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Short Communication

Metacognition of agency is reduced in high hypnotic suggestibility

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ABSTRACT

A disruption in the sense of agency is the primary phenomenological feature of response to hypnotic suggestions but its cognitive basis remains elusive. Here we tested the proposal that distorted volition during response to suggestions arises from poor metacognition pertaining to the sources of one's control. Highly suggestible and control participants completed a motor task in which performance was reduced through surreptitious manipulations of cursor lag and stimuli speed. Highly suggestible participants did not differ from controls in performance or metacognition of performance, but their sense of agency was less sensitive to cursor lag manipulations, suggesting reduced awareness that their control was being manipulated. These results indicate that highly suggestible individuals have aberrant metacognition of agency and may be a valuable population for studying distortions in the sense of agency.

1. Introduction

The primary phenomenological feature of a response to a hypnotic suggestion is the perception that one is not the author of one's actions or experience (Oakley & Halligan, 2013). This disruption of one's sense of agency is reliably observed in highly suggestible (HS) individuals, who comprise 10–15% of the population (Woody & Barnier, 2008). The magnitude of these disruptions closely parallels those of patients with schizophrenia (Polito, Langdon, & Barnier, 2015), indicating that HS individuals may be valuable in identifying the neurocognitive bases of distortions in the sense of agency (Terhune, Cleeremans, Raz, & Lynn, in press).

The mechanisms underlying response to suggestion and distorted volition among HS individuals are poorly understood but multiple theories converge on the hypothesis that distorted sense of agency during hypnotic responding arises from a disruption of meta-awareness. Different models have proposed that hypnotic responding is driven by cognitive control that is experienced as extra-volition because of a disruption of executive monitoring (Dienes & Perner, 2007; Hilgard, 1977; Kunzendorf, 1985-86; Miller, Galanter, & Pribram, 1960) (see also Kirsch & Lynn, 1998; Spanos, 1986). One theory has specifically hypothesized that responses to suggestion are facilitated by a disruption of meta-awareness of intentions pertaining to one's responses (Dienes & Perner, 2007).

Multiple lines of evidence offer support for an involvement of aberrant metacognition in high hypnotic suggestibility. Hypnotic suggestibility is negatively associated with mindfulness and meditators display reduced or average hypnotic suggestibility (Semmens-Wheeler & Dienes, 2012; Spanos, Steggles, Radtke-Bodorik, & Rivers, 1979). Meditators seem to have greater awareness of motor intentions (Jo, Hinterberger, Wittmann, & Schmidt, 2015) whereas HS individuals seem to have delayed awareness of such intentions (Lush, Naish, & Dienes, 2016). Reducing meta-awareness may also enhance suggestibility (Brown, Antonova, Langley, & Oakley, 2001). Finally, HS individuals display reduced prefrontal activity or prefrontal functional connectivity either at baseline or following a hypnotic induction (Jamieson & Burgess, 2014; McGeown, Mazzoni, Venneri, & Kirsch, 2009; Terhune, Cardeña, & Lindgren, 2011), including in medial prefrontal regions that have been implicated in metacognition of agency (Miele, Wager, Mitchell, & Metcalfe, 2011). Nevertheless, the prediction that metacognition pertaining to one's sense of agency is diminished in HS individuals has not yet been directly tested.

In this study we tested the prediction that high hypnotic suggestibility is characterized by reduced metacognition of agency. HS participants and controls completed a motor control task in which performance was disrupted through surreptitious manipulations related (cursor lag), and unrelated (stimuli speed), to motor control (Metcalfe & Greene, 2007; Metcalfe, Van Snellenberg, DeRosse, Balsam, & Malhotra, 2012). They were presented with

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descending visual stimuli and attempted to capture targets and avoid non-targets using a moving cursor and subsequently judged their performance and control. Previous research showed that sense of agency in patients with schizophrenia was less sensitive to cursor lag manipulations than in controls (Metcalfe et al., 2012), suggesting impaired metacognition of agency. On the basis of the phenomenological similarity of distorted agency in patients with schizophrenia and HS individuals (Polito et al., 2015), we expected that the latter group's sense of agency would be similarly less sensitive to manipulations of cursor lag, but not of stimuli speed, relative to controls.

2. Methods

2.1. Participants

74 right-handed individuals (M_{Age} = 24.5, SE = 0.8; 48 females; years of post-secondary education: 3.6 ± 0.3) consented to participate in this study in accordance with local ethical approval. We expected an effect size for the primary group difference in the within-participant regression analyses to be similar to that of a previous study on patients with schizophrenia (ds = 0.96–1.17; Metcalfe et al., 2012) and so we made a conservative estimate of d = 0.8. Assuming a two tailed α = 0.05 and $1 - \beta$ = 0.90 and an allocation ratio of 2:1 (approximately twice as many controls as HS participants), this amounted to a required sample size of 62 participants. We collected data past this number to increase statistical power and account for the possible omission of participants (none were omitted from the final sample); we ceased data collection once a certain time point in the academic calendar had been reached. Participants were recruited randomly from a larger sample (N = 617) that had previously undergone testing for hypnotic suggestibility.

2.2. Materials and procedure

Hypnotic suggestibility was measured with the *Harvard Group Scale of Hypnotic Susceptibility: Form A* (HGSHS:A; Shor & Orne, 1962), a widely-used, group-administered behavioral measure of hypnotic suggestibility. This scale has been extensively validated (Woody & Barnier, 2008) and exhibited acceptable internal consistency (Cronbach's α = 0.67). The scale consists of a relaxation-based hypnotic induction and 12 suggestions of varying difficulty. Representative items include facilitative motor (e.g., arm heaviness), inhibitory motor (e.g., arm paralysis), and inhibitory cognitive (e.g., posthypnotic amnesia) suggestions. Participants rate their responsiveness to each suggestion based on overt behavioral responses and responsiveness to each item is scored dichotomously. Summary scores range from 0 to 12 with scores in the range of 9–12 reflecting high hypnotic suggestibility.

The *Metacognition of Agency Task* (Metcalfe & Greene, 2007; Metcalfe et al., 2012) indexed the extent to which participants were aware that their motor control had been manipulated. Each trial consisted of 54 stimuli (the letters X and O; Arial, white font, font size 20; 27 each) descending from the top to the bottom of the monitor (see Fig. 1). A grey horizontal track (1 cm tall) that stretched across the monitor 20 cm from the bottom included a superimposed 1 × 1 cm cursor (white square) that was controlled by the mouse. Participants were instructed to capture targets (Xs) using the cursor, while avoiding non-targets (Os) and received performance feedback (32 ms auditory tone; high pitch [5000 Hz] for correct responses; low pitch [1000 Hz] for incorrect responses) (for further details, see (Metcalfe, Eich, & Castel, 2010)). We manipulated two variables: Stimuli speed (8 v. 10 pixels per frame rate [slow v. fast conditions, respectively]) and Cursor lag (0 v. 3 v. 6 frame rates of delay of mouse movements [control (0 ms) v. short lag (50 ms) v. long lag (100 ms) conditions, respectively]). Participants were not pre-informed about these manipulations. Trials took approximately 28–34 s to complete. After each trial, participants rated their performance (*Judgments of Performance* [JOPs]; from *poor* to *perfect*) and control (*Judgments of Agency* [JOAs]; from *no control* to *completely in control*) using visual analogue scales (0–1) on the monitor.

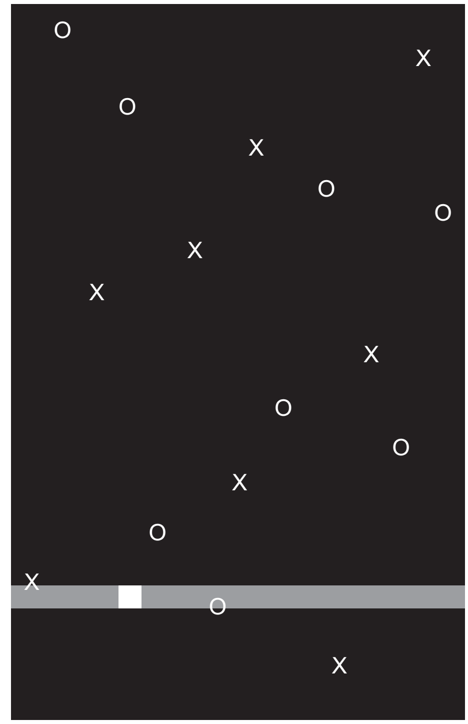

Fig. 1. *Metacognition of Agency Task* (MAT). Participants moved a cursor (white square) along a horizontal track in order to capture descending targets (Xs) and avoid descending non-targets (Os). Stimuli speed and cursor lag were surreptitiously manipulated on different trials to disrupt performance (see Section 2).

Participants completed the HGSHS:A and MAT on separate days. The experimenter administering the MAT was masked to participants' HGSHS:A scores and participants were naïve to the hypotheses under test, ensuring a double-blind design. Prior to the task, video/computer gaming experience was evaluated on a 7-point Likert scale (1: *never*, 2: *a few times*, 3: *more than a few times*, 4: *once in a while*, 5: *many times*, 6: *regularly*, 7: *daily*) (data were missing for one participant). The MAT was completed on a PC using a rotatable DELL LED display (1920 × 1200 pixels, 56 × 36cm; refresh rate: 60 Hz) at a distance of 70 cm with the monitor in the vertical orientation. Stimulus presentation and response collection was implemented with Psychtoolbox (Brainard, 1997; Kleiner, Brainard, & Pelli, 2007) for MATLAB® (2014a, MathWorks, Natick, MA). Participants completed two practice trials followed by 30 experimental trials with each combination of Stimuli speed (2 levels) and Cursor lag (3 levels) occurring with random presentation in five blocks of 6 trials. After completing the task, participants were asked whether they had noticed the lag (scored dichotomously: yes or no) and to estimate the frequency of trials on which a lag was present (0–100%).

2.3. Analyses

Raw data are available in the Supplementary Material. The dependent variables included performance measures (d', hit rates [proportion of "caught" targets] and false alarm rates [proportion