

The emerging neuroscience of hypnosis

A review of '*Hypnosis and conscious states: The cognitive neuroscience perspective*' by

Graham Jamieson (Ed)

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In recent years, hypnosis has begun to gain traction as a potentially valuable tool in the increasingly diverse repertoires of cognitive neuroscience and cognitive neuropsychiatry (Oakley and Halligan, 2009). Hypnosis consists of a set of procedures beginning with an induction, which involves instructions and suggestions to promote absorption in (i.e., effortless attention toward) the words of the operator. An induction is typically followed by a series of suggestions for alterations in various dimensions of consciousness, perception, action, and cognition. In response to specific hypnotic suggestions, highly suggestible individuals are capable of experiencing marked changes in affect, attention, memory, and perception. Hypnotic suggestions can be used to model psychiatric and neurological conditions or test predictions that are otherwise difficult to address in the laboratory (*instrumental research*); alternatively, researchers may investigate the phenomenology and mechanisms underlying response to a hypnotic induction and particular suggestions or the determinants of hypnotic suggestibility (*intrinsic research*) (Reyher, 1962; Oakley and Halligan, 2009). As neuroscientific research on hypnosis continues to grow, it becomes increasingly necessary to integrate it with contemporary neurophysiological models of cognition, to ensure that neuroscientists using hypnosis have a sound understanding of its mechanisms, and to critically examine the prospects and limitations of the utilization of hypnotic suggestion as an experimental tool. Taken within this context, Graham Jamieson's edited volume, *Hypnosis and conscious states: A cognitive neuroscience perspective* fulfills a much-needed gap in this literature and is a welcome contribution to this nascent area of neuroscience. In what follows, we briefly review the emerging neuroscience of hypnosis through the lens of this book's chapters.

A common concern among cognitive neuroscientists is whether hypnotic responses are real, in the sense of whether highly suggestible individuals are actually experiencing what they

report. Although the extent to which the mechanisms underlying hypnotic responses (e.g., hallucinations) parallel those of their referent non-hypnotic responses is not yet fully clear, there is a wealth of data pointing to a close correspondence. Boly et al. (chapter 2), Miltner and Weiss (chapter 4), De Pascalis (chapter 5), and Lynn et al. (chapter 9) review electrophysiological and functional neuroimaging results bearing on this issue. As an example, Derbyshire et al. (Derbyshire et al., 2004) found a remarkably close correspondence between the brain activation patterns associated with *real* pain and *hypnotically suggested* pain, both of which included activation of insula, thalamus, and anterior cingulate, inferior parietal, prefrontal, and secondary somatosensory cortices, which comprise a pain network or neuromatrix. In contrast, *imagined* pain was associated with only minimal activation in the insula and anterior cingulate and secondary somatosensory cortices. These results indicate that the neural substrates of hypnotic pain more closely resemble those of actual pain than imagined pain. On the other hand, the cortical activation patterns associated with hypnotic responses are not always equivalent to comparable non-hypnotic responses. For instance, in two fMRI studies of hypnotic and conversion arm paralysis (Cojan et al., 2009b; Cojan et al., 2009a), Cojan et al. found clear similarities across both types of paralysis that were not observed with simulated paralysis, including activation of the precuneus and changes in its connectivity with motor cortex but also differential activation patterns in the ventromedial prefrontal cortex and the right inferior frontal gyrus. The former findings suggest that both forms of paralysis are occurring through a core process involving the precuneus whereas the latter point to different supporting mechanisms, perhaps those related to changes in monitoring following a hypnotic induction.

The most well attested empirical finding regarding hypnosis is that the general population displays marked individual differences in hypnotic suggestibility. Investigating the determinants

of hypnotic suggestibility is a fundamental part of intrinsic hypnosis research and some preliminary evidence has been gained regarding its genetic basis and neuroanatomical and electrophysiological characteristics (De Pascalis, chapter 5; Lynn et al., chapter 9). A number of studies have linked hypnotic suggestibility with the COMT genetic polymorphism (Lichtenberg et al., 2000; Lichtenberg et al., 2004; Szekely et al., 2010), although the effects are not always consistent across genders and the particular allele. These results suggest a basis for the heritability of hypnotic suggestibility (e.g., Morgan et al., 1970) and a link with dopaminergic systems and prefrontal cortical functioning (see also Lichtenberg et al., 2008).

There is also evidence that high hypnotic suggestibility is associated with an increased rostrum in the corpus callosum, which would presumably support greater information transfer between prefrontal cortices (Horton et al., 2004). Lynn et al. (chapter 9) offer an informed methodological critique of this and other studies aiming to identify the neural correlates of hypnotic suggestibility that also applies to other areas of cognitive neuroscience. They note how contrasts between two special populations that occupy bipolar positions on an indicator variable, such as low and highly suggestible individuals, do not lend themselves to sound inferences regarding unique features of one group (e.g., increased rostrum in highly suggestible individuals) because the observed effects may rather reflect a characteristic in the other group (e.g., decreased rostrum in low suggestible individuals). For this reason, it is imperative that future studies investigating the neural markers of high hypnotic suggestibility include medium suggestible individuals as controls.

Despite the exceptional strength of these and other chapters discussing hypnotic suggestibility, we believe this book would have profited from a greater focus on the measurement issues pertinent to neuroimaging studies of hypnosis. Proper screening of

participants is of fundamental importance for experimental hypnosis research, in particular for identifying highly suggestible individuals. The chapters of this book largely neglect how to optimize the measurement of hypnotic suggestibility for neuroimaging research and how to advance hypnotic suggestibility measurement more broadly. Typically, experimental hypnosis research involves the administration of two standardized measures of hypnotic suggestibility – a group and individual measure (Shor and Orne, 1962; Weitzenhoffer and Hilgard, 1962), which consist of different hypnotic suggestions for alterations in motor, cognitive, and perceptual functions. Although these scales have strong psychometric properties, they are somewhat outdated. The suggestion content is very often tangential (e.g., age regression) to that used in neuroimaging research (e.g., analgesia, executive control). In addition, scale scores are based on self-reports and overt behavioural responses for single-trial suggestions and are thereby less precise than scores derived from mental chronometry. That is, aside from providing an index of an individual's general level of hypnotic suggestibility, they provide relatively little information that is pertinent to a researcher's specific question and necessitate further screening for the respective function being studied. Insofar as the further development of hypnotic suggestibility measures is essential for the progress of neuroscience research, it is unfortunate that this issue was not addressed in this book.

If hypnotic suggestion can be used to effectively modulate consciousness in highly suggestible individuals, a critical next step is to isolate its necessary and sufficient conditions. An obvious place to start is the role of a hypnotic induction. Inductions can take many forms but all of them arguably facilitate absorption in the words of the operator and a concomitant reduction in meta-cognition. It is well known that an induction produces a significant, albeit only minor, increase in suggestibility on standardized scales (Braffman and Kirsch, 1999). This evidence has

been marshaled to support the argument that inductions are not essential, a position described by Lynn et al. (chapter 9). However, using standard suggestibility measures to assess the impact of an induction masks more subtle features regarding this impact. For example, a posthypnotic suggestion is more effective at improving performance on a Flanker task than a comparable non-hypnotic suggestion (Iani, Ricci et al., 2006). In one study involving suggestions for alterations in fibromyalgic pain, responses to hypnotic suggestions were associated with greater activations in all regions of a pain neuromatrix, except mid-anterior cingulate cortex, than responses to non-hypnotic suggestions (Derbyshire et al., 2009). These results demonstrate the effectiveness of inductions but also point to the limitations of relying on standard hypnotic suggestibility measures when relating similarities and differences in the mechanisms underlying hypnotic and non-hypnotic responding because these scales are inferior to techniques involving mental chronometry and neuroimaging.

What neurophysiological changes underpin the effects of a hypnotic induction? One view is that an induction produces a reorganization of frontal executive control and monitoring networks (Egner and Raz [chapter 3] and Jamieson and Woody [chapter 7]). Egner and Raz summarize research showing how an induction alone, that is, without particular suggestions, can effect a *reduction* in cognitive control, as measured by the Stroop colour-naming task, among highly suggestible individuals. Further results from an fMRI study suggest that this effect is mediated by a disruption of the coordination of the anterior cingulate and dorsolateral prefrontal cortices (Egner et al., 2005), reflecting a weakening of the communication between monitoring and control processes, respectively. This is a finding of paramount importance that paves the way for more refined neurophysiological theories of hypnosis. Moreover, it is commensurate with electrophysiological research showing that hypnotic analgesia is associated with a reduction in

gamma band coherence between somatosensory and frontal electrode sites (Miltner and Weiss, chapter 4). Naish (chapter 15) reviews research showing how highly suggestible individuals experience time distortions during hypnosis suggestive of a slowing of their internal clock, whereas low suggestible individuals display the converse effect. These results are arguably consistent with those reviewed by Egner and Raz, but perhaps point more to deficient monitoring among highly suggestible individuals during hypnosis. How, and whether, these effects contribute to the phenomenology of hypnotic responding, such as the experience of extravolition, is worth examining.

The impact of an induction on consciousness is not restricted to cognitive control. Pekala and Kumar (chapter 10) summarize research on a wide variety of spontaneous experiential distortions (e.g., alterations in body image) during hypnosis. Pekala and Kumar's results provide fascinating data regarding the impact of an induction on consciousness and can be used to predict hypnotic suggestibility. However, one concern we have with their approach is that at the moment it is relatively narrow – their phenomenological data need to be integrated with behavioural, electrophysiological, and neuroimaging methods, in particular, other concomitants of a hypnotic induction (Egner and Raz, chapter 3).

Research described by Egner and Raz (chapter 3) was greatly inspired by one of the most dominant accounts in contemporary hypnosis research over the last two decades, *dissociated control theory* (Woody and Bowers, 1994). This account proposes that a hypnotic induction produces a weakening of the supervisory attentional system (Norman and Shallice, 1986), delegating control over hypnotic responses to contention scheduling, which is normally reserved for well-trained automatic responses. This theory provides a clear set of predictions and has proved to be highly valuable insofar as it has generated considerable debate and research (Kirsch

and Lynn, 1998). However, its central prediction, namely that contention scheduling governs hypnotic responses is at odds with the available data, in particular the fact that some hypnotic responses (e.g., amnesia) clearly require some form of executive control (Dienes and Perner, chapter 16).

One of the major strengths of this book is its inclusion of three new theories of hypnosis that improve upon dissociated control and other theories of hypnosis. Jamieson and Woody (chapter 7) advance an updated version of dissociated control theory that is more tightly integrated with contemporary neurophysiological models of cognition and with the available evidence. Rather than the disruption of control, as originally proposed by dissociated control theory, according to this revised theory, hypnosis disrupts the relay of information from monitoring to control processes, resulting in a weakened ability to flexibly regulate control. Thus, executive control can be utilized, but not flexibly adjusted, to facilitate hypnotic responses. One limitation of this account is that its central tenet is largely based on one study (Egner et al., 2005), which found reduced gamma band coherence between two frontal electrodes during hypnosis than in a control condition. Insofar as coherence is a measure of the correlation between the amplitudes of the signal output of two electrodes, it is inferior to other measures of EEG phase synchrony (see Burgess, chapter 11). This theory could be further improved by elucidating how disrupted monitoring of control networks facilitates hypnotic responding and how this contributes to the top-down modulation of other regions by the prefrontal cortex during hypnotic responding.

Dienes and Perner (chapter 16) advance an alternative model of hypnosis, *cold control theory*, which places emphasis on altered monitoring during hypnotic responding. This account maintains that higher-order thoughts about intending (e.g., “I am aware that I am intending to lift



my arm”) are suspended during hypnotic responses. Rather, responses to hypnotic suggestions are produced by intentions outside of awareness; a highly suggestible individual voluntarily performs a suggested behavioural response or conjures up a particular mental representation, but the underlying intention does not breach conscious awareness, resulting in the extra-volitional phenomenology of hypnotic responding. Cold control theory provides a clear basis for a relationship between hypnotic and non-hypnotic suggestibility and offers the prediction that highly suggestible individuals should experience greater distortions in agency in non-hypnotic tasks involving the manipulation of agency. This account closely resembles neodissociation theory (Hilgard, 1986), which proposes that monitoring functions are weakened during hypnotic responding but is unarguably more parsimonious because it foregoes various undesirable features of Hilgard’s original account, such as the proposal of an amnestic barrier during hypnotic responding. Nevertheless, we would have liked to see clearer divergent predictions regarding the neurophysiological underpinnings of cold control mechanisms during hypnotic responding.

Consensus is beginning to materialize that the primary explanandum in experimental hypnosis research is an individual’s *subjective*, rather than *behavioural*, response to suggestions, an idea explored by Woody and Szechtman (chapter 13). Woody and Szechtman maintain that hypnotic responses are characterized by *feelings of knowing*, that is, emotive states regarding the vividness of one’s experience, and these represent the central mechanism by which one responds to a hypnotic suggestion. According to these authors, these states are rooted in a limbic-based system that underlies an individual’s ability to assume a subordinate role in a social hierarchy and which becomes dominant – and suppresses prefrontal cortical processes supporting meta-cognition – during hypnotic responding. They further assign an important role to the insula in supporting hypnotic responses. This chapter proffers a novel social affective neuroscience

account of hypnotic responding that outlines some potentially fruitful avenues for research.

Although the model is consistent with other dissociation theories of hypnosis (Jamieson and Woody, chapter 7), the authors would have strengthened their position by integrating the two accounts, particularly with regard to the social and affective components integral to this model, which are largely absent from dissociation theories.

What is perhaps most appealing about hypnosis to cognitive neuroscientists is how it can be instrumentally used to experimentally manipulate different features of cognition and perception. Instrumental hypnosis research is advantageous because it allows for the manipulation of phenomena that are often difficult to study in the laboratory, such as auditory hallucinations (Szechtman et al., 1998), and thus permits tests of predictions that may have otherwise evaded experimental research. Moreover, the use of hypnotic suggestion to model a particular phenomenon allows for the subsequent cancellation of the suggestion, thereby enabling the use of within-group designs.

Given the promise of instrumental hypnosis research, it is surprising that this book contains no chapter that is singularly devoted to its prospects and the considerations that need to be taken when conducting such research. Rather, a number of chapters describe the instrumental use of hypnotic suggestion for studying particular phenomena, such as attention. Egner and Raz (chapter 3) review a series of studies showing how posthypnotic suggestions for alexia can reduce the Stroop interference effect (Raz et al., 2005; Raz et al., 2003; Raz et al., 2002). Raz and colleagues have shown that the effect is not due to blurring of visual focus. Furthermore, in an fMRI study, they found that reduction of the Stroop interference effect is associated with reduced activation in the extrastriate visual and anterior cingulate cortices, which suggest dampening of visual processing and reduction of response conflict, respectively. In a separate

experiment, the posthypnotic suggestion appears to have also dampened early (~ 100 ms) ERP components, which suggests that the suggestion affects early visual attention, a finding that merits further study. This effect has been independently replicated with Stroop, Flanker, Simon, and synaesthesia-Stroop tasks (Casiglia et al., 2010; Terhune et al., 2010; Iani et al., 2009; Iani et al., 2009), although at least one set of unpublished failed replications has been cited (Barnier et al., 2008). Cumulatively, these studies demonstrate that seemingly automatic processes can be overridden using hypnotic suggestion. In this regard, hypnotic suggestion may provide valuable information regarding the neurophysiology of automaticity. One issue that needs to be considered is whether these effects actually reflect superior attentional control. That is, rather than increasing cognitive control, the suggestion seems to obviate the *need* for control by reducing conscious awareness of the stimuli or representations producing the response conflict.

A responsible discussion of the utility of any technique must consider its limitations. Regrettably, the limitations of the instrumental use of hypnotic suggestion are largely neglected in this book. First and foremost, insofar as the experimental use of hypnosis most often necessitates highly suggestible individuals, who make up approximately 10-15% of the population (McConkey and Barnier, 2004), this research requires careful, laborious screening of hundreds of participants. Second, one must be aware of the limits of hypnotic suggestion. Hypnosis can be used to effectively modulate various aspects of cognition and perception but it cannot be used to induce a whole host of different phenomena. For instance, it is questionable as to whether hypnosis can be used to enhance intelligence, memory, and perception. Similarly, hypnotic suggestions, when effective, target explicit processing, whilst leaving implicit processes intact (see, e.g., Woody and Szechtman, chapter 13). For example, successful suggestions for hypnotic blindness produce the conscious experience of blindness, whereas implicit visual

processing remains (Bryant and McConkey, 1989). Researchers using hypnosis must also be aware of the wording of suggestions and how precision is required to carefully alter a response in the required manner (De Pascalis, chapter 5 and Lynn et al., chapter 9). Finally, a major obstacle confronting instrumental hypnosis research is heterogeneity among highly suggestible individuals. Highly suggestible individuals display marked variability in a variety of critical dimensions, including responsiveness to hypnotic suggestions (McConkey and Barnier, 2004), cognitive control during hypnosis (Terhune et al., in press), and the mechanisms underlying hypnotic responding (Galea et al., 2010). Heterogeneity poses a significant challenge for instrumental neuroimaging research because the inclusion of discrete subgroups that experience a phenomenon through disparate mechanisms in the same study will produce misleading results (Barnier and McConkey, 2003; Woody and McConkey, 2003).

Taken as a whole, *Hypnosis and conscious states* provides a comprehensive introduction to the emerging cognitive neuroscience of hypnosis. Insofar as a strong understanding of hypnosis is imperative for its utilization in the laboratory, this book will be a great asset to any neuroscientists who are considering using hypnosis. The book similarly covers a wide range of topics in cognitive neuroscience, including different methodologies and their limitations (Burgess, chapter 11) and conceptual frameworks for studying hypnosis (Jamieson, chapters 1 and 8), and thus will be equally informative to seasoned hypnosis researchers and those wishing to gain an introduction to this exciting area.

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