NEGATIVE AND POSITIVE VISUAL HYPNOTIC HALLUCINATIONS: Attending Inside and Out

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Abstract: Hypnotic perceptual alteration affects brain function. Those hypnotic instructions that reduce perception by creating an illusory obstruction to it reduce brain response to perception in the cognate sensory cortex, as measured by event-related potential (ERP) amplitude and regional blood flow (PET). Those hypnotic instructions that affect the subject’s reaction to perception activate the anterior attentional system, especially the anterior cingulate cortex in PET studies. Hypnosis involves activation without arousal and may be particularly mediated via dopaminergic pathways. Hypnotic alteration of perception is accompanied by measurable changes in both perceptual and attentional function of those specific regions of the brain that process these activities, modulated by the nature of the specific hypnotic instruction. Positive obstructive hallucinations seem to allow for a hypnotic focus inward, activating the functioning of attentional neural systems and reducing perceptual ones.

Perhaps the oldest and best established clinical use of hypnosis is pain control (Esdaile, 1846/1957; Hilgard & Hilgard, 1975). From almost the beginning of its history, the role of hypnosis in altering perception was one of its most visible and useful attributes. There is now considerable evidence that hypnosis is quite effective in ameliorating pain (Chaves, 1994; Hilgard & Hilgard, 1975; Holroyd, 1996; Kuttner, 1988; Lang & Joyce, 1996; Lang et al., 2000; McGlashan, Evans, & Orne, 1969; NIH Technology Assessment Panel on Integration of Behavioral and Relaxation Approaches into the Treatment of Chronic Pain and Insomnia, 1996; Patterson, Everett, Burns, & Marvin, 1992; Spiegel & Bloom, 1983; Whorwell, Prior, & Faragher, 1984; Zeltzer & LeBaron, 1982; Zeltzer, LeBaron, & Zeltzer, 1984). Therefore, it is of more than academic interest to understand how hypnosis modulates perception in the brain.

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There are a number of promising leads regarding brain mechanisms underlying hypnotic perceptual alteration. It has by now been well established that hypnotic alteration of perception is accompanied by measurable changes in brain electrical activity and blood flow. A major issue in the field now is the extent to which hypnotic perceptual alteration in general and hypnotic analgesia in particular can be accounted for by attentional shifts versus changes in primary perceptual processing (De Pascalis, 1999). De Pascalis suggests that both are involved but puts primary emphasis on attentional redeployment. Thus, one critical question now is the neuroanatomical location of the crucial changes: do they involve alterations in the primary sensory association cortices, in elements of the attentional system, or both?

**HYPNOTIC CHANGES IN SENSORY ASSOCIATION CORTEXES**

*Event-Related Potential Studies*

Early studies involved the relationship between perceptual alteration in hypnosis and event-related potential (ERP) amplitude. ERP studies provide good temporal but relatively poor spatial resolution and therefore contribute less to the anatomical question. The fundamental hypothesis is that if a hypnotized person reduces perception of the stimulus, there should be corresponding changes in the amplitude of the ERP to that stimulus. Half of some 20 early studies did demonstrate such an effect, although the rest did not. Problems with this early work included small sample size; the use of patient rather than normal populations, often with psychiatric or neurologic disease; and semi-quantitative analysis of ERP amplitude.

More recent studies have demonstrated ERP amplitude changes consistent with the content of hypnotic alterations, generally seen over the cognate sensory association cortex. Examples include hypnotic modulation of ERPs to visual (De Pascalis & Carboni, 1997; Jasiukaitis, Nouriani, & Spiegel, 1996; Spiegel, 1985; Spiegel & Barabasz, 1988), olfactory (Barabasz & Lonsdale, 1983), and somatosensory perceptual stimuli (De Pascalis, Magurano, & Bellusci, 1999; De Pascalis, Magurano, Bellusci, & Chen, 2001; Spiegel, Bierre, & Rootenberg, 1989).

In our laboratory, we found that highly hypnotizable normal individuals produced significant amplitude reductions in the P100 and P300 components of the visual ERP in response to a hypnotic suggestion of an obstructive hallucination blocking view of the stimulus generator (Spiegel, Cutcomb, Ren, & Pribram, 1985). We also found similar P300 reduction to somatosensory stimulation after a suggestion of hypnotic numbness (Spiegel et al., 1989). In a later study, we compared the effects of visual obstructive hallucination with the simple
instruction to attend to the contralateral visual field (Hillyard & Munte, 1984) in highly hypnotizable subjects. The directed inattention outside of formal induction reduced P100 in a manner similar to hypnotic obstruction (Jasiukaitis et al., 1996). Thus for this early component, there does not seem to be any special process different from inattention operating during obstructive hallucination, similar to the findings of Ray and De Pascalis (2003, this issue). However, for the P200 and P300 components of the waveform, directed inattention increased amplitude whereas hypnotic obstruction decreased it, especially over the occipital cortex, whereas the difference between simple visual field attention and inattention was primarily midfrontal. We believe the increased positive amplitude for these components in the frontal region during inattention reflects the absence of an underlying slow negativity, called processing negativity, which appears when particular sensory input features are selectively attended to. The reduced amplitude in the occipital cortex is consistent with a specific effect of hypnosis during obstructive visual illusion—the subject shows brain evidence of reduced perception consistent with the hypnotic illusion.

However, Barabasz initially observed the opposite of what we had found: that an obstructive hypnotic hallucination actually increased P300 amplitude (Barabasz & Lonsdale, 1983). This was puzzling in light of our finding that hypnotic visual obstruction reduced P300 amplitude (Spiegel, Cutcomb, Ren, & Pribram, 1985), a finding that has been confirmed by De Pascalis (De Pascalis & Carboni, 1997). Barabasz had utilized the anosmia to ammonia instruction of the Stanford Hypnotic Susceptibility Scale, which is worded: “You can no longer smell anything at all.” (Hilgard, 1965). Subjects who may have reduced their perception but not eliminated it completely might well have been surprised by the odor, and surprise increases P300 amplitude (Baribeau-Braun, Picton, & Gosselin, 1983). Barabasz accepted this interpretation (Spiegel & Barabasz, 1988) and went on to demonstrate in an elegantly designed experiment that an obstructive hallucination results in reduced ERP amplitude, whereas a negative hallucination results in increased amplitude (Barabasz et al., 1999; Jensen, Barabasz, Barabasz, & Warner, 2001). A crucial difference in the two instructions is the hardiness of the paradigm in the case of obstructive hallucination and the need to break with the paradigm if it does not work completely in the case of negative hallucination. An obstruction to perception need not be complete or perfect. One might well expect to see light through a curtain or box—this does not challenge the vividness or effectiveness of the instructed visual illusion. Thus, any degree of perceptual alteration still allows subjects to stay with the instructed paradigm—to focus on it rather than evaluate it or deal with competing input, therefore accounting for the associated and expected reduction in ERP amplitude. These studies underscore the importance of the specific wording and nature
of hypnotic instructions when studying their neurophysiological concomitants.

**Positron Emission Tomography and Functional Magnetic Resonance Imaging Studies**

Positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) both provide measures of brain function with far greater anatomical precision than that obtainable using electrophysiological techniques. Kosslyn and colleagues (Kosslyn, Thompson, Costantini-Ferrando, Alpert, & Spiegel, 2000) found that hypnotically induced illusions affecting color vision resulted in bidirectional blood flow changes in the color-processing cortex. Eight highly hypnotizable subjects were asked to see a colored pattern in color, a similar gray-scale pattern in color, the color pattern as gray scale, and the gray-scale pattern as gray scale during PET scanning using $^{15}$O-CO$_2$. The classic "color area" in the fusiform/lingual region was identified by analyzing the results when subjects were asked simply to perceive color as color versus when they were asked to perceive gray as gray. When subjects were hypnotized, both the left and right hemisphere color areas were activated when they were asked to perceive color, whether they were actually shown the color or the gray-scale stimulus. These brain regions showed decreased activation when the subjects were told to see gray scale, whether they were actually shown the color or gray scale stimulus. These results were obtained only during formal hypnosis in the left hemisphere color region, whereas blood flow changes reflected instructions to perceive color versus gray in the right hemisphere whether or not subjects had been formally hypnotized. The observed changes in subjective experience induced during a hypnotic state were reflected by changes in brain function similar to those that occur in perception—in this case believing is seeing.

**Hypnotic Changes in Attention Systems**

There is also evidence that hypnosis involves mechanisms related to arousal and attention but is not simply the product of them. The frontal lobes and the anterior attentional system, especially the cingulate gyrus, seem to be involved in this activity.

**The Anterior Attentional System**

Posner and colleagues (Fan, McCandliss, Sommer, Raz, & Posner, 2002; Posner & Petersen, 1990) postulate three components of attention: executive attention, alerting, and orienting. Executive attention, modeled as target detection, is related by Posner to the anterior cingulate gyrus. Based on their work, this attentional subsystem is described with a "spotlight" analogy, narrowing the focus of attention. The second
component, alerting, is a characteristic of the anterior attention system and is characterized by rapid response with an increase in error rates. This component is tied to the right medial aspect of the frontal lobe. The third and most posterior component is orienting, located in the anterior occipital/posterior parietal region. This area has strong connections from the superior colliculus and the thalamus. Lesions in these lower connections result in difficulty in orienting, focusing attention on the target, and avoiding distraction. Further, there is a differential type of orienting, with the right hemisphere bias toward global processing and the left toward local processing.

**Hypnotic Concentration**

Hypnotic concentration seems most similar to phenomena associated with a relative activation of the anterior as opposed to the posterior attention system, in Posner’s terms, especially the executive attention function of the anterior cingulate gyrus. In Pribram’s terms, this means activation rather than arousal (Pribram & McGuinness, 1975). His earlier conceptualization, quite consistent with Posner’s, links arousal to noradrenergic activity and parsing, or activating multiple systems, with external perception orientation being primary. Activation, on the other hand, is largely dopaminergic, involves “chunking,” or reducing the number of parallel systems, and an inner rather than outer focus. We have evidence, in fact, that hypnotizability is correlated with homovanillic acid (HVA) levels in the cerebrospinal fluid (Spiegel & King, 1992). HVA is a dopamine metabolite, providing evidence linking hypnosis to dopaminergic activity. Further, schizophrenics, who have abnormalities in dopamine activity and the D2 receptor (Lidow & Goldman-Rakic, 1997), generally show lower hypnotizability and the absence of very high hypnotizability (Lavoie & Elie, 1985; Lavoie & Sabourin, 1973; Pettinati et al., 1990; Spiegel, Detrick, & Frischholz, 1982).

**Responding to Words and Manipulating Images**

Hypnosis involves a narrowing of the focus of attention (Spiegel & Spiegel, 1987), analogous to looking through a telephoto rather than a wide-angle lens, along with a suspension of critical judgment, with decreased emphasis on evaluation of accuracy. Hypnotic inductions frequently involve eye closure (although this is not necessary), which may well inhibit the posterior vigilance attentional center proximate to the occipital cortex. Pathways from the thalamus to this center are clearly defined. This might shift the attentional balance anteriorly, with the consequence of narrowing the focus of attention and enhancing activation. Then mechanisms similar to those described by Hobson (Hobson & Stickgold, 1995) in dreaming may occur. Images are processed as though they had been received from outside, hence the
vividness of hypnotic imagery and the phenomenon of hypnotic hallucination, which can result in a reduction or increase of ERP amplitude. Indeed, hypnosis seems to involve an inversion of our usual means of processing words and images (Spiegel, 1998a, 1998b). In general, we respond to images and manipulate words, whereas in hypnosis we respond to words and manipulate images. In a trance, we accept verbal input relatively uncritically (suggestibility) but are capable of transforming images and perceptions. Much of the power of the hypnotic state involves the uncritical acceptance of the implausible, e.g., being able to reduce or eliminate pain when the same unpleasant stimulus is there. In this case, the verbal instruction to make a part of the body cool or numb overrides the usual perception of painful somatosensory input.

**Inducing or Reducing Automaticity**

This searchlight or focusing model of hypnosis receives support from recent data indicating that hypnosis can effectively decontextualize lexical perception and eliminate the delay in reaction time seen in the classical Stroop interference paradigm (Raz, Shapiro, Fan, & Posner, in press). In this experiment, high hypnotizables were instructed that the words they would see were written in a foreign language and would have no meaning. This finding is consistent with our own findings that hypnotic instruction to focus on just a portion of the letter reduces Stroop interference (Nordby, Hugdahl, Jasiukaitis, & Spiegel, 1999) and with even earlier work by Sheehan and colleagues (Sheehan, Donovan, & MacLeod, 1988). The one contradictory finding (Dixon & Laurence, 1992) may be accounted for by differences in hypnotic instruction. This can in fact be crucial for interpreting hypnotic effects. The bulk of these Stroop studies suggest that hypnosis can be employed to alter automaticity of word processing. This may seem odd given that hypnotic performance is typically seen as inducing automaticity when in this case it reduces the automaticity associated with word reading. The key feature of hypnosis may involve altering automaticity rather than simply increasing it. It may modulate the sense of agency.

**Hypnotic Attention Versus Vigilance**

The observed difference in ERP amplitude response between obstructive (reduced amplitude) and negative (enhanced amplitude) hallucinations (Barabasz et al., 1999; Jensen et al., 2001) is quite consistent with a searchlight or focusing model involving the anterior attention system and the anterior cingulate gyrus in particular. Breaching of a negative hallucination instruction would tend to trigger vigilance—something unexpected is happening that tends to break with the paradigm—and would likely activate the posterior attentional
Clinicians often structure hypnotic suggestions in ways that allow for varieties of responsiveness in both type and intensity (Crasilneck & Hall, 1985; Spiegel & Spiegel, 1978). The crucial thing is that the hypnotic state and the task performed within it reinforce rather than contradict one another, thereby facilitating the increase in circuit redundancy or activation rather than requiring arousal and external scanning awareness for new means of interpreting perceptions (Pribram & McGuinness, 1975). Recent work by De Pascalis (De Pascalis et al., 1999, 2001) confirms the importance of the type of hypnotic analgesia instruction. They found that focused analgesia in particular, but also dissociative imagery, produced more ERP changes, primarily P300 reduction, than did simple relaxation, and they also observed higher fronto-temporal N200 and smaller posterior parietal P300 during hypnotic analgesia among high hypnotizables.

The role of the anterior attentional system in hypnotic analgesia is emphasized by Crawford and colleagues (Crawford, Gur, Skolnick, Gur, & Benson, 1993). Using 133Xe regional cerebral blood flow (CBF) imaging, hypnotic analgesia to ischemic pain was studied using high and low hypnotizable groups. They found bilateral CBF increases in the orbito-frontal cortices of the high hypnotizable group during hypnotic analgesia. They also found changes in the somatosensory cortex. Ischemic pain produced CBF increases in the somatosensory region. During hypnotic analgesia, highly hypnotizable persons evidenced CBF increases in the somatosensory cortex, whereas low-hypnotizable persons showed decreases. Although one would expect changes in the somatosensory cortex, one would have predicted decreases rather than increases during hypnotic analgesia among the highs.

Rainville’s (Rainville, Duncan, Price, Carrier, & Bushnell, 1997) excellent PET study utilized a hypnotic intervention that sought to change distress about pain rather than perception of it: the suggestions were for increased or decreased “unpleasantness” of the pain (p. 970, Footnote 7). This may account for their observed differences in blood flow (rCBF) in the anterior cingulate but not in the primary sensory association cortex. A key question in the field is whether hypnotic effects on perception occur in the primary association cortex or in structures that mediate attention, such as the anterior cingulate. There is evidence that competitive attention tasks may involve activation tradeoffs in primary processing areas without any executive function activation as well to manage the balance (Fan et al., 2002).

In subsequent work, Rainville and colleagues (Hofbauer, Rainville, Duncan, & Bushnell, 2001) have indeed demonstrated reduced activity in region S1 of the somatosensory cortex during hypnotic analgesia involving instructions to reduce pain intensity rather than unpleasantness. Hypnotic instruction to increase pain intensity among these 10 volunteers resulted in increased activity in S1, S2, the anterior
cingulate, and the insular cortex. This body of work provides further evidence that hypnotic alteration of perception results in congruent changes in primary sensory association cortices, so the stimulus actually feels different, in addition to involving the anterior cingulate gyrus, part of the anterior attentional system.

**HEMISPHERIC LATERALIZATION**

It was popular in earlier decades to associate hypnotic phenomena with the functioning of the right cerebral hemisphere, given its capacity for parallel processing and spatial/intuitive operations (Hilgard, 1965). Early studies showed, for example, that under certain conditions (indirect observation) highly hypnotizable individuals were more likely than lows to deviate gaze to the left, indicating dominance of right hemispheric functioning (Gur & Reyher, 1973). However, more recent research has challenged this notion, suggesting that the sequential processing of the left hemisphere is at least as much involved (Jasiukaitis, Nouriani, Hugdahl, & Spiegel, 1997).

The literature is not uniform (De Pascalis, 1999). One study shows enhanced signal detection in the left visual field among high hypnotizables (McCormack & Gruzelier, 1993). When bilateral EEG was recorded among 16 high hypnotizables during hemisphere-specific tasks, the main finding was that in hypnosis the hemisphere specificity of the tasks was reduced, suggesting that hypnosis is associated with more general brain involvement in task performance, rather than specific activation of the right rather than the left cerebral hemisphere (Edmonston & Moscovitz, 1990). A recent study of neuropsychological testing among high and low hypnotizable subjects, including word fluency, Stroop interference, vigilance, and reaction time (Kallio, Revonsuo, Hämäläinen, Markela, & Gruzelier, 2001), showed no differences in performance between the two groups, further casting doubt on the right hemisphere hypothesis.

Jasiukaitis et al. (1996) actually found greater visual ERP reduction in amplitude in the right as compared to the left visual field among high hypnotizables, suggesting left hemisphere superiority in hypnotic perceptual alteration. This unanticipated finding was that hypnotic obstruction only reduced P200 when the obstructive hallucination and ERP-eliciting stimuli occurred in the right visual field. This hemifield superiority was not seen for any ERP effect of directed inattention. Contrary to earlier opinion, this suggests a special left hemisphere faculty in hypnosis, at least during visual obstructive hallucination. Work by Martha Farah (Farah, Weisberg, Monheit, & Peronnet, 1990) has demonstrated that the left hemisphere may have a special role in the generation of visual imagery. Volitional imagery processes could be
expected to play an important part in suggested positive visual hallucination.

In Kosslyn et al.’s PET study of effects of hypnosis on color vision processing (2000), blood flow was altered consistent with hypnotic visual illusions of the presence or absence of color in both the left and the right lingual gyri. However, the difference on the left occurred only when the subjects (all highly hypnotizable) were formally hypnotized, not merely when they were instructed out of hypnosis to see the difference in color. In the right hemisphere, blood flow changed in response to instruction in or out of formal hypnosis. This finding suggests that effects of the state of hypnosis per se activate the left hemisphere rather than the right, which in this study responded to nonspecific instruction.

**Neurotransmitters and Hypnosis**

It is reasonable to assume that certain neurotransmitter systems are especially involved in hypnotic phenomena. This type of investigation has proven fruitful in sleep research, with Hobson’s demonstration of a shift from noradrenergic to cholinergic activity in sleep, especially REM sleep (Hobson & Stickgold, 1995). Spiegel and King (1992) demonstrated a robust correlation between hypnotizability and levels of homovanillic acid, a dopamine metabolite, in the CSF. This study was based on Pribram and McGuinness’s work on activation and arousal and Tucker and Williamson’s (1984) on hemispheric laterality. This theory implicated dopamine in activation, which increases circuit redundancy and focusing, versus arousal, which decreases circuit redundancy, deploys attention more broadly, and is noradrenergic. Based on the Posner model of attention, the anterior attentional system involves activation and focusing, localized to the anterior cingulate and right frontal cortex. These areas are rich in dopaminergic neurons.

The idea is that hypnosis is activation without vigilance, a form of alertness or consciousness but with less sympathetic activation. This would be consistent with the Aston-Jones, Aston-Jones, and Koob (1984) observation of an adrenergic role in vigilance and the Morrison and Foote (1986) observation that the posterior visual system is strongly innervated by norepinephrine pathways, including the pulvinar and superior colliculus. They found weaker noradrenergic innervation of more ventral pattern recognition pathways. Posner and Petersen (1990) cite Clark and colleagues as showing that manipulation of norepinephrine levels pharmacologically had specific effects on attention shifting. Posner and colleagues (Berger & Posner, 2000) found that patients with right parietal lesions were especially affected by the omission of a warning signal, whereas those with left parietal lesions were not. These noradrenergic pathways arise in the locus coeruleus.
and are right-lateralized. Posner and Petersen postulate that activation of norepinephrine works through this posterior attention system. The anterior attention system, the alerting component, increases the speed of response selection but allows for a lower quality of information (Fan et al., 2002). This is information processing with a reduction in vigilance, or critique of the information processed. A crude analogy might be drawn to suggestibility or responsiveness to cues regardless of their incongruity. Could we think of the kind of social input that forces the individual to increase orienting, likewise forces them into a noradrenergic mode of interaction, heightening stress and its related health consequences, whereas a supportive hypnotic input is one that allows the person to decrease vigilance and shift more into a mode of target detection alerting—more of the dopaminergic and/or cholinergic mode. Thus, the idea is that selective activation of the anterior attention system is consistent with alerting without vigilance, with a relative suppression of noradrenergic input, and perhaps, therefore, output. Furthermore, our recent observation of a correlation between hypnotizability and CSF HVA further implicates specific involvement of the frontal lobes where the majority of dopaminergic pathways exist, followed by the basal ganglia. It is particularly interesting that the anterior cingulate gyrus is rich in dopaminergic neurons (Williams & Goldman-Rakic, 1998), providing converging evidence that the hypnotic state, which involves both arousal and focusing, may be associated with activation of the anterior cingulate gyrus. This is consistent with Rainville’s PET study showing involvement of the anterior cingulate during hypnotic analgesia (Hofbauer et al., 2001; Rainville et al., 1997, 1999).

Involuntariness and Manipulation of “Agency”

One can think of the brain as being divided into an anterior effector portion and a posterior receptive portion: action versus perception. Work on autobiographical memory suggests that it commences in the frontal lobes with a search strategy and works its way posterior toward activation of images in the occipital lobes. This is controlled, desired activity accompanied by a willing sense of agency. By contrast PTSD seems to move from back to front, with unbidden intrusive images that are experienced as uncontrolled and unwelcome (Horowitz, Field, & Classen, 1993). Brain imaging in PTSD (Rauch & Shin, 1997) shows hyperactivation of hippocampus (memory), amygdala (emotion), and occipital cortex (imagery), and hypoactivation of Broca’s area (speech). Thus, the deep and posterior portions of the brain are activated, while the effector systems, especially speech, are inhibited, adding to the sense of helplessness and involuntariness in PTSD. Such individuals feel they are being retraumatized by their memories.
There would seem to be a paradox: agency would seem to be associated with efferent activity rather than passive perception. Yet it is not uncommon that people engaged in motor performance lack self-awareness—actors, athletes, people in ‘‘flow’’ states (Csikszentmihalyi, 1991). Thus, agency does not uniformly accompany activity, even voluntary activity. One way to resolve this apparent paradox is to conceptualize self-awareness as a perception. Even if agency is best demonstrated by action, it may not be perceived if there is some inhibition of perception, e.g., if perceptual processing is saturated with intrusive imagery or redirected through hypnotic instruction. Motion can occur in hypnosis without the perception of agency. The well-established ability of hypnosis to alter perception may account for its less well understood ability to alter identity, memory, and consciousness—perception of self. Perception of motor activity is complex—it involves an expectation of a response to a motor act initiated—hence we cannot tickle ourselves. Thus, altering perception has great potential to alter the perception of agency regarding our own actions.

Another way to think about the evidence is that systems are affected that both respond to and manipulate perceptions. Typically, we respond to perceptions and manipulate words. In hypnosis, we seem to do the opposite: respond to words and manipulate perceptions. The majority of Stroop studies reviewed above indicate that words can be delexicalized by altering perception, but this is done in response to verbal instructions that in some ways do not make sense—the words are in English but they are perceived as unreadable, and Stroop interference decreases (Raz & Shapiro, 2002; Raz et al., 2002). So relatively illogical instructions to alter perception are accepted uncritically, and perception is changed, with resulting alterations in primary association cortex (e.g., Kosslyn et al., 2000) or the anterior cingulate gyrus (e.g., Crawford et al., 1993; Rainville et al., 1997). Perception is always a combination of raw sensory input and memory—stored images that facilitate pattern recognition (Kosslyn & Koenig, 1992). Thus, all perception is part hallucination, and in these hypnotic paradigms we seem to set up a competition between perception and imagination. Thus, analogous to the explication of dreaming as a kind of perceptual processing without the perceptions (Hobson & Stickgold, 1995), the hypnotic state could be characterized as a different kind of perceptual processing without the perception, hence, hypnotic hallucination and alteration of perception, such as analgesia. Other anatomical systems that must also be involved in hypnotic perceptual alteration include thalamic pathways, given the especially strong effect of hypnosis on pain, which is processed in the thalamus. The reticular activating system may well be involved, because it mediates alertness and arousal.
CONCLUSION

The research reviewed here demonstrates that hypnotic perceptual alteration clearly affects brain function. The nature of the specific hypnotic instruction matters a great deal. Positive hallucinations have the opposite effect of negative ones, overriding attention to external stimuli rather than competing with them. Those instructions that have the effect of reducing perception by creating an illusory obstruction to it reduce brain response to perception in the cognate sensory cortex, as measured by ERP amplitude and regional blood flow. The current evidence is strongest for this effect in the visual system: believing is seeing. Those hypnotic instructions that affect the subject’s reaction to the perception seem to activate the anterior attentional system, especially the anterior cingulate cortex, as measured by regional blood flow. The evidence for this effect is strongest in the somatosensory system: the strain in pain lies mainly in the brain. Thus, there is evidence that hypnotic perceptual alteration involves changed activity in the requisite sensory cortex, as well as altered function of attentional systems. Clearly, the nature of the hypnotic instructions can shift the balance: direct sensory alteration instructions that are not subject to derailing from partial response seem to alter response in sensory association cortices, whereas instructions to alter response to stimuli seem to trigger changes in the anterior attentional system. Hypnosis seems to involve activation without arousal and may be particularly mediated via dopaminergic pathways. Hypnotic alteration of perception is clearly accompanied by measurable changes in both perceptual and attentional function of those specific regions of the brain that process these activities, and the balance between the two seems to be modulated in part by the specific hypnotic instruction. Positive obstructive hallucinations seem to allow for a hypnotic focus inward, activating the functioning of attentional neural systems and reducing perceptual ones. To paraphrase Descartes, in hypnosis, sentio ergo sum.

REFERENCES


Negative und positive visuelle hypnotische Halluzinationen:
Attending Inside and Out

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Zusammenfassung: Veränderung der Wahrnehmung unter Hypnose beeinflusst die Hirnfunktion. Die Hypnosesuggestionen, die die Wahrnehmung durch Schaffung eines imaginären Hindernisses vermindern, reduzieren die Reaktion des Hirns auf die Wahrnehmung im verwandten sensorischen Kortex, und sind durch die Amplitude des ereigniskorrelierten Potenzials (EKP) und Durchblutung der Region (PET) messbar. Diese Hypnosesuggestionen, die die Reaktion der Person auf Wahrnehmung beeinflussen, aktivieren das präfrontale Aufmerksamkeitssystem, und zwar insbesondere den vorderen Gyrus Cinguli, wie aus PET-Studien hervorgeht.


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Hallucinations hypnotiques visuelles négatives et positives:

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Résumé: la perception modifiée par l’hypnose affecte le fonctionnement du cerveau. Ces instructions hypnotiques qui réduisent la perception en créant une obstruction illusoire réduisent la réponse du cerveau à la perception au niveau de cortex sensoriel apparenté, comme cela a pu être mesuré par l’amplitude (ERP) des potentiels connexes à un événement et le débit sanguin (PET scan). Ces instructions hypnotiques qui affectent la réaction du sujet à la perception, activent le système antérieur d’attention, particulièrement le cortex antérieur cingulaire dans des études faites au PET Scan. L’hypnose implique l’activation sans éveil et elle peut être particulièrement médiatisée par l’intermédiaire des voies dopaminergiques. Le changement de perception hypnotique est accompagné des changements mesurables de la fonction perceptive et attentionnelle de ces régions spécifiques du cerveau qui traitent ces activités, qui sont modulées par la nature de l’instruction hypnotique spécifique. Les hallucinations obstructives positives semblent tenir compte d’un foyer hypnotique centripète, activant le fonctionnement des systèmes neuraux attentionnels, réduisant alors les systèmes perceptifs.

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Alucinaciones hipnóticas visuales positivas y negativas: Atención interna y externa

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Resumen: Las alteraciones de percepción hipnóticas afectan al funcionamiento cerebral. Las instrucciones hipnóticas que reducen la percepción al crear una obstrucción ilusoria, reducen la respuesta del cerebro en la corteza sensorial apropiada, medida tanto por potenciales evocados (ERP) y flujo sanguíneo local (PET). Las instrucciones hipnóticas que afectan la reacción de la persona a la percepción activan el sistema atencional anterior, especialmente la corteza anterior cingulada en los estudios con PET. La hipnosis involucra activación sin excitación, tal vez mediada particularmente por los senderos dopaminérgicos. La alteración hipnótica de la percepción va acompañada por cambios medibles en las funciones cerebrales de la percepción y la atención en las regiones específicas del cerebro que procesan estas actividades, moduladas por la naturaleza específica de las instrucciones hipnóticas. Las alucinaciones positivas obstructivas parecen permitir un foco hipnótico interior, que activa el funcionamiento de sistemas nerviosos de atención y reducen los sistemas perceptuales.

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