical Hypnosis Modulates Functional Magnetic Resonance Imaging Signal Intensities and Pain Perception in a Thermal Stimulation Paradigm."Regional Anesthesia & Pain Medicine 29 (2004): 549-56. Print.

Wakeman, J R., and J. Z. Kaplan. "An experimental study of hypnosis in pain burns." Americal Journal of Clinical Hypnosis 21 (1978): 3-12. Print.

Weinstein, E. J., and P. k. Au. "Use of hypnosis before and after angioplasty." American Journal of Clinical Hypnosis 34 (1991): 29-37. Print.