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Hypnotic Clever Hands: Agency and Automatic Responding

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The Clever Hands task (Wegner, Fuller, & Sparrow, 2003) is a behavioral illusion in which participants make responses to a trivia quiz for which they have no sense of agency. Sixty high hypnotizable participants completed two versions of the Clever Hands task. Quiz One was a replication of the original study. Quiz Two was a hypnotic adaptation using three suggestions that were based on clinical disruptions to the sense of agency. The suggestions were for: random responding, thought insertion, and alien control. These suggestions led to differences in accuracy (action production) and estimates of accuracy (action projection). Specifically, whereas the random responding suggestion had little effect, the two clinically based suggestions had opposite impacts on action production: the thought insertion suggestion led to an increase in the rate of correct responses (although participants still believed they were responding randomly); while the alien control suggestion led to a reduction in the rate of correct answers and a pattern of results that more closely approximated randomness. Contrary to theoretical accounts that claim that hypnosis affects executive monitoring rather than executive control, this result indicates that specific hypnotic suggestions can also influence the implicit processes involved in action production.

Keywords: agency, control, executive monitoring, hypnosis, involuntariness

In most situations, we feel that we are able to control our actions. We feel that our movements follow reliably from our intentions and that we are aware of what our body is doing in the world. This experience of our own voluntary behaviors, or sense of agency, allows us to discriminate between events that are caused by us and events that follow from external causes (Haggard & Tsakiris, 2009). Most of the time, our sense of agency provides an accurate indication of our actual actions and behavior. There are several contexts, however, in which sense of agency can be disrupted.

The most obvious examples of disruptions to the sense of agency are those that occur in clinical conditions, such as delusions of control. Patients with these conditions report making movements, speaking, or thinking without consciously intending to (Frith, 2005). These disruptions can occur as a symptom of psychosis, particularly within the context of schizophrenia (Hur, Kwon, Lee, & Park, 2014). Disturbances to the sense of agency in psychosis manifest in two main ways: first, as an altered experience of thinking such as thought insertion, where patients report experiencing spontaneous thoughts that they believe are caused by an external agent (Mullins & Spence, 2003); and second, as an altered experience of body movements such as alien control, where patients report that particular motor actions have been generated by an external source (Voss et al., 2010).

Agency Alteration in Hypnosis

Agency disruption is also a key aspect of hypnosis. Hypnosis can be defined as a particular context of social interaction, characterized by alterations in perception, cognition, and action in response to suggestion (Kihlstrom, 2008). A hypnotic interaction typically involves a hypnotic induction, often consisting of a series of instructions to relax and concentrate, and then suggestions to perform specific actions (such as raising an arm) or to experience specific imaginative events (such as becoming aware of a mosquito flying around the room). There are considerable individual differences in susceptibility to hypnosis (Barnier, Cox, & McConkey, 2014; Laurence, Beaulieu-Prévost, & du Chéné, 2008). People with a low level of hypnotic ability may not experience anything unusual during hypnosis, whereas people with a high level of hypnotic ability consistently report dramatic alterations to their subjective experience, with striking changes in perceptual, imaginative, and affective processes. These changes are characterized by feelings of involuntariness over ones' own actions that, like clinical agency disturbances, may be associated with an altered experience of thinking or an altered experience of body movements (Polito, Langdon, & Barnier, 2015).

Although agency disruptions in hypnosis are well recognized (Hilgard, 1965; Kihlstrom, 2008; Terhune, Cleeremans, Raz, & Lynn, 2017; Woody & McConkey, 2003), there remains considerable controversy over why this disruption occurs. Broadly speaking, there are three major sets of accounts that purport to explain

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hypnosis: dissociated experience, dissociated control, and social cognitive theories. Here we provide a quick sketch of the key features of these accounts (for comprehensive reviews, see Woody & Sadler, 2008; Kirsch et al., 2008). The dissociated experience and dissociated control accounts are both derived from the earlier work of Hilgard (1979), and both claim that hypnosis involves disconnections between components of the cognitive system that controls action. Figure 1, adapted from Woody and Sadler (2008), shows a model of these potential disconnections. This model is compatible with dual-system models of action such as proposed by Norman and Shallice (1980). In this model, a higher level system of executive functioning (executive control and executive monitoring) is associated with conscious volition and planning (equivalent to the supervisory attentional system in Norman and Shallice's terminology). The actual performance and tracking of actions is taken care of by lower level subsystems of control (contention scheduling in Norman and Shallice, 1980).

Dissociated experience theory (K. S. Bowers, 1990) claims that hypnotic responding occurs due to a dissociation between the executive monitoring and executive control modules. As a result, action monitoring is impaired in hypnosis and actions that are actually initiated voluntarily are experienced as occurring without effort.

Dissociated control theory (K. S. Bowers & Davidson, 1991; Woody & Bowers, 1994), by contrast, claims that hypnotic responding occurs due to a dissociation between higher level executive functions and lower level subsystems of control. In this view, hypnotic suggestions can directly activate behavior without involving the higher executive components of control. Whereas dissociated experience leads to individuals misinterpreting effortful actions as effortless, in the dissociated control view, bypassing the executive functioning system means that actions are genuinely activated without cognitive effort.

Social cognitive theories do not explain hypnosis in terms of dissociations between cognitive processes, but rather in terms of social and environmental factors. One prominent account focuses in particular on contextually cued misattributions of agency (Lynn, Kirsch, & Hallquist, 2008). This view has some similarity to dissociated experience theory as it also claims that actions are generated voluntarily but are misinterpreted as effortless. In this case, however, the disruption in executive monitoring is explained by the mundane operation of social psychological factors, such as expectation and compliance. As an example, strong social cues that imply that hypnosis involves involuntary actions may influence participants to (genuinely) misattribute their actions as effortless (Spanos, 1991).

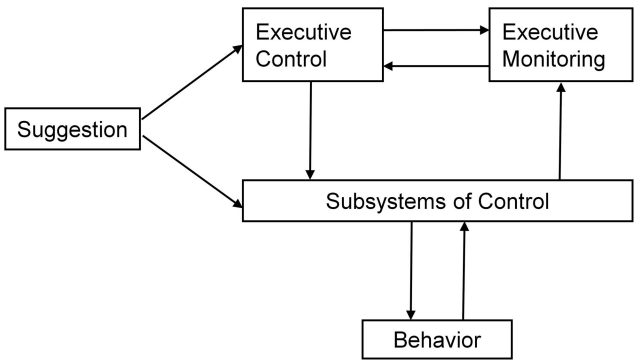

Figure 1. A model of dissociation theories of hypnosis. From "Dissociation Theories of Hypnosis" by E. Z. Woody and P. Sadler. In *The Oxford Handbook of Hypnosis: Theory, Research and Practice* (p. 90), by M. R. Nash and A. J. Barnier (Eds.), 2008, New York, NY: Oxford University Press. Copyright 2008 by Oxford University Press. Adapted with permission.

The theories sketched out here represent three historically influential accounts of hypnosis but are by no means exhaustive (for recent integrative accounts see also Barnier, Dienes, & Mitchell, 2008; Dienes & Perner, 2007; Woody & Sadler, 2008). These theories are presented as three useful lenses for understanding the potential mechanisms that lead to reduced sense of agency in hypnosis.

Researchers typically have investigated hypnotic agency change by asking participants to make ratings of their experiences following suggestions (K. S. Bowers, 1981; P. Bowers, 1982; Kirsch, Council, & Wickless, 1990; Spanos, Radtke, Hodgins, Stam, & Bertrand, 1983; Wilson & Barber, 1978). We have also developed a psychometric scale for indexing changes to the sense of agency (Polito, Barnier, & Woody, 2013; Pritchard, Zopf, Polito, Kaplan, & Williams, 2016). However, participants may not always have complete insight into the cause and nature of their actions (due to altered executive monitoring in hypnosis). A more complete picture of agency change in hypnosis could be provided by combining subjective reports with indirect objective measures of agency.

Behavioral measures of agency disruption primarily have been developed by researchers investigating sense of agency outside of the context of hypnosis. These experiments usually involve some kind of perceptual or behavioral illusion, which leads participants to misattribute the source or effects of their own, or others', actions. Examples include inducing out-of-body experiences by disrupting visual inputs (Ehrsson, 2007), using false video feedback to obscure participants' ability to identify their own hand movements (Daprati et al., 1997), manipulating the fluency of motor movements (Metcalfe & Greene, 2007), introducing spatial and temporal delays in action feedback (Blakemore, Frith, & Wolpert, 1999), and priming specific action expectations (van der Weiden, Ruys, & Aarts, 2013).

The Current Study

In this study, we sought to apply a behavioral illusion paradigm with a clear and objective measure of sense of agency alteration to a hypnotic context. The task we selected was the Clever Hands quiz from Wegner et al. (2003, Experiments 1 and 2). In the Clever Hands paradigm, participants made actions for which their sense of agency was dramatically reduced. Participants were asked to respond to yes/no questions in a trivia quiz that included a mix of very easy and very hard questions, but were given a clear instruction to answer all questions randomly. Wegner et al. (2003) found that, despite the instruction to respond randomly, participants answered far more of the easy questions correctly than they did the hard questions. Participants also were asked to estimate their accuracy in the trivia quiz. These estimates were significantly lower than participants' actual performance. So it seemed that participants believed they were responding relatively randomly even though in reality their responses were strongly influenced by

their knowledge of the correct answers. Participants had no insight—no sense of agency—for answering the questions correctly.

Although offering financial incentives for particular types of responding or imposing time limits can influence controlled behaviors (Bargh & Thein, 1985; Camerer & Hogarth, 1999), Wegner et al. (2003) found that neither money nor time had any effect on participants' ability to respond randomly in the trivia quiz. Incentives, however, did influence participants' estimates of their accuracy. Participants who were offered high incentives for random responding more severely underestimated their overall accuracy, but still answered most questions correctly.

These results indicate that the processes by which participants attribute agency (or authorship) to a particular action are distinct from the processes that lead to the performance of that action. Wegner et al. (2003) explained this by distinguishing between action production and action projection. Action production is the process that leads an individual to perform an action. In the trivia quiz, action production occurred as the participants' knowledge led them to make the correct responses to the trivia questions. Action projection is the process whereby an individual, having perceived that an action has occurred, then searches for the cause of that action. In the trivia quiz, Wegner et al. (2003) proposed that inaccurate action projections occurred as participants were not fully aware that they had produced answers to the quiz questions in an intelligent and deliberate manner. Wegner et al. (2003) claimed that instead of attributing the answers to their own effort, the instruction to respond randomly provided a viable alternate source of answers (chance or randomness).

This distinction between an individual's actions—action production—and their experience of their actions—action projection—is similar to the distinction between executive control and executive monitoring found in many theories of hypnosis (Barnier & Oakley, 2009; Woody & Sadler, 2008). In hypnosis research, action production is typically measured by evaluating whether an action passes a fixed behavioral criterion: for example, whether or not participants raise their arm more than 6 in. when given a suggestion to do so (e.g., Shor & Orne, 1962). Action projection is typically measured by asking participants to rate their sense of control for the relevant action: for example, to give a score from 1 to 5 indicating how voluntary an action felt (e.g., K. S. Bowers, 1981).

We extended the Clever Hands task as a way of investigating action production and action projection within hypnosis. In particular, we aimed to integrate three strands of research on sense of agency: (a) agency change in hypnosis, (b) a behavioral illusion paradigm that has been shown to alter sense of agency, and (c) clinical features of agency disruption. We did this by developing a hypnotic version of Wegner et al.'s (2003) paradigm with hypnotic suggestions based on the clinical agency disorders of thought insertion and alien control (Mullins & Spence, 2003; Voss et al., 2010). Participants completed two equivalent trivia quizzes. Quiz One, administered before a hypnotic induction, was a direct replication of the original Wegner et al. (2003) Clever Hands trivia task. Quiz Two, administered after a hypnotic induction, involved one important change: before completing the quiz, we gave participants one of three hypnotic suggestions aimed at altering their experience of responding to trivia questions. Participants received either a suggestion based on explicit random responding, a suggestion based on thought insertion, or a suggestion based on alien control.

The purpose of the random responding condition was to see if hypnosis had any impact on participants' performance. How would a hypnotic suggestion that emphasizes the ease of responding randomly compare with Wegner et al.'s (2003) original nonhypnotic instruction to respond randomly?

The thought insertion suggestion was based on reports of the phenomenological experience of thought insertion from genuine patients (Bortolotti & Broome, 2009; Mullins & Spence, 2003; Stephens & Graham, 1994; Vosgerau & Newen, 2007). These patients describe the sudden experience of thoughts belonging to some other person or entity, in a manner outside of their control. For example:

> I look out of the window and I think the garden looks nice and the grass looks cool, but the thoughts of Eamonn Andrews come into my mind. There are no other thoughts there, only his. . . . He treats my mind like a screen and flashes his thoughts on to it like you flash a picture (Mellor, 1970, p. 17).

Our thought insertion suggestion did not explicitly instruct participants to respond randomly but instructed them to make responses based on spontaneous inserted thoughts, unrelated to the content of the quiz questions.

The alien control suggestion was based on reports of the phenomenological experience of alien control from genuine patients (Frith & Done, 1989; Spence, 2001). These patients describe their body making purposeful actions that they do not feel they have caused. For example, "My fingers pick up the pen, but I don't control them. What they do is nothing to do with me" (Pacherie, Green, & Bayne, 2006, p. 569). Our alien control suggestion did not explicitly instruct participants to respond randomly but instructed them to make responses based on spontaneous arm movements, unrelated to the content of quiz questions.

We were particularly interested in whether these final two suggestions, which were based on clinical manifestations of agency disruption, could lead to similar agency changes in a laboratory setting. Whereas the random responding suggestions directly asked for the target behavior (i.e., making random responses), these clinically inspired suggestions aimed to induce two potential experiences that may indirectly lead to random responding. We expected that both of these clinically based suggestions would be more effective than the direct suggestion for random responding because they are modeled on genuine phenomena where the sense of agency is markedly reduced. We did not predict specific differences between the thought insertion and alien control suggestions.

Consistent with Wegner et al. (2003) we used participants' accuracy in the quiz task as the primary measure of action production; we also collected and report reaction times (RTs) as an additional indicator. Also consistent with Wegner, we used participants' estimates of their accuracy as the primary measure of action projection; we also report scores on the Sense of Agency Rating Scale (SOARS; Polito et al., 2013) as an additional indicator.

Based on the findings of Wegner et al. (2003), we expected in Quiz One that participants would answer more easy questions correctly than hard questions. We also expected that participants' estimates of their accuracy would be lower than their actual

accuracy. In Quiz Two, we were interested in the effects of hypnosis and hypnotic suggestions on action production and action projection. The theories of hypnosis outlined above make different predictions about how the hypnotic suggestions should influence results in Quiz Two.

The dissociated experience account attributes the effects of hypnosis to alteration of executive monitoring rather than executive control and would predict that action production should not differ from Quiz One to Quiz Two. That is, knowledge of the answers to easy quiz questions should continue to influence attempts to respond randomly (i.e., participants should still answer a high proportion of easy questions correctly). However, participants' action projection should change. In the nonhypnotic version of the Clever Hands task participants already underattribute their own agency in making correct responses (and believe they are responding randomly when they are not). Impaired executive monitoring in hypnosis should exaggerate this effect in the random responding condition. In the clinically based conditions participants should additionally have compelling subjective experiences of thought insertion or alien control, further obscuring the role of their own knowledge in generating responses and leading to less accurate action projection (i.e., participants should more severely underestimate their proportion of correct responses).

The social cognitive account, focused on contextually cued misattributions, likewise emphasizes alterations to executive monitoring rather than executive control and would make similar predictions but for different reasons (e.g., due to socially cued expectancies). Specifically, according to this account participants should continue to generate correct answers without being aware of doing so in Quiz Two (i.e., no change in action production). Social cues inherent in the hypnotic context should lead to impaired executive monitoring in all conditions. This should lead to participants underestimating their accuracy in all conditions, but this should be particularly pronounced following the clinically based suggestions.

Interpreting the predictions of the dissociated control account is slightly more complex. This account claims that hypnosis alters executive functioning such that hypnotic suggestions bypass the executive control module (supervisory attentional system) and directly activate subsystems of control (contention scheduling). Wegner et al. (2003) showed strong evidence implying that responding correctly to easy quiz questions is an automatic process not amenable to cognitive control. In other words, in the original, nonhypnotic version of the Clever Hands task, knowledge of the correct answers to easy quiz questions already activated contention scheduling in a manner that was resistant to the influence of the higher level supervisory attention system. If, as predicted by the dissociated control account, hypnotic suggestion can influence contention scheduling directly, it is possible that these suggestions could change the pattern of activation within this system such that action schemas associated with correct responding become deemphasized and alternate action schemas more compatible with the content of the hypnotic suggestions become activated (Egner & Raz, 2007; Woody & Sadler, 2008). In this case, the suggestions administered in the current study may influence action production, and change the rate of responding to easy questions such that participants' responses become more random. Notably, if this occurred it would not be due to participants being more able to effortfully generate random responses but would occur due to alterations in the pattern of activity in the subsystems of control that are relatively outside of cognitive control (and not directly affected according to either the dissociated experience or social cognitive accounts; see Figure 1).

We expected that this would be unlikely following the random responding suggestion. Evans and Graham (1980) showed that generating random sequences requires cognitive resources, so it does not seem plausible that changes in the operation of lower level subsystems of control could directly activate a complex pattern of abstract randomness without input from higher level systems. Both of the clinical suggestions, however, were associated with relatively response-driven instructions (i.e., in response to questions participants were instructed to imagine an answer or to make a simple motor movement). It seems plausible that these suggestions may provide motivation and opportunity to engage in activities that are less influenced by the content of quiz questions and indirectly lead to responses that more closely approximated randomness. Action production should not be directly affected by hypnosis, according to this account, but should change due to accurate monitoring of changed patterns of behavior. As such, dissociated control would predict reduced discrepancies between participants estimated and actual accuracy in Quiz Two.

Method

Participants

We tested 60 participants at the University of New South Wales (32 female, 28 male) of mean age 19.72 years. Participants received either course credit or payment of $25. Participants were selected on the basis of their scores on a 10-item modified version of the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS:A; Shor & Orne, 1962) and a 10-item tailored version of the Stanford Hypnotic Susceptibility Scale, Form C (SHSS:C; Weitzenhoffer & Hilgard, 1962; see also Hilgard, Crawford, Bowers, & Kihlstrom, 1979).[1] All participants were confirmed as high hypnotizable (scores of 7 or greater on both the HGSHS:A and the SHSS:C). This sample size was predetermined, based on a goal of 20 participants in each of three experimental conditions, in line with previous research using hypnosis to model delusory and hallucinatory experiences (Connors, Barnier, Langdon, & Coltheart, 2015; Cox & Barnier, 2010).

Participants scored an average of 8.07 (SD = 1.02) on the HGSHS:A and 8.33 (SD = 1.00) on the SHSS:C. We randomly allocated these high hypnotizable participants to one of three experimental groups, with each group receiving a specific hypnotic suggestion designed to alter their experience of generating answers in the trivia quiz: (a) a suggestion to experience random responding, (b) a suggestion to experience thought insertion, or (c) a

[1] The 10-item modified HGSHS:A included: head falling, eye closure, hand lowering, finger lock, moving hands together, communication inhibition, experiencing of fly, eye catalepsy, posthypnotic suggestion, and posthypnotic amnesia; arm rigidity and arm immobilization items were removed to ensure that the procedure could be conducted within the time limits of a 1-hour class. The 10-item tailored SHSS:C included: hand lowering, moving hands apart, mosquito hallucination, taste hallucination, arm rigidity, dream, age regression, arm immobilization, negative visual hallucination, and posthypnotic amnesia: anosmia and auditory items were removed.

suggestion to experience alien control. This study was approved by the University of New South Wales Human Research Ethics Committee.

Materials

Trivia quizzes. Participants completed two separate trivia quizzes based on the task by Wegner et al. (2003). Each quiz consisted of 20 easy questions (e.g., "Are there 12 months in a year?") and eight difficult questions (e.g., "Are there 7107 islands in the Philippines?"). The answer to every question was either "yes" or "no." These questions were constructed for an Australian sample. Pilot testing confirmed that the difficulty of questions in each category was consistent between the two quizzes.

The trivia quizzes were administered via a DMDX computer program (Forster & Forster, 2003) that displayed each question, one at a time, on the screen of a 15-in. laptop that was placed on a small table in front of the participant's chair. Questions appeared in 16-point black Arial typeface on a white background. Each question remained on the screen until participants made a response of either "Y" or "N." The program recorded each answer and the latency to respond (from the onset of the question to the keypress response) and then displayed the next question. Questions were displayed in the same pseudorandom order for each participant. Participants sat in a reclining chair suitable for hypnosis and, during the trivia quizzes, held a standard 104-key computer keyboard in their laps to make responses.

SOARS. Following each of the two trivia quizzes, participants completed the SOARS (Polito et al., 2013). This is a 10-item scale that indexes subjective alterations to sense of agency. Previously we have used this scale to quantify agentive alterations occurring across the course of an entire hypnotizability screening and also to index sense of agency changes associated with responding to specific suggestions (Költő & Polito, 2017; Polito, Barnier, Woody, & Connors, 2014). Participants rate their level of agreement with a series of statements on a 7-point Likert scale from *strongly disagree* to *strongly agree*. The scale has two factors: (a) Involuntariness, with items such as "I felt that my experiences and actions were not caused by me" that represent a subjectively experienced reduction in control over one's own actions, and (b) Effortlessness, with items such as "My experiences and actions occurred effortlessly" that represent a subjectively experienced increase in the ease and automaticity with which actions occur.

Procedure

Quiz One. This experiment was conducted by a single experimenter and was part of a two hour hypnosis session that contained several unrelated tasks. Quiz One occurred before participants received a hypnotic induction (i.e., before they were hypnotized). Upon arriving at the lab, participants were told that the study would be "looking at peoples' experiences and reactions to a variety of hypnotic phenomena." Participants were seated in a reclining chair and told that:

> Questions will appear on the screen and you should respond by pressing keys on the keyboard. All of the answers to the questions are either yes or no. You will read each question on the screen and then respond with a button press. To answer yes, you will need to press the "Y" key, to answer no you will need to press the "N" key.

After ensuring that participants understood the task and how to make responses, the experimenter then read the following instructions, taken from Wegner et al. (2003, p. 8):

> Please answer each question as randomly as you possibly can. Try not to generate a predictable pattern of yes/no or yes/yes/yes, but try to generate a random sequence. After each question make the most free and random choice you possibly can.

Participants then were instructed to press the space key to start the quiz. Questions were displayed one at a time on the screen until an appropriate response (pressing either the 'Y' or 'N' key) was made. After the trivia quiz, participants were asked: "What percentage of those questions do you think you answered correctly, if 0% means you didn't answer any question correctly and 100% means you answered every question correctly?"

Finally, participants completed the SOARS, rating their experience of responding to the quiz questions.

Quiz Two. Participants were then administered a hypnotic induction based on the SHSS:C (Weitzenhoffer & Hilgard, 1962). This induction lasted approximately 12 min and instructed participants to relax, breathe deeply, and focus their attention on the hypnotist's instructions. To ensure that participants were responding during hypnosis, following the induction, they were administered four items from standardized hypnosis scales: arm lowering, verbal inhibition, taste hallucination, and mosquito hallucination. After these filler tasks, participants completed Quiz Two. The procedure was identical to Quiz One, with the single exception that participants received a specific hypnotic suggestion in place of the original instruction to respond randomly. Participants in the random responding condition were told:

> When you respond to these questions I would like you to answer completely randomly. That's right, I want you to answer randomly. You will not generate a predictable pattern of yes/no or yes/yes/yes, but instead will generate a random sequence. You will find it easy and natural to just respond randomly to each question. You will find it easy to answer randomly. You will not follow any pattern or plan but instead will find yourself answering randomly to every question. After each question you will respond totally randomly, selecting either Yes or No, by chance, for each individual question.

This suggestion was very similar to the original nonhypnotic random responding instruction and acted as a control condition for the other two suggestions.

Participants in the thought insertion condition were told:

> As you read each question you will find that an answer to the question appears in your head automatically as if it had been placed there by someone else. This will not be your own internal dialogue answering the questions, instead you will find answers to the question appearing in your head as if they had been placed there by someone else. Thoughts will form in your head which are not your own and these thoughts will direct your answers. These thoughts will not be the correct or incorrect answer to the question, these will just be automatic thoughts appearing in your head from someone else, directing you to answer either yes or no. You may find these thoughts very clear and easy to identify or they may be subtle and faint. In any case you will find a thought in your mind giving an answer to each question and you will respond accordingly. As you sit there comfortably relaxed and deeply hypnotized, someone else, not you, will cause the thoughts which lead you to answer to each question.

Participants in the alien control condition were told:

> As you read each question you will find that your hand moves to press one of the response keys automatically as if it is being controlled by someone else. This will not be your own movement answering the questions, instead you will find your hand pressing the response keys as if it were being controlled by someone else. Someone else will cause your hand to move and direct your answers. These movements will not be the correct or incorrect response to the question, these will just be automatic movements caused by someone else, directing you to answer either yes or no. You may find these movements very clear and easy to identify or they may be subtle and faint. In any case you will find your hand moving automatically to give an answer to each question. As you sit there comfortably relaxed and deeply hypnotized, someone else, not you, will cause the movements which lead you to answer each question.

After receiving the appropriate suggestion, participants again responded to 28 trivia questions using the same computer equipment as in Quiz One. Following completion of Quiz Two, participants again gave a verbal estimate of their accuracy and completed the SOARS. Participants then were administered a hypnotic deinduction in which they were instructed to return to their normal state of wakefulness gradually as the hypnotist counted backward from 20 to one.

Results

Results focus first on participants' accuracy and RTs in the trivia quizzes (action production), and second on participants' estimates of accuracy and SOARS scores (action projection). Pass rates for the standard hypnotic items were high: 95.0% (*SD* = 22.0) passed arm lowering, 66.7% (*SD* = 47.5) passed verbal inhibition, 75.0% (*SD* = 43.7) passed taste hallucination, and 86.7% (*SD* = 34.3) passed mosquito hallucination. As there was no direct behavioral criterion for evaluating whether the hypnotic suggestions in Quiz Two were successful, we asked participants following hypnosis whether or not they experienced effects of the hypnotic suggestion they received: random responding, thought insertion, or alien control. Most participants reported that the suggestion had some effect. The proportion of participants experiencing each suggestion varied, with more random responding participants (94.1%) than thought insertion (57.9%) or alien control (68.8%) participants reporting that they experienced the hypnotic effects, Fisher's exact test $p = .035$.

Action Production

Action production in the Clever Hands task was primarily indexed by participants' behavioral yes/no responses to the quiz questions. In these analyses we were interested in whether participants produced random responses (as they had been instructed) or correct responses (due to the influence of their knowledge of the answers). We were interested also in time taken to answer each question. Table 1 presents participants' accuracy for easy and hard questions in both trivia quizzes. Participants are presented in separate groups according to which hypnotic suggestion they eventually received (i.e., even though no suggestions were administered in Quiz One, scores are shown according to which suggestion group participants were allocated to). A 2 (difficulty: easy vs. hard) × 2 (time: Quiz One vs. Quiz Two) × 3 (suggestion: random responding vs. thought insertion vs. alien control) mixed-model analysis of variance (ANOVA) with accuracy as the dependent variable revealed a main effect of difficulty such that participants answered correctly a greater proportion of easy (*M* = 67.88, *SD* = 2.00) than hard (*M* = 45.56, *SD* = 1.41) questions overall, $F(1, 57) = 62.73$, $p < .0005$; $\eta_p^2 = .524$, 90% CI [.367, .626].[2] This indicated that whereas participants answered the hard questions at rates close to chance, accuracy for easy questions was considerably higher despite the instruction for random responding in Quiz One and the hypnotic suggestions in Quiz Two. A main effect of suggestion indicated that the three hypnotic suggestions had different impacts on action production, $F(2, 57) = 4.09$, $p = .022$; $\eta_p^2 = .126$, 90% CI [.011, .245]. Since Quiz One occurred before hypnosis and before administration of these hypnotic suggestions, this effect appears to have been driven by participants' performance on Quiz Two. To better understand the influence of suggestion on action production, we performed separate analyses for the two quizzes.

Table 1
Action Production: Mean Proportion Correct (%)

Difficulty	Suggestion		
	Random responding	Thought insertion	Alien control
Quiz One			
Easy questions	70.00 (23.56)	76.50 (20.91)	66.50 (17.10)
Hard questions	48.30 (14.78)	42.75 (15.92)	44.00 (16.42)
Quiz Two			
Easy questions	62.75 (19.43)	75.50 (14.41)	56.00 (16.91)
Hard questions	44.00 (16.50)	47.10 (17.13)	47.20 (18.09)

Note. Values in parentheses are standard deviations.

For Quiz One, a 2 (difficulty) × 3 (suggestion) mixed-model ANOVA of participants' accuracy indicated there were no significant effects other than question difficulty, $F(1, 57) = 45.02$, $p < .0005$; $\eta_p^2 = .441$, 90% CI [.276, .558]. An examination of the distribution of responses to easy questions in Quiz One revealed that 85.0% of participants answered correctly a proportion of .50 or greater. These results show that, consistent with Wegner et al. (2003), participants produced correct responses for many of the easy questions in Quiz One, despite the instruction to respond randomly.

For Quiz Two, a 2 (difficulty) × 3 (suggestion) mixed-model ANOVA of participants' accuracy again revealed a main effect of difficulty, such that participants answered correctly a significantly greater proportion of easy questions (*M* = 64.75, *SD* = 18.63) compared with hard questions (*M* = 46.10, *SD* = 17.02), $F(1, 57) = 34.87$, $p < .0005$; $\eta_p^2 = .380$, 90% CI [.214, .505]. A main effect of suggestion indicated that thought insertion participants answered correctly the most questions overall (*M* = 61.30, *SD* = 2.69), followed by random responding participants (*M* = 53.38, *SD* = 2.69), and then alien control participants (*M* = 51.60, *SD* = 2.69), $F(2, 57) = 3.70$, $p = .31$; $\eta_p^2 = .115$, 90% CI [.006, .232].

More importantly, an interaction of difficulty and suggestion indicated that the difference between easy and hard questions varied across the three suggestions, $F(2, 57) = 3.21$, $p = .048$;

[2] Ninety percent confidence intervals are reported for eta-squared values, as suggested by Steiger (2004).

η_p^2 = .101, 90% CI [.001, .215]. One set of post hoc analyses (using a corrected alpha level of .05/3 = .017) investigated the difference between easy and hard questions separately for each suggestion. Participants answered a significantly greater proportion of easy questions correctly compared with hard questions when given the random responding, $t(19) = 3.42$, $p = .003$, 95% CI [7.28, 30.22], $d = .765$ or thought insertion, $t(19) = 5.26$, $p < .0005$, 95% CI [17.10, 39.70], $d = 1.177$ suggestions. The difference in accuracy for easy questions compared with hard questions for participants given the alien control suggestion was not significant, $t(19) = 1.59$, $p = .128$, 95% CI [−2.77, 20.37], $d = .356$; see Table 1.

A second set of post hoc tests (also using a corrected alpha level of .05/3 = .017) showed that easy question accuracy differed across the three suggestions $F(2, 57) = 6.76$, $p = .002$; $\eta_p^2 = .192$, 90% CI [.047, .318]. Specifically, participants in the thought insertion condition ($M = 75.50$, $SD = 14.41$) answered significantly more easy questions correctly than participants in the alien control condition ($M = 56.00$, $SD = 16.91$, $t(38) = 3.93$, $p = .002$, 95% CI [9.46, 29.56], $d = 1.241$). Although not statistically different from the random responding condition ($M = 62.75$, $SD = 19.43$), the thought insertion and alien control suggestions appeared to influence easy question accuracy in opposite directions.

Finally, one-sample t tests confirmed that participants given the random responding, $t(19) = 2.93$, $p = .009$, $d = .656$, and thought insertion, $t(19) = 7.91$, $p < .0005$, $d = .1.77$, suggestions answered easy questions at rates significantly higher than chance. There was no significant difference between alien control participants' easy question accuracy and chance responding, $t(19) = 1.59$, $p = .129$, $d = .355$. Participants who received the alien control suggestion appeared to be answering easy questions ($M = 56.00$, $SD = 16.91$, 95% CI [48.09, 63.91]) at rates closer to chance than participants who received either of the other suggestions (i.e., they appeared to be responding more randomly to easy questions).

Table 2 shows RTs for easy and hard questions in each quiz. A 2 (difficulty) × 2 (time) × 3 (suggestion) repeated measures ANOVA of participants' RTs revealed a main effect of difficulty, indicating that participants took longer to answer hard questions ($M = 1839.03$, $SD = 117.66$) than easy questions ($M = 1700.02$, $SD = 117.66$), $F(1, 57) = 7.05$, $p = .010$; $\eta_p^2 = .110$, 90% CI [.015, .242]. An interaction of time and suggestion $F(2, 57) = 6.42$, $p = .003$; $\eta_p^2 = .184$, 90% CI [.042, .310] showed that RTs (collapsed across difficulty) decreased from Quiz One to Quiz Two for random responding participants (from $M = 2067.88$, $SD = 226.13$ to $M = 1400.35$, $SD = 186.68$, $t(19) = 3.35$, $p = .003$, 95% CI [250.96, 1084.10]). To better understand the influence of suggestion on RTs, we performed separate analyses for Quiz Two. A 2 (difficulty) × 3 (suggestion) repeated measures ANOVA of participants' RTs confirmed a main effect of difficulty, indicating that participants took longer to answer hard questions ($M = 1782.81$, $SD = 1015.29$) than easy questions ($M = 1{,}599.48$, $SD = 826.50$). A main effect of suggestion, $F(1, 57) = 10.35$, $p = .002$, $\eta_p^2 = .154$, 90% CI [.036, .291] showed that RTs varied overall in each condition. Post hoc analyses (using a corrected alpha level of .05/3 = .017) showed that thought insertion participants ($M = 2199.13$, $SD = 823.55$) were significantly slower than both random responding ($M = 1400.35$, $SD = 981.66$, $t(38) = 2.79$, $p = .008$, 95% CI [218.75, 1378.81], $d = .881$) and alien control participants ($M = 1473.96$, $SD = 670.14$, $t(38) = 3.05$, $p = .004$, 95% CI [244.55, 1205.79], $d = .965$).

Action Projection

Action projection in the Clever Hands task referred to participants' insight into their own self-generated actions; did they recognize the degree to which they answered questions correctly or did they misattribute their behavior to external causes? We measured this by comparing participants' estimates of their accuracy in the quiz task with their actual overall accuracy, as shown in Table 3. A 2 (measure: estimate vs. actual) × 2 (time) × 3 (suggestion) mixed-model ANOVA revealed a main effect of measure such that participants' estimates ($M = 42.19$, $SD = 2.22$) were significantly lower than their accuracy ($M = 61.43$, $SD = 1.36$), $F(1, 57) = 96.72$, $p < .0005$; $\eta_p^2 = .629$, 90% CI [.493, .711]. This result shows that participants were unaware of the degree to which they were answering quiz questions correctly. A main effect of suggestion, $F(2, 57) = 6.15$, $p = .004$; $\eta_p^2 = .178$, 90% CI [.038, .303], and an interaction of time and suggestion, $F(2, 57) = 3.22$, $p = .47$; $\eta_p^2 = .102$, 90% CI [.001, .216] indicated that the suggestions differentially influenced participants' accuracy and estimates. Since Quiz One occurred before hypnosis and before administration of these hypnotic suggestions, this effect appears to have been driven by participants' performance on Quiz Two. To better understand the influence of suggestion on action projection we performed separate analyses for the two quizzes.

For Quiz One, a 2 (measure) × 3 (suggestion) mixed-model ANOVA of participants' estimates and accuracy revealed a main effect of measure such that participants significantly underestimated their accuracy overall (estimate $M = 42.96$, $SD = 21.66$;

Table 2
Mean Reaction Times (ms)

Difficulty	Suggestion		
	Random responding	Thought insertion	Alien control
Quiz One			
Easy questions	2021.72 (1227.32)	1789.70 (536.42)	1590.23 (978.65)
Hard questions	2114.04 (1461.13)	1902.04 (747.28)	1669.69 (1120.85)
Quiz Two			
Easy questions	1308.96 (879.53)	2026.72 (723.44)	1462.77 (723.60)
Hard questions	1491.74 (1117.88)	2371.54 (995.18)	1485.15 (643.11)

Note. Values in parentheses are standard deviations.

Table 3
Action Projection: Mean Estimated and Actual Accuracy (%)

Measure	Suggestion		
	Random responding	Thought insertion	Alien control
Quiz One			
Estimated accuracy	46.13 (19.24)	45.25 (24.25)	37.50 (21.24)
Actual accuracy	63.75 (16.44)	66.80 (12.92)	60.05 (12.20)
Quiz Two			
Estimated accuracy	36.00 (22.80)	56.50 (19.34)	31.75 (22.38)
Actual accuracy	57.30 (15.12)	67.30 (10.66)	53.35 (13.28)

Note. Values in parentheses are standard deviations.

actual $M = 63.53$, $SD = 14.02$), $F(1, 57) = 73.14$, $p < .0005$; $\eta_p^2 = .562$, 90% CI [.411, .657]. In Quiz One, unsurprisingly, there was no main effect of suggestion or interaction.

For Quiz Two, a 2 (measure) × 3 (suggestion) mixed-model ANOVA of participants' estimates and accuracy revealed a main effect of measure such that estimated accuracy ($M = 41.42$, $SD = 23.83$) was again significantly lower than actual overall accuracy ($M = 59.32$, $SD = 14.21$), $F(1, 57) = 53.16$, $p < .0005$; $\eta_p^2 = .483$, 90% CI [.320, .592]. A main effect of suggestion indicated that the three hypnotic suggestions had different impacts on participants' patterns of action projection (that is, the average of their estimated and actual accuracy), $F(2, 57) = 9.10$, $p < .0005$; $\eta_p^2 = .242$, 90% CI [.082, .369]. Post hoc analyses of participants' estimates (using a corrected alpha level of .05/3 = .017) showed that thought insertion participants made significantly higher estimates of their accuracy ($M = 56.50$, $SD = 19.34$) than both random responding ($M = 36.00$, $SD = 22.80$; $p = .012$, 95% CI [3.68, 37.32]) and alien control ($M = 31.75$, $SD = 22.38$; $p = .001$, 95% CI [7.93, 41.57]) participants.

A more complete picture of participants' experience of their actions was provided by responses to the SOARS. Immediately after each quiz, participants completed the SOARS, rating their subjective sense of agency while responding to the trivia questions. Higher scores on this measure correspond to alterations of sense of agency along two dimensions: Involuntariness and Effortlessness.

Table 4 shows mean scores for these two subscales for participants in each condition. A 2 (time) × 3 (suggestion) mixed-model ANOVA for Involuntariness scores revealed a main effect of time, such that participants' responses were associated with greater levels of Involuntariness in Quiz Two ($M = 23.74$, $SD = 5.49$), during hypnosis, compared with Quiz One ($M = 14.69$, $SD = 6.19$), before hypnosis, $F(1, 55) = 78.43$, $p < .0005$; $\eta_p^2 = .588$, 90% CI [.439, .679]. A main effect of suggestion indicated that the three hypnotic suggestions had different impacts on Involuntariness, $F(2, 55) = 3.27$, $p = .046$; $\eta_p^2 = .106$, 90% CI [.001, .223].

Since Quiz One occurred before hypnosis and before administration of these hypnotic suggestions, this effect appears to have been driven by participants' performance on Quiz Two. To better understand the influence of suggestion on Involuntariness we performed separate analyses for the two quizzes. For Quiz One, one-way ANOVA showed no significant effect of suggestion. For Quiz Two, one-way ANOVA revealed a significant effect of suggestion such that alien control participants ($M = 26.10$, $SD = 3.78$) reported higher levels of Involuntariness than either the thought insertion participants ($M = 22.35$, $SD = 5.74$) or the random responding control participants ($M = 22.20$, $SD = 6.42$), $F(2, 57) = 3.31$, $p = .044$; $\eta_p^2 = .104$, 90% CI [.002, .219], although post hoc testing revealed no significant pairwise differences when adjusted for multiple comparisons.

Similar analyses for Effortlessness found no main effects or interactions for suggestion or time. The average Effortlessness scores for Quiz One ($M = 23.55$, $SD = 5.64$) and Quiz Two ($M = 26.12$, $SD = 5.76$) showed that participants experienced both quizzes as substantially effortless. By way of comparison, in an earlier study, high hypnotizable participants who retrospectively rated their experiences during the HGSHS:A recorded a mean Effortlessness score of 26.31 ($SD = 4.01$) whereas medium hypnotizable participants recorded a mean score of 23.22 ($SD = 5.12$; Polito et al., 2013). Overall results from the SOARS indicated the hypnotic induction (and hypnotic suggestions) had a considerable impact on participants' experience of Involuntariness whereas levels of Effortlessness in the trivia quizzes remained fairly constant regardless of suggestions. Considered together with participants' accuracies and estimates, the variation in Involuntariness across suggestions provides converging evidence that the alien control suggestion was associated with experienced and actual involuntariness in Quiz Two.

Taken together, the analyses of action production and action projection show that the hypnotic suggestions had different effects on participants' behavior and experience in the Clever Hands task. The random responding suggestion had little impact on participants' performance in Quiz Two relative to Quiz One and these participants served as a control for the suggestions based on clinical disruptions to sense of agency. The thought insertion suggestion led to an altered pattern of action projection with higher estimates of accuracy compared with controls. The alien control suggestion led to a somewhat altered pattern of action production, with reduced easy question accuracy compared with thought insertion participants, and no evidence that responses differed from chance. Surprisingly, these participants did appear to produce random responses.

Discussion

This experiment investigated the capacity of hypnosis and specific hypnotic suggestions to influence individuals' sense of agency during a behavioral illusion task. We adapted Wegner et al.'s (2003) Clever Hands task to the hypnotic context and admin-

Table 4
SOARS Scores

Measure	Suggestion		
	Random responding	Thought insertion	Alien control
Quiz One			
Involuntariness	15.37 (7.40)	12.85 (5.82)	15.95 (4.99)
Effortlessness	24.95 (6.17)	26.00 (6.09)	23.21 (5.46)
Quiz Two			
Involuntariness	22.20 (6.42)	22.35 (5.74)	26.10 (3.78)
Effortlessness	26.95 (4.88)	27.55 (4.74)	23.85 (6.95)

Note. SOARS = Sense of Agency Rating Scale. Values in parentheses are standard deviations.

istered suggestions based on the features of clinical sense of agency disruption to high hypnotizable participants. These suggestions had distinct effects on participants' behavior and experience and led to marked changes in action production and action projection. To unpack these findings, we now discuss each of the quiz tasks in detail.

Quiz One: Replicating Wegner's Clever Hands

As in Wegner et al.'s (2003) original study, participants in Quiz One produced significantly more correct responses for easy questions than for hard questions, indicating that, despite the instruction to respond randomly, knowledge of the correct answers strongly influenced their responses. At the same time, participants' estimated accuracy was far below their actual accuracy, suggesting that they projected their answers to an external source and were unaware that they had answered a considerable proportion of questions correctly. In Wegner et al.'s (2003) original study, the average estimate of accuracy was greater than the expected value of 50% (which would correspond to truly random responding). Wegner et al. (2003) reasoned that estimates above 50% indicated that participants had some insight into the fact that their responses tended toward answering correctly, even if they severely underestimated the degree to which this was occurring. In Quiz One, however, our participants' average estimate was below 50% (M = 42.96, SD = 21.67, one sample $t(59) = -2.52$, $p = .015$), which suggests that these participants were not aware of any tendency toward correct responding and instead believed they had performed particularly poorly in Quiz One. There are two possible explanations for this. The first is that participants may have interpreted the instruction to respond randomly as saying that they should not answer questions correctly; that is, that they should provide incorrect answers. Participants may have thought they were being asked to perform poorly in the trivia quiz and estimates below 50% could indicate that they believed they had indeed responded in that way. A second possibility is that participants may not have understood the connection between correctness and randomness in the trivia quiz. Immediately following the completion of the quiz, we asked participants to estimate what percentage of questions they had answered correctly. Participants may not have realized that truly random responding would equate to 50% accuracy. As in the original task, participants were not explicitly told that there were an equal proportion of questions with the correct answer "yes" as there was for "no"; they were expected to infer this from the fact that there were only two possible responses.

Quiz Two: Hypnotic Alteration of Agency

Quiz Two occurred during hypnosis and following the administration of hypnotic suggestions designed to alter participants' sense of agency. These suggestions influenced participants' experience and behavior in quite distinct ways. Following from Wegner et al. (2003), we expected that responding in the trivia quiz would be a largely automatic process whereby the knowledge of correct answers would influence participants without their awareness. Based on theories of hypnosis that emphasize impairments in executive monitoring rather than executive control (K. S. Bowers, 1990; Hilgard, 1979; Lynn et al., 2008), we expected that action production would be unaffected but action projection would change due to the suggestions.

The first suggestion, random responding, had little effect on participants' action production or action projection, compared with Quiz One. Although an altered sense of agency is often considered a key feature of hypnosis (Weitzenhoffer, 1974; Woody & McConkey, 2003), recent work has indicated that feelings of control and agentive experience may be predominantly influenced by the performance of particular suggestions rather than as an effect of hypnotic induction alone (Polito et al., 2014). Consistent with this view, participants who received the hypnotic version of Wegner et al.'s (2003) instructions did not respond any differently from their nonhypnotic baseline. These participants acted as a control condition for the two other suggestions.

The most striking finding of this experiment was that the suggestions based on clinical sense of agency disruptions had distinct effects on participants' action production in Quiz Two. The thought insertion suggestion led to easy question accuracy that was higher than chance and higher than easy question accuracy in the alien control condition. By contrast, the alien control suggestion led to a pattern of results that more closely approximated randomness. Easy question accuracy was not significantly different from chance in the alien control condition and we found no significant difference between easy and hard question accuracy for alien control participants. We cannot make definitive claims about these null findings, however, taken together, this pattern of results suggests that the alien control suggestion may have led to inhibition of correct responses in Quiz Two. These results are significant for two reasons. First, they indicate that specific hypnotic suggestions can have contradictory impacts on participants' control (and to a lesser degree their experiences) during hypnosis. This is important as it implies that changes to executive functioning that occur during hypnosis are less a direct effect of the hypnotic context, and may be better understood as effects of particular suggestions. Second, although it is not particularly remarkable that the thought insertion suggestion led to an increase in correct responding to easy quiz questions, it *is* surprising that the alien control suggestion seemed to inhibit correct responding. This is surprising because Wegner et al. (2003) found that knowledge of the correct answers to easy quiz questions automatically influenced participants' responses and that this influence was resistant to effortful control (Bargh & Thein, 1985; Camerer & Hogarth, 1999). Participants given the alien control suggestion here appeared able to overcome the tendency to provide correct answers and instead responded in Quiz Two at rates closer to chance. This indicates that, for these participants at least, hypnosis was not only impacting upon experience but may also have influenced subsystems of control (i.e., directly influencing contention scheduling in Norman and Shallice's terminology; Woody & Sadler, 2008). This interpretation is consistent with dissociated control theory, but contradicts a number of contemporary accounts that claim that the locus of effects in hypnosis is limited to influencing only introspective awareness (Barnier & Oakley, 2009; Haggard, Cartledge, Dafydd, & Oakley, 2004; Kihlstrom, 2008). In recent years, however, hypnosis has been reported to affect primary processes involved in word reading in the Stroop task (MacLeod & Sheehan, 2003; Raz & Campbell, 2011; Raz, Moreno-Íñiguez, Martin, & Zhu, 2007; Raz, Shapiro, Fan, & Posner, 2002). As in the case of the hypnotically modified Stroop task, the current finding demonstrates the capacity of a hypnotic suggestion to influence implicit action selection in such a way that participants are able to overcome the

tendency toward otherwise automatic behavior. We return to the implications of this finding shortly.

In terms of action projection, we expected that the clinically based suggestions would lead these high hypnotizable participants to experience noticeable alterations in perception and cognition (i.e., thoughts intruding into consciousness or the subjective experience of an arm moving of its own accord), which they would judge as being the likely cause of their responding in Quiz Two. Dissociated experience and social cognitive theories of hypnosis predict that executive monitoring should be altered such that participants would attribute their actions to these unusual experiences and that this would lead them to believe they had responded randomly. Accordingly, we anticipated that these suggestions would alter participants' estimates of their accuracy (but did not expect to see the changes in action production described above). In both quizzes, participants significantly underestimated their accuracy, although there were some differences between suggestions in Quiz Two. Participants given the thought insertion suggestion made significantly higher estimates of their accuracy than other participants. These participants still underestimated their accuracy, but demonstrated greater insight into the degree to which they were answering questions correctly than did any of the other participants. Participants given the random responding and alien control suggestions showed no significant alterations to their estimates of accuracy compared with Quiz One. On the whole, these findings do not match the predictions of dissociated experience or social cognitive theories. Accurate monitoring of responses was already impaired in the nonhypnotic Clever Hands task. The addition of hypnotic suggestions did not cause further distortions in executive monitoring.

Mechanisms of Hypnotic Agency Change

Participants who received the alien control suggestion provided answers to easy quiz questions that appeared to be more random than other participants. These participants generated answers to easy quiz questions that were indistinguishable from chance. This finding is consistent with work demonstrating the elimination (Raz et al., 2002) or reduction (Raz et al., 2007) of Stroop interference following hypnotic suggestion (although see Raz, Kirsch, Pollard, & Nitkin-Kaner, 2006 for evidence that suggestion may also influence Stroop performance outside of the hypnotic context). In both the hypnotic Stroop paradigm and the current experiment, participants were exposed to textual stimuli that would normally be processed automatically (color words in the Stroop task; easy quiz questions in the Clever Hands task) and yet, did not appear to be influenced by the content of the text. The specific suggestions used in these two cases, however, were substantially different. The hypnotic Stroop experiments used a posthypnotic suggestion that focused on disrupting participants' visual sensory-perceptual experience. Specifically, participants were instructed to perceive the Stroop text as if it were written in a foreign language. By contrast, the alien control suggestion in the current experiment was not focused on perceptual experience. Instead this suggestion was aimed at altering participants' action generation and included explicit instructions for motor movements. This effectively prevented participants' knowledge of the answers to quiz questions from influencing their responses. Additionally, the SOARS scores of alien control participants indicated that their responses were experienced as involuntary, and perhaps as random. Furthermore, RTs for these participants were not reduced relative to the control condition, showing no evidence of responding without reading. Interestingly these two quite different suggestions—one a high level suggestion for altered visual perception and one focused on altered experience of motor actions—were both successful in modifying a behavior previously considered relatively automatic. Egner and Raz (2007) explain the capacity of specific hypnotic suggestions such as these to provide an effective external scaffold to improve task performance in ways not usually open to change.

Participants who received the thought insertion suggestion turned out not to be very random in their responses at all. One possible explanation is that this suggestion did lead to changes in subsystems of control such that new thoughts were generated (compatible with the predictions of dissociated control theory). But unlike the motor movements associated with the alien control suggestion, the content of these thoughts may have been susceptible to conscious knowledge regarding the correct answers and so this suggestion ended up backfiring and leading to an increased rate of correct responses. This interpretation is supported by the finding that RTs were significantly longer for thought insertion participants in Quiz Two compared with random responding and alien control participants, suggesting that more time was spent deliberating over answers.

An alternative explanation for the increase in correct responses following the thought insertion suggestion may be ironic processes of mental control (Wegner, 2009). The demands of the Clever Hands task were for participants to disregard the content of the quiz questions with which they were presented and instead generate an unrelated sequence of random yes/no responses. In the case of thought insertion, participants seemed particularly unable to disregard the content of quiz questions and instead responded with enhanced rates of accuracy, compared with the random responding control condition. Participants' efforts at not thinking about the content of quiz questions may have, paradoxically, increased the frequency of question related thoughts arising. This explanation is particularly applicable to the thought insertion condition where participants were explicitly instructed to pay extra attention to their thoughts. This deliberate and increased monitoring of thoughts may have led to an increase in ironic errors (i.e., responses inadvertently caused by efforts not to think about the correct answer), and consequently higher rates of correct responding. A further possible explanation of the elevated accuracies and estimates for thought insertion is that these participants may simply have confused their knowledge of the correct answers with the spontaneous thoughts they had been instructed to experience.

Clinical cases demonstrate very clearly that sense of agency can be impaired for both motor actions (Voss et al., 2010) and for thoughts (Mullins & Spence, 2003). In this experiment both our motor suggestion (alien control) and our thought suggestion (thought insertion) altered participants' monitoring of self-generated actions (and also their level of control over their actions). However, it seems that the thought insertion suggestion did not lead participants to experience an external cause for their responses and instead resulted in increased feelings of control and reduced experience of randomness. This may have been due to the way this suggestion was worded. These participants were told that they would experience thoughts spontaneously appearing *in their heads* that would not belong to them and that these thoughts would

be the answers to the quiz questions. The internal focus of this suggestion may have prevented participants experiencing their thoughts as externally generated. This interpretation is consistent with Wegner and Wheatley's (1999) theory of apparent mental causation, which claims that we experience a sense of agency for an action when we interpret our thoughts as the cause of that action. Walsh et al. (2014; Walsh, Oakley, Halligan, Mehta, & Deeley, 2015) used an alternate version of a thought insertion suggestion that successfully led participants to experience their thoughts as externally generated, and this may be a promising route for future attempts at modeling thought insertion with hypnosis.

Theoretical Implications

These results have implications for our theoretical understanding of hypnosis and executive functioning more generally. The finding that the alien control suggestion overcame the tendency to respond correctly to easy trivia questions means that we must take seriously the notion that hypnosis can alter patterns of behavior that seem otherwise uncontrollable. Wegner (2002) reviewed a range of hypnotic tasks that involve alteration to low level control systems including pain control, thought inhibition, amnesia, and wart control. In recent years considerable attention has also been paid to hypnotic control of the Stroop effect (reviewed above), and the McGurk illusion (Lifshitz, Aubert Bonn, Fischer, Kashem, & Raz, 2013; Lifshitz, Howells, & Raz, 2012). These findings cannot easily be explained by theories of hypnosis that claim that hypnotic effects are predominately due to impaired executive monitoring (K. S. Bowers, 1990; Hilgard, 1979) or sociocognitive factors (Lynn et al., 2008; Spanos, 1991). Dissociated control theory (Woody & Bowers, 1994; Woody & Sadler, 2008) provides a framework for understanding how such alterations occur in terms of Norman and Shallice's (1980) dual-control model of the initiation and control of behavior. It seems that specific response-driven hypnotic suggestions can lead to profound changes in lower level subsystems of control. As Egner and Raz (2007, p. 35) explain:

> It is an intriguing conjecture that the high efficiency in implementing external hypnotic instructions is precisely due to the fact that task-processing is unencumbered by signals from internal performance monitoring mechanisms, and may consequently be performed in a more automatic manner, akin to a "contention scheduling" system.

An important point to note, however, is that executive functioning was not altered in the same way for all participants in this experiment. Individuals who received the random responding suggestion showed no changes in quiz accuracy, and participants who received the thought insertion suggestion became less random. This demonstrates that hypnosis can change both monitoring and control processes and that alterations to executive functioning may not be inherent effects of the hypnotic context but may be associated with particular suggestions (and for particular participants).

A similar theoretical consideration applies to participants' subjective experiences. The current experiment combined converging indicators of participants' sense of agency: estimates of quiz question accuracy showed the degree to which participants realized they were making correct responses to trivia questions, and SOARS scores showed levels of experienced Involuntariness and Effortlessness. Despite reduced sense of agency commonly being described as a general effect of hypnosis (Hilgard, 1965; Kihlstrom, 1985; Lynn, 1997; Polito et al., 2013; Woody & McConkey, 2003) these measures varied considerably across suggestions. There was evidence that the hypnotic induction had some general effect on sense of agency, shown by increased Involuntariness scores from Quiz One to Quiz Two. In Quiz Two however, participants administered the alien control suggestion experienced particularly pronounced changes in Involuntariness. These findings are consistent with earlier work that showed the most significant influence on an individual's sense of agency was the type of suggestion administered (Polito et al., 2014). More generally, these results support a "component abilities" perspective of hypnosis (Woody, Barnier, & McConkey, 2005; Woody & McConkey, 2003), whereby a basic generalized capacity to experience hypnosis is accompanied by a range of specific hypnotic abilities.

Future Directions

This experiment was limited in a number of ways that could be improved in future research. First, there appeared to be some ambiguity around the instruction to respond randomly in Quiz One. Some participants may not have realized that random responding in the quiz task would equate to 50% accuracy overall. Future adaptations of the Clever Hands task could make this explicit (Neuringer, 1986). Furthermore, more accurate reports might be obtained by asking for estimates of accuracy at multiple time points within each quiz, which avoids the problem of a final (and potentially unrepresentative) subjective average of a complex experience over time (McConkey, Wende, & Barnier, 1999). Second, our interpretation of the significance of the decline in easy question accuracy following the alien control suggestion assumes that these participants did indeed read the trivia questions. These results could be strengthened with a formal test of comprehension, such as an additional task at the conclusion of the experiment where participants have to identify quiz questions they have just seen from a list including distractor items. Third, this experiment tested only high hypnotizable participants. It would be useful to try this task in other hypnosis designs to determine if the results reported here are specifically due to hypnotic effects. One important extension would be to compare response with the alien control and thought insertion suggestions in and out of hypnosis. A further extension would be to compare the performance of genuine high hypnotizable participants with participants simulating hypnosis.

Despite these limitations the current experiment was a successful adaptation of Wegner et al.'s (2003) Clever Hands task to the hypnotic context. Results showed that hypnotic suggestions based on the features of clinical cases of agency disruption could significantly alter both action production and action projection. These suggestions altered the automatic bias to respond correctly (as seen with the alien control participants who did respond more randomly than other participants), and also the way self-generated actions were experienced (as seen with the thought insertion participants who estimated that they were responding less randomly than other participants). Importantly, this experiment demonstrated that although theories of hypnosis tend to describe alterations to executive functioning and sense of agency as being associated with the overall hypnotic context, these alterations may be better understood as applying to particular suggestions. Overall, these findings

highlight the utility of hypnosis both as a tool for creating targeted alterations to sense of agency and for influencing otherwise difficult to modify behavioral responses.

Context

This study continues a program of research from our lab using hypnosis to model the features of clinical delusions. This line of research has been useful in identifying the cognitive mechanisms that underlie specific delusions and testing clinical theories in an experimental context. The current study focused on modeling clinical disruptions to the sense of agency in a hypnotic analogue of the Clever Hands task. We found that hypnotic suggestions based on the features of thought insertion and alien control delusions differentially influenced the generation and monitoring of self-produced movements. In particular, the key finding of this study was that the alien control suggestion allowed participants to overcome the usual tendency to provide correct answers to easy trivia questions in the Clever Hands task: a bias that has previously been shown to be robust to manipulations thought to influence controlled behaviors (i.e., time limits and financial rewards). The implication of this finding is that a particular kind of social interaction (a hypnotic induction plus hypnotic suggestion) may lead to changes in executive functioning and attentional capacities that allow individuals to inhibit patterns of behavior that are usually considered automatic and outside of conscious control.

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