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Hypnosis meets neuropsychology: Simulating visuospatial neglect in healthy participants

Konstantinos Priftis [a,b,*], Sami Schiff [c,d], Valérie Tikhonoff [c], Nunzia Giordano [c,e], Piero Amodio [c,d], Carlo Umiltà [a,d], Edoardo Casiglia [c,d,e]

[a] Department of General Psychology, University of Padova, Italy
[b] Laboratory of Neuropsychology, IRCCS San Camillo Hospital, Lido-Venice, Italy
[c] Department of Clinical and Experimental Medicine, University of Padova, Italy
[d] C.I.R.M.A.N.ME.C, University of Padova, Italy
[e] Italian Centre for Clinical and Experimental Hypnosis, Torino, Italy

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ABSTRACT

Neglect patients are not aware of stimuli in the contralesional space. We aimed to simulate neglect-like behaviour in healthy participants, by asking them to orient their visuospatial attention in two conditions: non-hypnotic suggestion and post-hypnotic suggestion. Results showed that directing visuospatial attention to one side of space caused neglect of stimuli in the opposite side of space, but only when participants were under post-hypnotic suggestion. Furthermore, directing visuospatial attention to the right side of space caused more neglect of left-sided stimuli than directing visuospatial attention to the left side of space did for right-sided stimuli. We propose that post-hypnotic suggestion can be a useful tool for (de)activating neurocognitive mechanisms underlying visuospatial awareness, a function that is fundamental for our survival. The use of post-hypnotic suggestion could be applied to the study of many domains of cognitive neurosciences (e.g., neurocognitive rehabilitation).

1. Introduction

Our survival in complex environments would be impossible without our specific brain mechanisms subserving visuospatial attention, that is, our ability to select and to process efficiently specific locations in the environment (for review, see Umiltà, 2000). Visuospatial attention orienting can be impaired selectively, because of damage to the parietal-frontal networks (for review, see Corbetta & Shulman, 2002). One of the most dramatic manifestations of impaired visuospatial attention orienting is neglect, a neurological deficit, which affects awareness of contralesional stimuli (Bisiach & Vallar, 2000; for the relation between awareness and attention, see Mack & Rock, 1998; but see Lamme, 2003, for an alternative account). Following right-hemisphere damage, left neglect patients fail to respond, report, or orient to stimuli in the left side of space (Heilman, Watson, & Valenstein, 1979).

Neglect has been studied extensively in order for researchers to unlock the secrets of visuospatial attention and awareness (e.g., Bisiach, Luzzatti, & Perani, 1979). But how does visuospatial attention operate? Visuospatial attention can be deployed in the environment as the result of two opposing subsystems (Kinsbourne, 1993). The first subsystem is localised in the left hemisphere. This subsystem orients visuospatial attention from the left to the right side of space (i.e., a left-to-right gradient). The second subsystem is localised in the right hemisphere. This subsystem directs visuospatial attention from the right to the left side of space (i.e., a right-to-left gradient). These gradients are asymmetric. The left-hemisphere subsystem is more powerful in directing visuospatial attention rightwards than the right-hemisphere subsystem is in directing visuospatial attention leftwards (Kinsbourne, 1993). In the chronic phase (i.e., after three months from the onset of the lesion), this hemispheric asymmetry could explain the higher rate and severity of left neglect following right-hemisphere lesion with respect to right neglect after left-hemisphere lesion (Stone, Halligan, & Greenwood, 1993). In sum, neglect would not be the result of contralesional hypoattention, but the consequence of ipsilesional hyperattention (Kinsbourne, 1993).

Visuospatial attention orienting is the result of three neurocognitive processes. More precisely, visuospatial attention “disengages” from its current spatial location because of inferior parietal lobule activation, “moves” to the new spatial location because of superior culliculi activation, and finally “engages” at the new spatial location because of pulvinar activation (Posner, Cohen, & Rafal, 1982). When targets are presented in the left side of space, left neglect patients with right parietal damage are very

* Corresponding author at: University of Padova, Department of General Psychology, Via Venezia, 8, 35131 Padova, Italy. Tel.: +39 0498277468; fax: +39 0498276600.
E-mail address: konstantinos.priftis@unipd.it (K. Priftis).

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slow in disengaging their visuospatial attention from the right side of space (Posner, Walker, Friedrich, & Rafal, 1987). Thus, ipsilesional hyperattention might be the result of two brain mechanisms. First, hyperactivation of the left-hemisphere subcomponent directs visuospatial attention to stimuli in the right side of space. Second, the disengagement deficit maintains visuospatial attention in the right side of space overtime (Kinsbourne, 1993; Posner et al., 1982, 1987).

Good evidence in favour of the ipsilesional hyperattention hypothesis could be obtained through the experimental induction of neglect-like behaviour in healthy participants. We hypothesised that by asking healthy participants to direct their visuospatial attention either to the right or to the left side of space, they would show neglect-like behaviour. That is, they would be less efficient in processing stimuli presented in the opposite side of space (i.e., left or right, respectively). In addition, the aforementioned hemispheric asymmetry should be expected (Kinsbourne, 1993). That is, directing visuospatial attention to the right side of space should cause more severe neglect for stimuli in the left side of space than vice versa.

Using post-hypnotic suggestion, we tested this hypothesis. It has been proposed recently that post-hypnotic suggestion can be a valuable tool for simulating and exploring neuropsychological disorders in healthy participants (Oakley & Halligan, 2009). That is, specific cognitive components can be (de)activated selectively by means of post-hypnotic suggestion, in order to improve our understanding of normal neurocognitive functions (Oakley & Halligan, 2009).

Several clinical conditions, indeed, have been simulated by means of post-hypnotic suggestion, such as blindness, amnesia, auditory hallucinations, conversion disorder paralysis, and selected delusions (for review, see Oakley, 2006; Oakley & Halligan, 2009). In the domain of attention, Raz, Fan, and Posner (2005) and Raz, Kirsch, Pollard, and Nitkin-Kaner (2006) have showed that, in highly hypnotisable participants, post-hypnotic suggestion reduces the automatic tendency to read printed words in a Stroop task, where participants have to indicate the colour of the word by pressing a key (see also Casiglia et al., 2010). Iani, Ricci, Baroni, and Rubichi (2009) have reported that the Simon effect (i.e., facilitation of lateralised responses, when they are executed in the same side of space as that of the stimulus) can be reduced following post-hypnotic suggestion, but only in highly susceptible participants.

Oakley and Halligan (2009) have proposed that post-hypnotic suggestion might be comparable to neuroscientific techniques (e.g., transcranial magnetic stimulation, TMS; for review, see Sandrini, Umiltà, & Rusconi, 2011) that can interfere selectively with the function of specific brain regions, in order for the researcher to study behavioural changes. Oakley and Halligan reported analogues of well-known neuropsychological disorders, such as prosopagnosia and hemianopia, which were induced by post-hypnotic suggestion in BW, a neurologically healthy, highly susceptible participant (see Oakley & Halligan, 2009, supplementary material online). In addition, when BW was given the following instruction: 'When you open your eyes in a moment the left half of your world will have disappeared from your awareness and you will feel no need to make any allowance for it at all (that is you will not be aware of the deficit)", he ignored the left side of visual arrays of stimuli (i.e., left visuospatial neglect).

In the present study, we elaborated more on Oakley and Halligan, 2009 pioneering observations on BW. In order to investigate further whether post-hypnotic suggestion could be used to induce visuospatial neglect in healthy participants, we designed an experiment, following the theoretical framework proposed by Kinsbourne (1993) and by Posner et al. (1982, 1987). Therefore, we asked healthy participants to direct their visuospatial attention to either visual hemifield (right vs. left), in two experimental conditions: non-hypnotic suggestion and post-hypnotic suggestion. We hypothesised that we would achieve some control over their visuospatial attention orienting, but only when participants were under post-hypnotic suggestion (see MacLeod, 2011; Raz et al., 2005). We expected that if neglect was a consequence of ipsilateral hyperattention, then by asking participants to direct their visuospatial attention to one side of space, they would neglect stimuli in the opposite side of space. Finally, we assumed that after having directed their visuospatial attention to the right side of space participants would show more severe neglect of stimuli in the left side of space than vice versa (i.e., the hemispheric asymmetry; Kinsbourne, 1993).

2. Methods

2.1. Participants

Ten healthy participants (mean age: 28 ± 3 years; 6 women) were enrolled in the study. They had been defined previously as eligible for hypnosis, on the basis of an ad-hoc questionnaire and of a personal interview. In addition, participants were administered the Minnesota Multiphasic Personality Inventory II (Cancheri & Sirigatti, 1995), because we wanted to exclude participants with borderline personality disorder, who could show unwanted effects during hypnosis (see Kroger, 2007, p. 226). We measured the level of hypnotisability of each participant, by means of the Harvard Group Scale of Hypnotic Susceptibility (De Pascalis, Russo, & Marucci, 2000). All participants were highly susceptible to hypnosis (Harvard Group Scale range: 8–12). The present study adhered to the principles of the Declaration of Helsinki and was approved by the local Ethics Committee. All participants gave their consent in order to take part in the study.

2.2. Apparatus, stimuli, and procedure

2.2.1. Preliminary study

The preliminary study took place some days before the experimental study (see below). In the preliminary study, we aimed to test directly the hypnotisability of the participants and to train them for reaching hypnosis more rapidly in the experimental study. Participants underwent hypnotic induction individually (Casiglia et al., 2006, 2010). An expert hypnotist guided each participant to focus his/her attention on a single thought. Hypnotic induction consisted of a brief enumeration coupled with suggestions to feel good, to perceive eyelid heaviness, to breath regularly and deeply, and to stare at a point (Casiglia et al., 2006, 2010). After spontaneous eyelid closure was reached, participants were invited to concentrate their attention on their own body (from head to foot), while the hypnotist induced them to reach a feeling of heaviness and muscular relaxation. The hypnotist verified whether participants were hypnotised by observing in them the presence of signals, such as arm levitation, easing of facial tension, dropping of the lower jaw accompanied by a slight opening of the mouth, and slowing of the breathing rate (Casiglia et al., 2006, 2010). The analysis of these signals enabled the hypnotist to verify that the participants were really hypnotised and to maintain or modify their level of hypnosis, by means of continuous, appropriate suggestions. At the end of the preliminary session, participants were non hypnotised.

2.2.2. Experimental study

The experimental study took place in a sound-attenuated and dimly lit room. Participants sat at a distance of 87 cm in front of a 17 in. computer screen. Each participant positioned his/her head in an adjustable head-and-chin rest. Stimuli were white and were displayed against a black background. Each trial (Fig. 1) started with the presentation of a fixation cross ($0.4^{\circ} \times 0.4^{\circ}$) in the centre of the screen. The fixation cross was displayed together with four horizontally aligned square boxes (side: 2°). Two of the boxes were placed to the right of the fixation cross (near right, far right) and the other two were placed to the left of the fixation point (near left, far left). The distance between the centre of the fixation cross and the inner side of each near box was 3°. The distance between the centre of the fixation cross and the inner side of each far box was 6° (Fig. 1). On each trial, the target (i.e., a circle measuring 0.8° in diameter) was displayed randomly for 90 ms in the centre of one of the four boxes, after a variable stimulus onset asynchrony interval (i.e., the time interval between the onset of the fixation cross/boxes and the onset of the target; range: 500–700 ms). Participants were asked to fix and to maintain their eyes on the fixation cross. They were asked to press as fast as possible the right button of the mouse each time the target appeared on the screen. The right button of the mouse was aligned with the centre of the screen. Visual feedback on reaction time (RT) was displayed for 1500 ms after response execution. The inter-trial interval was 2500 ms.

In the non-hypnotic suggestion condition, participants were asked "to pay attention to the left visual hemifield" (session 1) and then "to pay attention to the right visual hemifield" (session 2). Following session 2, participants were hypnotised and they received the suggestion "to pay attention to the left visual hemifield", once non hypnotised. Participants were, then, non hypnotised and performed session 3 under post-hypnotic suggestion. Afterwards, participants were hypnotised again, the previous suggestion was removed, and they were asked "to pay attention to the right