Consciousness and Cognition 21 (2012) 100–116

Contents lists available at SciVerse ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Suggested visual hallucination without hypnosis enhances activity in visual areas of the brain

William J. McGeown [a], Annalena Venneri [b,c,1], Irving Kirsch [d], Luca Nocetti [e], Kathrine Roberts [a], Lisa Foan [a], Giuliana Mazzoni [a,*]

[a] Department of Psychology, University of Hull, UK
[b] Department of Neuroscience, University of Sheffield, Sheffield, UK
[c] S. Camillo Research Hospital, IRCCS, Venice, Italy
[d] Harvard Medical School and Beth Israel Deaconess Medical Center, United States
[e] Azienda Universitaria-Ospedaliera Policlinico, Modena, Italy

ARTICLE INFO

Article history:
Received 21 February 2011
Available online 27 November 2011

Keywords:
Suggestibility
Hypnosis
Color
Perception
Brain imaging

ABSTRACT

This functional Magnetic Resonance Imaging (fMRI) study investigated high and low suggestible people responding to two visual hallucination suggestions with and without a hypnotic induction. Participants in the study were asked to see color while looking at a grey image, and to see shades of grey while looking at a color image. High suggestible participants reported successful alterations in color perception in both tasks, both in and out of hypnosis, and showed a small benefit if hypnosis was induced. Low suggestible people could not perform the tasks successfully with or without the hypnotic induction. The fMRI results supported the self report data, and changes in brain activity were found in a number of visual areas. The results indicate that a hypnotic induction, although having the potential to enhance the ability of high suggestible people, is not necessary for the effective alteration of color perception by suggestion.

1. Introduction

Hypnosis consists of two components, a hypnotic induction, during which a presumed hypnotic state is induced, followed by a series of suggestions for various changes in experience and behavior (Oakley & Halligan, 2009). Hypnotic inductions typically contain requests for the participant to relax and enter a hypnotic state. Typical hypnotic suggestions can ask for the production of automatic movements, temporary paralyses, hallucinations, and alterations in memory or other cognitive functions. One of the major unresolved issues in research on hypnosis refers to the relation between these two components of hypnosis (Kirsch & Lynn, 1995; Lynn, Kirsch, & Hallquist, 2008; Oakley, 2008; Oakley & Halligan, 2009). Is the induction of a hypnotic state necessary for the experience of hypnotic suggestions, does it increase the likelihood of responses to suggestion, does it enhance the response to a suggestion, or is it merely an epiphenomenon, with no causal relation to the experience of subsequent suggestions?

We have recently found that in highly suggestible persons, hypnotic induction procedures produced a condition in which anterior default mode activity was reduced during hypnosis without increasing activity in other cortical regions (McGeown, Mazzoni, Venneri, & Kirsch, 2009). These changes were observed by carrying out an analysis on the brain activity that

* Corresponding author. Address: Department of Psychology, University of Hull, Cottingham Road, Hull HU6 7RX, UK. Fax: +44 1482 465599.
E-mail address: g.mazzoni@hull.ac.uk (G. Mazzoni).

[1] AV had a collaboration with the Department of Neuroscience at the University of Modena and Reggio Emilia, Italy, funded by a grant from MIUR when data collection for this study took place.

1053-8100/$ - see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.concog.2011.10.015

occurred during numerous rest periods which were found between suggestions to which the participants were instructed to respond. Reductions in default mode activity typically occur when people actively engage in a goal-directed cognitive task with an external focus, rather than merely letting their minds wander. The decrease in anterior default mode activity in high suggestible participants when resting under hypnosis suggests that during the alleged hypnotic state subjects were able to suspend spontaneous non-goal-directed, internally focused cognitive activity (e.g., daydreaming, self referential processing), in the absence of a task. This change in brain activity reflects an active adjustment in highly suggestible participants during which they may prepare themselves for any suggested future activity that they may be required to perform.

In another previous study, we found that highly suggestible participants reported experiencing suggested visual hallucinations when no hypnotic state had been induced, and they did so to a similar level as experienced following hypnotic induction (Mazzoni et al., 2009). The data from the study by Mazzoni et al. (2009) suggest that the hypnotic state might be an epiphenomenon, in that it is not required nor does it facilitate the experience of suggestion. As the data reported by Mazzoni and colleagues were based on self-report alone, we used fMRI in the present study to further examine the relation between the induction of a hypnotic state and the experience of suggested visual illusions. Our questions were: does the induction of hypnosis in highly suggestible subjects enhance the effects of suggestions for perceptual alterations and if so is the increased ability related to alterations in the level of activity in areas of the visual cortex associated with color perception?

The effects of hypnotic induction on neurophysiological activity and on the neurophysiology of suggestion have been the object of investigation in several studies (reviewed in Oakley & Halligan, 2010). The most pertinent to the study reported here was that carried out by Kosslyn and colleagues (2000). The authors used Positron Emission Tomography (PET) to compare brain activity with hypnotic and non-hypnotic suggestions to alter color perception. Our study was designed as a replication and extension of the Kosslyn et al. study.

Kosslyn et al. (2000) reported that hypnotic suggestions to perceive color in a grey-scale stimulus and to drain color from a colored stimulus altered brain activity bilaterally in the extrastriate visual cortex of highly suggestible subjects. They also reported that these changes in activation were limited to the right hemisphere when the participants were asked to imagine changes in color without the induction of hypnosis. The authors interpreted their results as indicating that suggestion-related perceptual changes require the induction of a hypnotic state. However, this study confounded the induction of hypnosis with the wording of the suggestions for altered perception. In hypnosis there was a suggestion that they would 'see' the colors as different from what they really were, but in the no-hypnosis condition participants were instead asked to 'remember and visualize' the differences in color. Hence, it is not possible to know whether the differences in brain activation were due to the induction of hypnosis (as the authors suggested) or to the difference in wording used to elicit the reported changes in color perception. Differences in the wording of hypnotic suggestions are crucial, as there is a clear difference in brain activation depending on whether the participant is given a suggestion to experience, or asked to imagine a subjective change (e.g., Derbyshire, Whalley, Stenger, & Oakley, 2004 [pain]; Szechtman, Woody, Bowers, & Nahmias, 1998 [auditory hallucination]).

In our study the suggestion provided to the participants was kept constant between hypnotic and non-hypnotic conditions. This enabled an accurate assessment of the effects of hypnosis *per se* on color altering ability. The brain areas associated with color perception (veridical viewing) have been reported in a number of research articles. In a study using PET, Zeki et al. (1991) identified an area located across the lingual and fusiform gyri (termed V4) which was uniquely associated with the perception of color. Activation to color was observed bilaterally, but was greater on the left. Other brain regions were also active for the color stimuli, including the striate cortex (V1) and the adjacent cortical region (V2); however, the activation of these brain regions was not specific to color stimuli, in that they also showed changes in activation in response to motion stimuli. Studies using fMRI have also identified a role for the fusiform and lingual gyri in the processing of color (e.g., Beauchamp, Haxby, Jennings, & DeYoe, 1999). Studies of achromatopsia further highlight the association of the lingual and fusiform gyri in color perception (e.g., Bouvier & Engel, 2006). In the current study, the monitoring of changes in brain activity in the fusiform and lingual gyri enabled us to differentiate alterations in brain activity that occurred due to suggestion from those resulting from hypnotic induction and suggestion. Rather than focus only on those regions however, in the current study a whole brain fMRI analysis was carried out. This allowed us to identify the neural circuit used to perform the color alteration tasks.

This study differed from the Kosslyn et al. (2000) study in two other ways. First, we had participants report the vividness of the color they perceived during the tasks using a rating scale, unlike in the study by Kosslyn et al. (2000) in which they had to only inform the investigators whether they could see color or not. Besides allowing us to compare the effect of hypnotic induction on self-reported subjective responses, this method also allowed us to analyze correlations between self-reported experiences of altered color perception and changes in brain activation. Second, in the current study, the responses of low suggestible participants were also assessed. Accepting the conventional presumption that low suggestible participants are not capable of being hypnotized, we had the opportunity to discriminate induction effects that are specific to hypnosis from those that are produced by non-hypnotic aspects of the induction procedure, such as simple relaxation.

To summarize, Kosslyn et al. (2000) did not assess the effect of hypnosis by providing participants with an identically-worded suggestion for visual alterations with and without the hypnotic induction, nor did they assess self-reports of the intensity of the color alterations that occurred in participants. The present fMRI study assessed whether self reports of visual alterations of perception are accompanied by bilateral changes in color-responsive areas of the visual cortex and whether the changes of experience are associated with alterations in brain activation produced by the induction of hypnosis.