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Brain states and hypnosis research☆,☆☆

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Abstract

Research in cognitive neuroscience now considers the state of the brain prior to the task an important aspect of performance. Hypnosis seems to alter the brain state in a way which allows external input to dominate over internal goals. We examine how normal development may illuminate the hypnotic state.

In their paper designed to relate research on hypnosis to neuroscience Raz and Shapiro (2002) say:

“Historically, hypnosis was defined as an altered state of consciousness, characterized by heightened compliance with suggestion and extreme focused attention. Whereas this definition presumes a specific theoretical view, over the years this characterization of hypnosis was gradually refined and amended to reflect a more theoretically neutral approach. Nonetheless, one persistent barrier to the scientific use of hypnosis has been the idea that it involves a special and “mysterious” state of consciousness, often referred to as *trance*.” Page 85

Recently there has been great interest in cognitive neuroscience in the specification of brain states. Throughout the history of brain research there has been competition between an emphasis on intrinsic brain activity and stimulation from sensory input. The discovery, following World War II, of the reticular activating system (Moruzzi & Magoun, 1949) turned attention to sleep wake cycles, and arousal functions and led to the discoveries of a number of neuro modulatory systems.

In the 1960s and 1970s, however, the discoveries of Hubel and Wiesel (1979) in particular changed the emphasis to understanding brain systems designed to receive and interpret sensory input. In the current scene, this discussion is between an emphasis on brain states such as the default state obtained from fMRI scans when the person is given no task to solve (Raichle et al., 2001) and the neural network views arising from specific brain activations obtained from the analysis of cognitive and emotional tasks (Posner & Rothbart, 2007). Raichle's studies reveal two large scale networks that oscillate during the resting state. Resting state fMRI has been used to trace changes in development, account for psychopathology and understand differences in performance.

If brain state influences psychological performance it does seem important to understand how one can influence the achievement of an appropriate state. This is one of the reasons that hypnotism is of current concern. Raz and Shapiro (2002) specifically recognized this

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interest in their paper. The current paper (Raz & Campbell, 2011) goes beyond state differences to examine a more specific effect, probably on the visual word form area. Their finding that high suggestible individuals more than low suggestibles show reduced Stroop interference indicates that being able to achieve the hypnotic state also influences performance.

Strong evidence for the importance of brain states on performance is in the studies of Tang et al. (2007), who show following meditation training an improvement in performance on the attention network task conflict scores. Since this improvement goes beyond anything found for the control of relaxation training there is more to the state than merely being relaxed. Imaging studies (Tang et al., 2009) suggest that this state involves higher connectivity between anterior cingulate and the parasympathetic branch of the autonomic nervous system. Other studies have suggested that brain states influence the process of achieving insight during problem solving (Kounios & Beeman, 2009). Sleep and sensory deprivation have also induce brain states induced by that change performance in important ways.

Raz and Shapiro (2002) argue that a neuroscience of hypnotism suffers because the state induced by hypnosis is “an altered state or a mysterious one”. What sort of state is induced by hypnosis? Our recent longitudinal studies of early infant to child development might generate useable hypotheses. We find that control of cognition and emotion involves brain networks of attention. However, the particular network appears to change with development. In infancy control over emotions and thoughts is exercised largely through an orienting system that involves the inferior and superior parietal cortex, frontal eye fields and some subcortical areas. It depends heavily upon caregiver interventions. For example, novel objects are often used by the caregiver to induce soothing (Harman, Rothbart, & Posner, 1997). However, the introduction of a novel object has two effects, they not only induce soothing, but also activate the anterior cingulate (Shulman et al., 2009) and other brain areas related to the developing executive attention network. There is evidence that the cingulate system used by adults in monitoring their performance for error is also present in infancy (Berger, Tzur, & Posner, 2006). However, the cingulate connection to other brain areas seems to develop in early childhood and perhaps later (Gao et al., 2009; Fair et al., 2009). These findings suggest that control systems in infancy involve orienting to external stimuli, and while this network continues to be present in adults, it is dominated by the executive network which is controlled more by the person's own goals.

The idea of transition in control networks is supported by studies involving candidate genes. Previous work by Raz (2005) has shown that alleles of the COMT gene are related to susceptibility to hypnotic suggestion. Multiple studies of adults and older children have shown that genetic variations of the COMT gene are related to executive attention, particularly the ability to resolve conflict. In our longitudinal study we found that the association of the COMT gene changes in early development. At two years of age the gene relates strongly to a selective looking task (Voelker, Sheese, Rothbart, Posner, & Rothbart, 2009) which appears to involve mainly the orienting network. However, our as yet unpublished data at age 4 suggest that the COMT gene is more closely related to the executive network as is found in later developmental (Diamond, Briand, Fossella, & Gehlbach, 2004) and adult studies (Blasi et al., 2005). Since these effects are clearest using a set of genetic variants related to pain perception (Diatchenko, Slade, Nackley, et al., 2005) they may relate to the analgesic nature of the hypnotic state. These genetic findings may also produce a more evolutionary account of the hypnotic state as suggested by Ray and Tucker (2003).

Do caregivers have anything to do with these genetic changes? We find that at age 2 variations of the COMT gene interact with parental quality so that higher quality parenting leads to better overall attention control (Voelker et al., 2009). We do not know if the quality of parenting also helps foster the transition to the executive network, but this is a possibility.

It seems to us that the hypnotic state may induce greater reliance on the early developing orienting network, rather than the executive network, as a means of control over behavior. Control by the orienting network would lead the susceptible person to be “under the influence of external control”. Just as in early development the child's control rests with the caregiver, during hypnotism the adult's control is given to the hypnotist. While these ideas are clearly very speculative they do provide an important link between brain networks of control during development and their dominance during the hypnotic state. In this sense we hope they help to realize the goal of making the hypnotic state less “mysterious” and more susceptible to empirical test and psychological theory.

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