Can unconscious intentions be more effective than conscious intentions? Test of the role of metacognition in hypnotic response

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Abstract

Theories of hypnotic responding can be assigned to two classes based on their reliance on metacognition. While several theories assume that responses to hypnotic suggestions can be implemented without executive intentions, the metacognitive class of theories postulate that the behaviors produced by hypnotic suggestions are intended and the accompanying feeling of involuntariness is only a consequence of strategically not being aware of the intention, proposing that hypnotic responding is the product of a purely metacognitive process. In this project, we seek to disentangle these two classes of theories in a behavioural experiment by testing a central prediction of the simplest metacognitive theory, namely the cold control theory. To this aim, we compared the performance of highly suggestible participants in reducing the Stroop interference effect in a post-hypnotic suggestion condition (word blindness: that words will appear as a meaningless foreign script) and in a volitional condition (asking the participants to imagine the words as a meaningless foreign script) to explore whether the simplest version of the cold control theory, could account for hypnotic phenomena. The results of the pilot experiment revealed that the Stroop interference effect was smaller in the post-hypnotic suggestion condition than in the volition condition calling into question the core idea of the cold control theory as these data suggest that there is more to hypnotic response than a simple change in monitoring of higher order thoughts of intentions. Consequently, the cold control theory may need to be revised to fit the idea that an unconscious intention can be more effective than a conscious one, which indicates that possessing a higher order thought of a mental state can have a causal role on one`s first order abilities. Given the importance of the issue, we believe a pre-registered experiment is imperative to draw strong conclusions as it would provide us with more credible evidence.

Keywords: Hypnosis, Post-hypnotic suggestion, Higher order thoughts, Metacognition, Stroop effect

The cornerstone of hypnotic responding is the feeling of involuntariness that accompanies an otherwise goal-directed behaviour (Weitzenhoffer, 1974, 1980; Terhune, Cleeremans, Raz & Lynn, 2017). Responses to hypnotic suggestions vary widely in terms of their difficulty. Some motor actions can be done by almost everyone (e.g., feeling a magnetic power between the palms that is pulling them towards each other), whereas the imaginative exercise to produce vivid hallucinations of noises can only be performed by a minority of the population (usually highly suggestible people, henceforth highs). The question of how these alterations in cognition can be implemented with a disrupted sense of agency has been the focus of scientific endeavour for decades. Theories from the sociocognitive tradition of hypnosis stress the role of demand characteristics in forming the subjective experiences involved with hypnotic responding and often highlight the strategic nature of the action as appropriate to the specific context (Comey & Kirsch, 1999; Spanos, 1986). The cognitive approach also often underscores the active role of the participants in creating an altered sense of reality (e.g., Kihlstrom, 1998) and several theories of this tradition, the dissociation theories (Bowers, 1990; Hilgard, 1977, 1991; Kihlstrom, 1985), propose that the sense of involuntariness can emerge by dampening the monitoring of one's own control processes. Recently, a theoretical attempt has been made to synthesize these views by depicting a metacognitive account of hypnosis, namely the cold control theory (Barnier, Dienes & Mitchell, 2008; Dienes, 2012; Dienes & Perner, 2007), that draws from the higher-order thought theories (Lau & Rosenthal, 2011; Rosenthal, 2005) of consciousness.

The (higher-order thought) HOT theory of consciousness postulates that a representation or a state is only conscious if one becomes aware of its content by the existence of a "higher-order thought" or state (HOT) that refers to it (Rosenthal, 2005). A higher order mental state is a mental state not just about the world (which is first order) but about a mental state. For instance, imagine having a first-order state about the world (e.g., "there is a tree"). According to HOT theories, one has no conscious experience of the world unless one possesses in addition a second-order thought about that first-order state (e.g., "I see that there is a tree"). HOTs are not restricted to perception, thus they can refer to any mental state, including those with control functions.

Cold control theory stresses that the mechanism by which hypnotic responding (behavior accompanied by the feeling of involuntariness) emerges is a process that allows people to replace the HOTs about their intentions with inaccurate ones (Dienes, 2012). For instance, to create the experience of the hallucination of a noise (e.g., the buzz of a mosquito), one has to have an intention about imagining that particular noise (e.g an,intention with the content "imagine a buzzing mosquito"), while forming an inaccurate HOT about the intention (e.g. with the content, "I`m not intending to imagine a buzzing mosquito"). The theory also claims that the intention to produce the appropriate response is formed by the actor and it is implemented by regular cognitive control processes implying that the behaviour will be in accord with the goals of the actor and that a hypnotic response cannot be more efficient than a non-hypnotic one (if a simple first-order intention is logically sufficient to produce the response). In a nutshell, cold control theory posits that hypnosis is solely a metacognitive phenomenon, and, in the simplest version of cold control, the theory assumes

that hypnosis is targeting specifically the HOT of intending thereby leaves the first-order states untouched.[1] The latter assumption coincides with the idea that HOTs, or in other words, being conscious of mental states, have only limited or zero function in terms of influencing first-order states (Lau & Rosenthal, 2011; Rosenthal, 2008)[2]. In addition, this assumption also implies that the theory deems hypnotic responding as a form of unconscious control as it claims that responses to suggestions are intended (implemented by executive control processes) while the intention to act is unconscious by virtue of possessing an inaccurate HOT that the intention does not exist.

The notion that hypnotic responses are produced by a strategically relinquished metacognition of one's intentions has gained some support. For instance, individual differences in metacognition, particularly the tendency to generate inaccurate HOTs of intending, are moderately associated with hypnotisability (Dienes, 2012). Further, experimental evidence suggests that the temporary disruption of the dorsolateral prefrontal cortex (DLPFC), which has a vital role in the functioning of metacognition (Lau & Passingham, 2006; Rounis, Maniscalco, Rothwell, Passingham & Lau, 2010), with rTMS (Coltheart et al, in press; Dienes & Hutton, 2013) or alcohol (Semmens-Wheeler, Dienes & Duka, 2013) facilitates hypnotic responding[3]. Another line of research also corroborates the idea that hypnotic responding is the product of a purely metacognitive process by revealing that behaviors created by hypnotic suggestions are not related to first-order abilities of cognitive functioning (apart from metacognition). For example, several studies have presented evidence that performance on tasks involving first-order abilities of executive functioning such as inhibition (Dienes et al., 2009) or sustained attention (Jamieson & Sheehan, 2002) do not predict hypnotisability. Moreover, evidence counts against the claim that responses to hypnotic suggestion can enhance first-order abilities compared to responses that are non-hypnotic. For instance, there is no evidence for the superiority of hypnotic suggestions in recollection (Erdelyi, 1994; Nogrady, McConkey, & Perry, 1985), (more controversially) analgesia (Milling, Kirsch, Meunier & Levine, 2002; Spanos, 1986; for a counter-argument: e.g. Derbyshire, Whalley & Oakley, 2009; Hilgard, 1977; Miller & Bowers, 1993) and endurance (Barber, 1966, Levitt & Brady, 1964). However, an experimental finding, the word blindness effect (Raz, Shapiro, Fan & Posner, 2002; the term was first used by Parris, Dienes & Hodgson, 2012), calls into question the key statement of

[1] Cold control theory assumes that hypnotic response involves strategic changes in HOTs about solely intentions. This claim is independent of whether or not there is domain specificity in metacognitive abilities (e.g. Fleming, Ryu, Golfinos & Blackmon, 2014), or whether hypnotisability involves alterations in metacognition over other domains as well, such as perception.

[2] Of note, a special case of HOT theories, the cross-order integration theory (COI; Kriegel, 2007), stresses that first-order states and HOTs can causally influence each other by binding together to a unified conscious representation, which can, for instance, enhance cognitive functioning.

[3] It is to be noted that none of the experimental manipulations were exclusive in a sense that they might impaired cognitive functions aside from metacognition (Dienes, 2012), allowing for theories focusing on the role of disrupted executive functioning (Woody & Sadler, 2008) to account for the data. Moreover, a recent replication failure of the Rounis et al. (2010) study suggests that the stimulation of the DLPFC with rTMS might not impair visual awareness (Bor, Schwartzman, Barrett & Seth, 2017); the meaning of these findings is a matter of ongoing debate (Ruby, Maniscalco & Peter, 2018; c.f., Bor, Barrett, Schwartzman & Seth, 2018).

the theory, as it suggests that highs can acquire abilities through hypnosis that they do not possess when responding non-hypnotically.

The word blindness phenomenon can be induced by suggesting to highs that they will see words as meaningless characters, or as words of a foreign language, while they are engaged in a color naming Stroop task (Stroop, 1935). Generally, the suggestion is applied post-hypnotically, which means that it is provided during a hypnotic induction prior to the Stroop task and only later activated by a clue (e.g., a clap). It has been shown by various independent laboratories that when this suggestion is given to highs, they can lower the interference and the Stroop effects (as measured by the difference in response times (RTs) between the incongruent and neutral, and the incongruent and congruent trials, respectively) compared to their own performance in a non-hypnotic condition (Augustinova & Ferrand, 2012; Parris et al., 2012; Raz et al., 2002; Raz, Kirsch, Pollard & Nitkin-Kaner, 2006). Moreover, low suggestible people cannot reproduce this improvement in performance (Casiglia et al., 2010; Raz & Campbell, 2011; Raz et al., 2002, 2003) further underlining the notion that hypnosis and so the ability to respond hypnotically can have a causal influence on first-order states. It has been proposed that the word-blindness suggestion allows people to gain control over otherwise automatic processes (i.e., reading), specifically, by being able to dampen the processing of input words (Raz et al., 2002; Raz et al., 2006; Raz, Fan & Posner, 2005).

Overall, these findings cast doubt on the idea that a response by becoming hypnotic only impacts HOTs of intending and cannot alter first order abilities, but the findings do not refute the cold control theory *per se*. First, the cold control theory postulates that to produce the word blindness effect, one has to have a first-order intention to create the experience of the script as being meaningless by using a strategy at the disposal of the person without having an accurate HOT about intending to do so. Consequently, cold control theory asserts that the mere comparison of a suggestion and a no suggestion (Stroop task under normal circumstances) condition overlooks the fact that people have been (implicitly) instructed to create an experience of meaninglessness in the former case but they were told not do so in the latter one (Dienes, 2012). Therefore, this contrast cannot inform us whether the power of imagination (i.e., creating a counterfactual model of reality in which meaning cannot be extracted from the script) depends on the form of the accompanying HOT. Second, individual differences between highs and lows in the ability to create word blindness can account for the disparity in their performance, and indeed, it has been found that highs and not lows can produce the word blindness effect as a response to suggestions in the absence of a hypnotic induction (Parris & Dienes, 2013). This latter finding may seem to settle the matter in favour of cold control: subjects have no more first-order abilities responding hypnotically as non-hypnotically. However, this conclusion depends on hypnotic responding being entirely conditional on a previous hypnotic induction. If a subject can, without an induction, respond hypnotically, then the mere presence or absence of a hypnotic induction is irrelevant to theory testing. Indeed, it has been shown that highs can for example produce hallucinations in response to suggestion, or dramatically relieve pain, without a previous hypnotic induction (e.g., Kirsch et al., 2008; Milling et al., 2002). Moreover, it has been demonstrated that the

induction procedure might be irrelevant to the production of the feeling of involuntariness, which is the core feature of a hypnotic response; for example, highs reported comparable levels of involuntariness after a suggestion to experience a sex change with and without a prior induction (McConkey, Szeps & Barnier, 2001). Thus, the use of an induction or not is not relevant to testing the prediction of cold control theory. What is relevant is requesting subjects to have the same first-order intentions while having an accurate or inaccurate HOT about the intention. That is, a clear test of the key prediction of cold control theory necessitates the contrast of the control of highs experienced as voluntary with the control of highs experienced as involuntary (henceforth voluntary and involuntary control) in the capacity of reducing the Stroop interference effect while asked to achieve this by having the same first-order intention. By this, we could investigate whether hypnosis is purely a metacognitive phenomenon. Cold control theory defines hypnotic responding as nothing more nor less than acting intentionally while having the inaccurate HOT that one is not intending to perform that action. This is perhaps one of the simplest theories of hypnosis one could have: the essence of a response being hypnotic lies only in a type of metacognitive monitoring. Thus, critically testing the theory is important: Is a more complex theory needed or not?

One might argue that former research has already tested the core claim of cold control theory in studies investigating the efficiency of imagination compared to hypnotic responding to suggestions and that the theory has been disconfirmed. For instance, there is evidence that the fusiform activation of highs is bilateral when they are responding to a hypnotic suggestion to hallucinate colours whereas only the right fusiform shows activation when they are requested to imagine a grey-scale pattern in color, indicating that voluntary imagination might not produce the same visual experience as hypnotic responding (Alpert & Spiegel, 2000, Kosslyn, Thompson, Costantini-Ferrando). In addition, it has been shown that highs produce stronger pain experience of heat when responding to a hypnotic suggestion contrasted with a request to imagine the same type of pain (Derbyshire, Whalley, Stenger & Oakley, 2004). However, in both of these studies other factors than a mere change in monitoring of the HOT of intending might have been in play to produce varying experiential and neuropsychological responses. For example, if the wording is not carefully phrased in the non-hypnotic and hypnotic conditions than it can create demand characteristics resulting in a "hold back" effect (Spanos, 1986; Zamansky, Scharf & Brightbill, 1964) or stronger expectations in the hypnotic condition (Braffman & Kirsch, 1999), as the participants aim to please the experimenter or they do not believe that their non-hypnotic response can be as effective as the hypnotic one. We argue that none of these studies provide an unequivocal test of the prediction of cold control theory as the expectations of the subjects were not measured in any of them. The wording of the conditions in Kosslyn et al.`s (2000) experiment were not designed to convince the participants that they can and should try to create comparable responses in the different conditions. Further, and crucially, it was not demonstrated in these examples that the imagination condition involved greater feelings of voluntariness than the hypnotic condition; thus cold control may have been the mechanism in both conditions. Therefore, a genuine test of the prediction of cold control theory need to possess a volitional request that can create equal level of expectations about the efficiency of non-hypnotic and

hypnotic responses ensuring that the participants expect to perform the same with and without the HOT of intending.

To address this issue, we constructed a fully within-subjects design experiment in which the performance of involuntary and voluntary control can be directly compared. We employed three experimental conditions using highly suggestible subjects. In the posthypnotic suggestion condition (henceforth simply "suggestion" condition), we used the word-blindness posthypnotic suggestion to see the words as meaningless characters during the Stroop task. In the volition condition, we told the participants to reproduce the effect of the word blindness suggestion by responding to our volitional request to imagine the words as meaningless characters while doing the Stroop task. In the no suggestion condition, we asked the participants to undertake the Stroop task with the instruction of not imagining the words as meaningless so that we can measure their baseline performance. In this scenario, the cold control theory predicts that people can overcome the Stroop interference to the same extent in the suggestion and volition conditions when compared to the no suggestion condition. Therefore, if the results show a stronger reduction of the interference effect in the suggestion compared to the volition condition then one has to conclude that there is more to hypnosis then the strategic relinquishment of metacognitive monitoring in the form of accurate HOTs of intending. The experiment is testing a core prediction of the simplest version of cold control theory and so if it is disconfirmed, we need to revise the theory to fit the data. The key assumption of cold control theory is that the difference between hypnotic versus non-hypnotic responding is just the difference between having and not having a HOT; if this assumption is retained, the finding of a greater Stroop reduction in the suggestion rather than volition condition would imply that the HOT of an intention can have a causal influence on first order states by hindering cognitive control processes (a rare finding of conscious executive processing being less effective than unconscious, contrast Cleeremans, 2006).

A key relevant outcome neutral test is that subjects experienced the word blindness effect as more volitional in the volition condition than in the suggestion condition. This would be the evidence that there was a difference in the presence of relevant HOTs of intending. To the best of our knowledge, this study is the first that measured the subjects' conscious experience of control over 'word meaninglessness' to unravel whether such an experience feels like something that has been intentionally imagined or merely perceived. Investigating the phenomenological level of the participants' cognition can inform us whether their behaviour felt involuntary when the suggestion was active compared to the volitional control. Moreover, controlling the potentially confounding role of expectations is imperative (Braffman & Kirsch, 1999), so we implemented a self-report measure to gauge the participants` expectations about seeing the words as meaningless characters. If subjects reported different levels of expectation for producing a word blindness effect in the suggestion than in the volition condition, expectations alone may explain differences in Stroop reduction in the two conditions (Magalhães De Saldanha da Gama et al, 2013). In addition, we took the participants` subjective experiences of `word meaningfulness` to explore the extent to which voluntary and involuntary control can alter the conscious experiences of the world. The measures reflect the extent to which subjects subjectively

responded to the suggestions and to the volitional request; they could therefore constitute the crucial test of whether suggestions and volitional requests are equally effective. However, as the apparent problem for cold control lies with the objective measure of Stroop reduction, it is the RT measures that form the crucial test. Finally, we measured the `depth` of hypnosis to shed more light on the nature of the experienced state that accompanies the implementation of both types of control. This is an exploration, a sideline from the main point of the experiment, testing the assumption that the experience as of being in a hypnotic state, as interpreted by the participants, does not accompany post-hypnotic suggestion (e.g., Terhune, Luke & Cohen Kadosh, 2017).

First, we report a pilot experiment using this procedure. While the results yielded moderate evidence against cold control theory, the procedure and analyses were not pre-registered. Further, there was not a strict stopping rule (albeit Bayesian analyses were used). Thus, the pilot study will serve as a basis for a proper pre-registered test of cold control theory.

Pilot Experiment

Methods

Participants. Thirty-three highly suggestible students of the University of Sussex, all proficient readers of English, attended the experiment in exchange for course credits or payment. Eleven participants were recruited in 2013 and twenty-two students were recruited in 2014. The students had been screened in group sessions for being highly suggestible prior to the study. Students scoring 9 or higher on the Waterloo-Stanford Group Scale of Hypnotic Susceptibility, Form C (WSGC; Bowers, 1993) were recruited to the study. The participants granted their informed consent before participation and the Ethical Committee of the University of Sussex has approved the study.

Stimuli and apparatus. The stimuli of the experiment closely followed those used by Raz et al. (2002). The stimuli consisted of 4 types of color words (RED, BLUE, GREEN, and YELLOW) and 4 types of neutral words (LOT, SHIP, KNIFE, and FLOWER). The stimuli set of the congruent condition included the color words presented in colours matching the meaning of the words (e.g., RED in the color red). The incongruent items were color words displayed in colours mismatching the meaning of the word (e.g., RED in the color blue). The neutral words were length-matched to the color words and so all items had their corresponding presentation color (e.g., LOT presented always in red). All words were written in upper-case font and presented against a white background. The vertical visual angle of the stimuli was 0.5º, while the horizontal visual angle of the stimuli lied between 1.3º and 1.9º depending on the length of the word. The distance between the participants` eyes and the computer screen was approximately 65cm. The response keys used in the experiment were “V”, “B”, “N”, “M” for the colours red, blue, green and yellow, respectively. The keyboard buttons were not colour-labelled. The experiment was produced in and run by the software Experiment Builder (SR Research Ltd, Ottawa, ON, Canada).

Design and procedure. The study had a 3x3 within subjects design with the independent variables of the congruency type of the trial (congruent vs. neutral vs. incongruent) and the experimental condition (no suggestion, suggestion, volition). The proportion of congruent, neutral and incongruent trials was equal (33%) in each condition and the presentation of color and neutral words was frequency and length matched. The conditions were counterbalanced across participants and the Stroop trials (144 per condition) were displayed in a random order within each condition.

The experiment took place in a small room with the experimenter present and only one participant at a time. After providing their informed consent to the study, the participants engaged in a practice Stroop task for 5 minutes. The participants were asked to lay their left middle finger on "V", left index finger on "B", right index finger on "N" and right middle finger on "M" while undertaking the Stroop task. The participants were told to focus on the middle of the screen during the Stroop task, where a black fixation cross appeared for 1500ms at the beginning of each trial. The fixation cross was replaced by one of the Stroop stimuli and remained on the screen until response. Finally, a feedback ("CORRECT" or "INCORRECT") flashed in black on the screen and then a new trial started with the fixation cross. The response to stimulus interval was 2000ms. This sequence remained constant among the experimental conditions.

Next, a hypnotic induction[4] with the post-hypnotic suggestion to see the words as meaningless characters (Raz et al., 2002) was delivered by the experimenter and the participants were told that a clap would activate and a double clap would deactivate this suggestion. To test the effectiveness of the suggestion, the experimenter activated it by the clap and asked the participant to rate the meaningfulness of a presented coloured word on the following scale: 1 - completely clear, 2 - little unclear, 3 - unclear, 4 - completely unclear. Those who reported to see the word completely clear or little unclear received an additional instruction: "Notice how as you look at the word on the screen, you can look at it with the meaning fading to the background of your mind. We have found even when people consciously experience some meaning after this suggestion, they still process the words differently at a deeper level. You know you are capable of not reading meaning fully, remember how you have zoned out while reading a book.". Finally, the suggestion has been deactivated, and the participants have been brought back to wakefulness by a deinduction. For the exact wording of the protocol, see Appendix A.

Subsequently, the participants undertook the three experimental conditions in a random order. In the no suggestion condition, the participants were told to respond as fast and as accurately as they could, and they were asked not to make any attempt to see the words as gibberish or words of a foreign language. The suggestion condition started with a clap accompanied by a sentence highlighting that the suggestion had been activated. At the end of the condition, the suggestion was deactivated by the double clap. In the volition condition, the participants were requested to voluntarily reduce the Stroop interference:

[4] Although, according to the cold control theory, the usage of the induction procedure is not necessary to produce a hypnotic response to a suggestion, we included the induction in the protocol to make sure that the responses of the subjects can unambiguously be considered as hypnotic.

"Highly hypnotisable individuals such as you have been shown to be able to eliminate the interference from the irrelevant word when under the influence of the post-hypnotic suggestion and even when the suggestion is given without hypnosis. We would like you to voluntarily strongly and clearly imagine the irrelevant words as gibberish, words of a foreign language so that no meaning can be taken from them. This is not a hypnotic suggestion and we have not hypnotised you for this part of the task. You'll notice we have not initiated a suggestion by clapping or giving any other cue. You have the ability to do that anytime you please, under your control, as effectively as you just did. Please now voluntarily remove meaning from the words. You can do this so that it is under your control, just by exercising your imagination. You can be aware it is your imagination at the same time as it produces powerful effects."

Throughout the experiment, we administered several self-report measures, and in each case, the experimenter read out loud the question and provided the answer options on a sheet for the participants. Before the start of the Stroop task in each condition, the participants reported their expectations on how certain they are that the words will be meaningless. When they finished the Stroop task, the following measures were taken: four items assessing the subjective experience of the meaningfulness of the words; a task to recall the words they have seen[5]; depth of hypnosis scale (Hilgard & Tart, 1966); an item gauging the experienced control over the meaningfulness of the words; a dichotomous question whether they perceived or imagined the words as meaningless[6]. For the exact questions and answer options see Appendix B. After finishing the last condition, the participants were thanked and debriefed.

Data analysis

Statistical analyses. We conducted all of our analyses with the statistical software R 3.3.1 (R Core Team, 2016). Since we had a fully within subjects design, we calculated difference scores so that we were able to test directly all of our hypotheses with Bayesian paired t-tests (we only conducted direct contrasts; i.e. not an omnibus *F* or *B* comparing the three conditions as the omnibus statistic would not be informative in terms of our hypotheses). Along with frequentist statistics, we calculated the corresponding Bayes factor (B) which was used as the basis of decision making in respect of the compared hypotheses.

Bayes factor. The Dienes and McLatchie (2018) calculator in the R environment was used to calculate the Bayes factors, which has a t-distribution as a likelihood function for the data, and we set the degrees of freedom of the theory to 10,000 in each analysis to have a likelihood function for the theory close to normal. The computation of the B requires the specification of the prediction of the two models that we intend to compare. We applied a half normal distribution with a mode of zero to model the predictions of the alternative hypotheses, as the tested hypotheses have directional predictions and assume that smaller effects are more probable than larger effects (Dienes, 2014). We report Bs in the following format: $B_{H(0,\ X)}$, in which H indicates that the model is half-normal, the first parameter (0)

[5] The data regarding this question have not been utilised for this project.

[6] This question was omitted from the no suggestion condition

stands for the mode of the distribution and the second parameter (X) is the SD of the distribution. To specify the standard deviation of the alternative models, we applied the following strategies. Based on the meta-analysis of Parris, Dienes & Hodgson (2013) who have found that the word blindness suggestion generally halves the interference effect of the baseline (no suggestion) condition, we employed half of the interference effect observed in the no suggestion condition as the SD of all models testing the difference between the suggestion and volition and the no suggestion conditions. In order to test the traditional Stroop and interference effects, we used the average of the Stroop and interference effects found among studies containing the word blindness suggestion (See Table 1 of Parris et al., 2013). Concerning the self report measures, we applied the rule of thumb of Dienes (2014) that suggests, in the absence of prior information, to halve the scale of measurement and use it as the SD of the one-sided model (if that matches scientific intuitions closely enough: In this case a population mean difference anywhere on the scales is not completely unreasonable).

Although, B is a continuous measure of evidence by definition, we used the convention of 3 and 1/3 to distinguish between no evidence and good enough evidence for the alternative and null hypotheses, respectively (Jeffreys, 1961). Moreover, we use the label of moderate evidence for the values between 3-10 or 1/3-1/10, and the label of strong evidence for Bs greater than 10 or smaller than 1/10, in order to highlight the strength of the evidence (Lee & Wagenmakers, 2013).

A Bayes factor is the strength of evidence for one model over another and thus depends on what the models are (Rouder, Morey, Verhage, Province & Wagenmakers, 2016; Rouder, Morey & Wagenmakers, 2016). We have endeavoured to keep the models simple and otherwise scientifically informed; nonetheless, the chosen parameters (e.g., the SD of a half-normal distribution) could be motivated in different ways. Therefore, to ascertain the robustness of our Bayesian conclusions to the SDs of the H1 models, we report a robustness region for each B, providing the range of SDs of the half-normal models that qualitatively support the same conclusion (using the threshold of 3 for moderate evidence for H1 and ⅓ for moderate evidence for H0) as the chosen SD[7]. The robustness regions are notated as: RR [x1, x2] where x1 is the smallest and x2 is the largest SD that gives the same conclusion.

Bayesian parameter estimation with 95% Credibility intervals. To explore the extent to which the post-hypnotic suggestion or the voluntary control reactivates a hypnotic trance, we applied parameter estimation rather than hypothesis testing. To conduct the estimation, we report the condition means of the depth of hypnosis with the 95% Credibility Intervals (CI). Note that the 95% CIs are numerically identical to the 95% Confidence Intervals as we employed uniform prior distributions.

Results

Data transformation. The data of three participants were partially missing (one participant had only response time data whereas two participants had only self-reported data),

[7] Thanks to Balazs Aczel for this suggestion

and therefore they were excluded from the analyses. Trials with errors were omitted from the analysis of the response times (RTs) data (4.7% in total from which 1.4% from the no suggestion, 1.9% from the suggestion and 1.5% from the volition conditions)[8]. Moreover, using the outlier exclusion criterion of Raz et al. (2002), we deleted RTs that were 3 standard deviations either above or below the mean (1% of the correct trials from which 0.2% from the no suggestion, 0.3% from the suggestion and 0.4% from the volition conditions). In order to test the congruency related effects, we computed new variables. We calculated the extent of interference effect (RT incongruent – RT neutral) in the different suggestion conditions for each participant. The interference effect was specifically identified by Parris et al. (2013) as the Stroop component most reliably affected by the word blindness suggestion.

Outcome neutral tests 1: Was there a Stroop effect and did the suggestion work? As expected, the RTs were the longest in the incongruent (M = 811, SD = 182) followed by the neutral trials (M = 766, SD = 177) and the fastest in the congruent trials (M = 729, SD = 173). Comparing the conditions revealed support for the Stroop interference ($t(29) = 6.34$, $p < .001$, $M_{diff} = 45$ ms, $d_z = 1.16$, $B_{H(0, 62)} = 8.1*10^3$, RR[3, $1.47*10^5$]) and the Stroop effects ($t(29) = 8.09$, $p < .001$, $M_{diff} = 82$ ms, $d_z = 1.48$, $B_{H(0, 90)} = 7.4*10^5$, RR [5, $2.79*10^5$]). Also importantly, we found moderately strong evidence for the classical word blindness effect ($t(29) = 1.99$, $p = .056$, $M_{diff} = 34$ ms, $d_z = 0.36$, $B_{H(0, 30)} = 3.99$, RR [15, 63]), as the extent of the Stroop interference was reduced from the baseline of 60 ms to 26 ms in the suggestion condition.

Outcome neutral tests 2: Did suggestion and volition conditions differ in experienced degree of control? The analysis of the experienced level of control over the meaningfulness of the words indicated that the instruction to imagine the word as meaningless characters triggered a process experienced as more controlled than the suggestion ($t(29) = 5.34$, $p < .001$, $M_{diff} = 0.9$, $d_z = 0.98$, $B_{H(0, 1.5)} = 5.4*10^3$, RR [0.07, $2.75*10^2$]). Although, the participants tended to report that they *perceived* the script as meaningless in the suggestion condition (64% of the participants reported that they perceived rather than imagined the meaninglessness) and they rather *imagined* it in the volition condition (57% of the participants reported that they imagined and not perceived the meaninglessness), the results remained insensitive concerning whether the two procedures are different in nature ($t(25) = 2.00$, $p = .056$, $M_{diff} = 0.23$, $d_z = 0.39$, $B_{H(0, 0.5)} = 2.78$, RR [0.45, 4.8]).[9]

[8] Note that we do not possess the raw data collected in 2013 anymore (only the RTs averaged across trials and within conditions and participants), therefore, these percentages have been based on the data collected from 22 participants in 2014.

[9] Note that the corresponding item of the questionnaire had only two levels (either imagination or perception), but we analysed the data as a continuous variable to make it comparable with the measure we will use in the pre-registered experiment. The Supplementary Materials include an analysis of these data that considers this item as a dichotomous variable and aims to estimate the effect size. The results are in accordance with those in the main text, namely, the estimation revealed that the effect size lies within a broad range covering values larger as well as smaller than 1(OR = 4, 95% CI[0.64-25.02]).

Crucial test: Is the suggestion equally effective for suggestion and volition conditions? Next, we tested the key prediction of the cold control theory by comparing the suggestion and volition conditions in terms of the RTs of interference effects, and the analysis yielded supporting evidence of a smaller interference effect in the suggestion condition ($t(29) = 2.03$, $p = .052$, $M_{diff} = 25$ ms, $d_z = 0.37$, $B_{H(0, 30)} = 4.00$, RR[11, 50]). The participants managed to decrease the interference by 34 ms in the suggestion condition and only by 9 ms in the volition one compared to the no suggestion condition. However, the evidence regarding the difference between the volition and no suggestion conditions remained insensitive ($t(29) = 0.51$, $p = .611$, $M_{diff} = 9$ ms, $d_z = 0.09$, $B_{H(0, 30)} = .74$, RR[0, 81]). Table 1 displays the descriptive statistics of the RTs in the congruency conditions broken down by the experimental conditions. Figure 1 depicts the distribution of the Interference scores in the three experimental conditions.

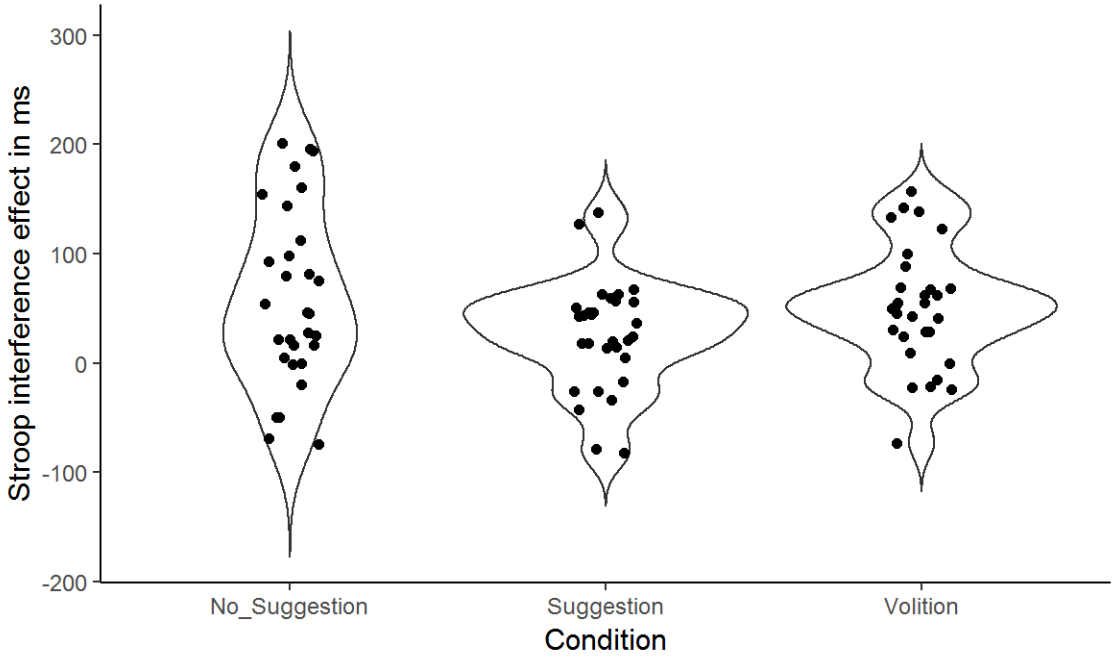

Figure 1. Violin plot portraying the distribution of interference scores in the three experimental conditions. The black dots indicate individual data points; one dot represents the interference score of a single participant.

The expectations to see the words as meaningless characters were raised in both of the suggestion ($t(29) = 5.99$, $p < .001$, $M_{diff} = 1.7$, $d_z = 1.09$,$B_{H(0, 2.5)} = 3.19*10^4$, RR[0.11, $5.42*10^2$]) and the volition conditions ($t(29) = 5.65$, $p < .001$, $M_{diff} = 1.58$, $d_z = 1.03$, $B_{H(0, 2.5)} = 1.27*10^4$, RR[0.11, $4.93*10^2$]) compared to the no suggestion condition. Yet, these increments were comparable (See Table 1) and there is evidence for no difference between the suggestion and volition conditions ($t(29) = 0.38$, $p = .710$, $M_{diff} = 0.12$, $d_z = 0.07$, $B_{H(0, 2.5)} = 0.18$, RR[1.33, Inf]) implying that the the suggestion effect was enhanced hypnotically versus volitionally beyond the impact of expectations (we have not regarded this as an outcome neutral test, in that if there had been an difference in expectancies we still could have conducted a version of the crucial test by partialling out expectancy effects).

Supporting test of interest: Do suggestions and volitional requests produce the same subjective response? We investigated whether the manipulation of the meaninglessness of the words was successful on the subjective level of the participants, and whether the posthypnotic suggestion and volitional request produced similar subjective responses. The descriptive statistics about the subjective experience of meaninglessness are shown in Table 2 for each question and condition separately. Note that the first question was phrased reversed compared to the other three questions, thus, smaller values indicate stronger experience of meaninglessness in that case. The results of the phenomenological data on how the meaninglessness was sensed were only partly in line with the findings of the RTs. Statistically speaking, we found strong evidence favoring suggestion and volition over no-suggestion in creating vivid experiences of meaninglessness. Although, the participants reported that they sensed more meaningless words in the suggestion than in the volition condition (in case of three measures from the four) the evidence regarding the advantage of the posthypnotic suggestion over volition remained insensitive in each case.

Q1. We found strong evidence for a difference between no-suggestion and each of the suggestion ($t(29) = 5.78$, $p < .001$, $M_{diff} = 45$, $d_z = 1.05$, $B_{H(0, 50)} = 2.04*10^4$, RR[3, $1.42*10^4$]) and volition conditions ($t(29) = 4.29$, $p < .001$, $M_{diff} = 36.8$, $d_z = 0.78$, $B_{H(0, 50)} = 4.15*10^2$, RR[4, $9.45*10^3$]). However, the evidence is insensitive in respect of the difference between these latter two conditions($t(29) = 1.56$, $p = .13$, $M_{diff} = 8.2$, $d_z = 0.29$, $B_{H(0, 50)} = 0.65$, RR[0, 99]).

Q2. The results revealed strong evidence in favour of the difference between no suggestion and suggestion conditions ($t(29) = 4.69$, $p < .001$, $M_{diff} = 34.1$, $d_z = 0.86$, $B_{H(0, 50)} = 1.10*10^3$, RR[3, $9.65*10^3$]) and moderate evidence favouring a difference between no suggestion and volition conditions: ($t(29) = 2.64$, $p = .013$, $M_{diff} = 19.6$, $d_z = 0.48$, $B_{H(0, 50)} = 6.90$, RR[5, $1.23*10^2$]). The data show insensitivity whether the suggestion and volition conditions differ ($t(29) = 2.04$, $p = .0502$, $M_{diff} = 14.5$, $d_z = 0.37$, $B_{H(0, 50)} = 1.99$, RR[31, $3.14*10^2$]).

Q3. The results indicate strong evidence favouring a difference between no suggestion and suggestion conditions ($t(29) = 3.66$, $p < .001$, $M_{diff} = 24.5$, $d_z = 0.67$, $B_{H(0, 50)} = 71.47$, RR[3, $1.35*10^3$]) and between no suggestion and volition conditions ($t(29) = 3.32$, $p = .002$, $M_{diff} = 28.7$, $d_z = 0.61$, $B_{H(0, 50)} = 36.9$, RR[4, $7.33*10^2$]). Moreover, we have strong evidence that the suggestion and volition do not differ ($t(29) = -.59$, $p = .557$, $M_{diff} = -4.3$, $d_z = -0.11$, $B_{H(0, 50)} = 0.09$, RR[14, Inf]).

Q4. Similarly to Q2, we found strong evidence for a difference between the no suggestion and suggestion conditions ($t(29) = 5.31$, $p < .001$, $M_{diff} = 34.4$, $d_z = 0.97$, $B_{H(0, 50)} = 5.51*10^3$, RR[3, $1.05*10^4$]), moderate evidence for a difference between no suggestion and the volition condition ($t(28) = 2.60$, $p = .015$, $M_{diff} = 17$, $d_z = 0.48$, $B_{H(0, 50)} = 5.71$, RR[4, 100]) and insensitive evidence for the difference between suggestion and volition conditions ($t(28) = 2.05$, $p = .049$, $M_{diff} = 15.2$, $d_z = 0.38$, $B_{H(0, 50)} = 2.11$, RR[33, $3.35*10^2$]).

Exploration: Do post-hypnotic suggestions produce a hypnotic trance at the time of activating the suggestion? The suggestion might not be truly *post*-hypnotic as the participants reported being relaxed or even hypnotised (M = 1.37, 95% CI[1.06 – 1.67]) when the post hypnotic suggestion was triggered, indicating that a hypnotic state might have been experienced. Seemingly, voluntary control does not involve experiencing this hypnotic state, as the upper bound of the 95% CI (M = 0.8, 95% CI [0.52 - 1.08]) barely exceeded the level of being relaxed.

Table 1

Summary Table about the Means of the RTs and Self-report Measures in the three Experimental Conditions

		Experimental condition		
Category	Item (scale)	No Suggestion	Suggestion	Volition
Response times (RTs)	Incongruent (ms)	853 (187)	775 (207)	805 (213)
	Neutral (ms)	793 (183)	749 (205)	755 (198)
	Congruent (ms)	748 (141)	712 (212)	726 (214)
Expectations	Expecting the words to be meaningless (0-5)	0.59 (1.03)	2.29 (1.40)	2.17 (1.28)
Experienced Control	Control over meaningfullness (0-3)	2.33 (0.84)	1.1 (0.69)	2 (0.71)
	Perception vs. Imagination (% of perception)	-	64% (49)	43% (50)
Depth of hypnosis	Depth of hypnosis during the task (0-3)	0.43 (0.5)	1.37 (0.81)	0.8 (0.76)

Note. The Standard Deviations (SD) of the means are shown within the brackets.

Table 2

Summary Table of the four Items Measuring the Subjective Experience of Meaninglessness

Item	Experimental condition		
	No suggestion	Suggestion	Volition
Q1: „Was the meaning of the words on the screen completely clear to you"	81.8% (25.9)	36.8% (28.5)	45% (35)
Q2: „Were you aware of only an unclear meaning of the words on the screen"	13.7% (25.7)	47.8% (34.3)	33.3% (30.6)
Q3: „Were you just aware of the color and had no idea of what script of the words were written in"	20.9% (29.3)	45.3% (31.8)	49.6% (33.7)
Q4: „Were the words on the screen written in a clear yet meaningless script"	12.6% (23.1)	47% (30.5)	30% (31)

Note. The Standard Deviations (SD) of the means are shown within the brackets.

Discussion

In this experiment we aimed to discover whether highly suggestible people can produce the word-blindness effect outside of hypnotic context by voluntarily imagining the words as meaningless. The results provided moderate to strong evidence supporting the successfulness of the experimental manipulations in outcome neutral tests. Most importantly, the classical word-blindness effect was replicated and the volitionally induced meaninglessness was experienced as voluntary compared to its post-hypnotic counterpart. Although, the second measure assessing the nature of control was not sensitive, the amount of evidence was close to the convention of 3 (B = 2.78), suggesting that the process of meaninglessness was experienced as imagined in the volitional condition and as perceived in the suggestion condition. This difference between the two measures of control might be due to the fact that the latter item was only dichotomous and so not sensitive enough to capture the mild difference in how people sensed the meaninglessness. Therefore, a continuous item assessing the nature of control would be more appropriate. In sum the outcome neutral tests were satisfied and we can proceed with the crucial test.

The main results revealed that volitionally induced control by imagining the words as meaningless characters did not enhance performance on the Stroop task to the same extent as the post-hypnotic suggestion. The evidence remained insensitive regarding the efficiency of voluntary control. Theories of hypnosis that regard the unique hypnotic nature of a response is constituted simply by a change in a monitoring HOTs, such as the simplest versions of the cold control theory, cannot account for these data as it seems that the suggestion allowed highly suggestible people to more efficiently resolve conflict than it was possible for them through non-hypnotic means. Thus, retaining the assumption of cold control that hypnotic vs non-hypnotical action differ primarily in accurate HOTs of intending, it seems HOTs of intention, at least the intention to create the experience of meaninglessness, can disrupt task performance; thus, HOTs can have causal effects on first-order states (cf. Rosenthal, 2008). Incidentally, this finding depicts a counterexample for the concept that conscious cognitive control processes are superior to unconscious ones (Cleeremans, 2006), given the assumption that the hypnotic and volitional processes differ in the conscious status of the intentions.

A plausible candidate that can influence the two types of control to produce different results is the expectation about their efficiency, which is a well-known predictor of behaviors elicited by suggestions (Kirsch, 1985; Braffman & Kirsch, 1999). Our scale measuring the participants` expectations emphasised the experience of `word meaninglessness` and the results derived from these data indicate that expectancy was the same in the volitional and the suggestion condition, implying that expectancies of meaninglessness alone cannot account for the difference in the effectiveness in producing the word blindness effect in the two conditions. However, the underlying mechanism of the word blindness suggestion may not be related or restricted to visual processing, which would call into question the relevance of the scale we used in gauging expectations. Recent behavioral and neural studies of the word blindness suggestion provide evidence for the notion that the suggestion affects cognitive control processes rather than the visual input stream, thus, the successfulness of the suggestion might lie in the enhanced conflict resolution and not in the dampened perception

of the meaning of the words (Casiglia et al., 2010; Augustinova & Ferrand, 2012; Parris et al., 2013; Zahedi, Stuermer, Hatami, Rostami & Sommer, 2017). In line with this view, the suggestion, in our experiment, seemed to influence the performance mostly on the incongruent trials by reducing it compared to the no suggestion and volition conditions. Therefore, a measure of the expectations should aim to assess the beliefs of people about the efficiency of voluntary and involuntary control and not solely focus on the experience of meaningfulness. Incidentally, this new design will also allow us to critically evaluate the simplest form of the response expectancy theory (Kirsch, 1985), which claims that expectations are the single driving factors of hypnotic responses. Were the extent of interference different in volition and suggestion conditions while the expectations to see the words as meaningless characters, and to exert control be comparable in the two conditions, the response expectancy theory will need to be revised.

Cold control theory asserts that to create the experience of meaninglessness the subjects need to have a first-order intention to produce it by engaging in an active strategy. The exact mechanism of this strategy is a mystery currently, but several empirical studies have been conducted on this issue that can help us exclude possible explanations. For instance, as mentioned above, it has been demonstrated that neither the dampening of the visual input (Raz et al., 2003), nor the inhibition of meaning processing can be responsible for the whole word blindness effect (Augustinova & Ferrand, 2012; Parris et al., 2013; Zahedi, et al., 2017). These findings are in consonance with the fact that a posthypnotic suggestion that specifically requires highs to lose the ability of reading did not result in the reduction of the Stroop interference effect; it appears that the suggestion needs to include a phrase such as "words are meaningless gibberish" to be successful in enhancing performance (MacLeod, 2011). Consequently, the meaning of the words must be processed to some extent even in the suggestion condition indicating that the information that the scripts of the stimuli are in fact meaningful is available to the participants. This strikes a chord with the idea that highs need to hold two models of reality in the suggestion condition as they do in the volition one. In one model, the meaning can be extracted from the words, as they are meaningful, whereas in the other counterfactual model, this is not possible. Entertaining multiple models is the basis of pretence and imagination (Perner, 1991); not being aware that one intended to engage in pretence or imagination would, according to cold control theory, lead to the experience of hallucination or delusion.

Pre-registered Experiment

In this experiment, we intend to replicate the pilot experiment as a multi-lab pre-registered replication project to increase the evidential value (by virtue of a larger sample) of our data. Moreover, we introduce a new item measuring the participants` expectations to how easily they can overcome the interference in each condition. With this, we aim to address more thoroughly whether involuntary control can be more efficient than the voluntary counterpart beyond the influence of expectations. In addition, we will measure the depth of hypnosis during induction and after de-induction to provide the participants a baseline against which they may compare their experienced depth of hypnosis during the Stroop task.

The questions that will be addressed are those of the pilot study: (a) Outcome neutral test: Was there a Stroop effect and did the suggestion work?; (b) Outcome neutral test: Did suggestion and volition conditions differ in experienced degree of control?; (c) Crucial test: Is the suggestion equally effective for suggestion and volition conditions in reducing Stroop interference as measured in RTs (taking into account expectations)?; (d) Supporting test of interest: Do suggestions and volitional requests produce the same subjective response?; (e) Side interest: Do post-hypnotic suggestions produce a hypnotic trance at the time of activating the suggestion? Is the depth of hypnosis different for the suggestion and volition conditions? In addition, we will explore whether the post-hypnotic suggestion produces a subjective experience of being in hypnosis while it is activated: Traditionally it is assumed that a post-hypnotic suggestion, by virtue of being post-hypnotic, does not involve the experience of being in a hypnotic state at the time of responding (Terhune, Luke & Cohen Kadosh, 2017). Furthermore, we will estimate the extent to which self-reported measures of the feeling of voluntariness converge to assess their validity. Finally, we will run an exploratory correlation analysis to estimate the extent to which the participants are engaging in the same cognitive strategy in the volition and suggestion conditions. The results of this analysis can be used to estimate the sample size of a future study that aims to reach a good enough evidence supporting the idea that the underlying mechanisms of the responses are either the same or different in the two conditions.[10]

Methods

Participants. Labs from the following institutions will recruit participants throughout the academic year of 2018-19: University of Sussex, School of Psychology (US) University of Bournemouth, Department of Psychology (UB) Lancaster University Department of Psychology (LaU); Lund University, Department of Psychology (LuU). We will invite highly suggestible students who are proficient readers of English[11] to attend the experiment in exchange for course credits or payment. The amount of payment and course credits will be in line with the regulations of the local universities (£6 at US, £8 at UB, £7 at LaU and vouchers for movie tickets that worth about 110 SEK at LuU). The suggestibility of the students will be gauged by the Sussex Waterloo Susceptibility to Hypnosis scale (SWASH; Lush, Moga, McLatchie & Dienes, 2018) prior to participation and the threshold of highly suggestibility will be based on the composite SWASH score (top 15% of the population) of the first year psychology students at Sussex (year 2018)(matching typical percentages used to define "high" in the literature; Barnier & McConkey, 2004; Anlló, Becchio & Sackur, 2017). To reduce the cost of screening at UB, LaU and LuU, where possible we will invite participants to undertake the SWASH who were previously identified as highs with other measures. The participants will be asked to read an information sheet about the study and consent to the terms of participation before starting the experiment. The local Ethical Committees have approved the study.

[10] Thanks to an anonymous reviewer for suggesting this analysis.

[11] Apart from the Stroop stimuli, the English materials will be used at Lund University and it will be highlighted in the recruitment letter that fluency in English is an inclusion criterion of the study. During the Stroop task in the Swedish sample, we will use the color words RÖD [RED], BLÅ [BLUE], GRÖN [GREEN] and GUL [YELLOW]; and we will use the neutral words HUS [HOUSE], BIL [CAR], KNIV [KNIFE] and SMÅ [SMALL].

Since we will rely solely on Bayes factors to draw statistical inference, we can use optional stopping (Rouder, 2014). The minimum sample size is set at 20 and then we will conduct all of the crucial analyses after roughly every subject (as different labs are involved there may be some clumping). We will stop collecting the data when all outcome neutral tests provide at least moderate evidence supporting that they have been successful, or else have failed, and when the main test of the study, comparing volition and suggestion conditions, also become sensitive (i.e. the B either larger than 3 or smaller than 1/3). A sample size estimation based on the data of the pilot study suggests that we will need around 40 participants to show supporting evidence for the null, if the difference between the samples is 0 ms and if the standard deviation of the crucial measure will be the same in this study as observed in the pilot study (See Supplementary Materials for details of the analysis). Should any of the four analyses remain insensitive with 60 participants, we will desist from recruiting more participants. We will immediately begin to recruit participants after the date of in-principle acceptance (either the spring term of 2018 or autumn term of 2018) and stop if all of the specified analyses reach sensitivity, if we have 60 participants or if the spring term of 2019 finishes (end of May).

Stimuli and apparatus. The materials of the registered experiment will be identical to those used in the pilot. We will employ OpenSesame (Mathôt, Schreij, & Theeuwes, 2012) to compile and run the Stroop task part of our experiment. The resolution of the applied computer screens will be either 1280x1024 or adjusted to these values so that the size of the presented stimuli will be constant across labs.

Design and procedure. The design of the registered experiment will be in accordance with those of the pilot experiment. To ensure that none of our participants possesses color vision deficiency, we will include a statement in the recruitment letter that only people with intact color vision can attend the study. In addition, we will make three modifications in the instruction of the volition condition. Namely, we will put the sentence "You have the ability to do that anytime you please, under your control, as effectively as you just did." before the following two sentences "You have the ability to do that anytime you please, under your control, as effectively as you just did. You'll notice we have not initiated a suggestion by clapping or giving any other cue.", in order to avoid the implication that the participants have the ability to activate the suggestion without the clap even in the volition condition. Moreover, we will replace the "as effectively as you just did" part with "as effectively as you did it during the hypnotic induction" to make it clear that we refer to the word blindness test that was done during the induction procedure. In addition, we will add an extra sentence highlighting that the effect of a suggestion can be achieved through voluntary means. See Appendix C for the final instruction of the volition condition.

In addition, we will introduce four amendments in the self-report measures: (a) we will include a new item at the beginning of each Stroop condition measuring the expectations about the efficiency to control the interfering information; (b) we will replace the dichotomous answer option of the question measuring the experienced nature of meaninglessness by a continuous scale; (c) we will omit the question concerning the recall of the words; (d) we will replace the item measuring the depth of hypnosis to the one which is

used in the SWASH (2017). See Appendix D for the new items. Moreover, we will measure the depth of hypnosis during the induction procedure, right before the delivery of the suggestion, and we will also measure it after the de-induction.

Data analysis

The steps of the data analysis will closely follow those of the pilot experiment, including the exclusion criterion regarding RT data and how we draw conclusions based on the results of the Bayes factors (e.g., outcome neutral tests and the crucial test).

In terms of Bayes factor calculation, we will retain the parameters of the H1 models of the analyses with RTs. However, to increase the sensitivity of our tests with the self-report measures in comparing the suggestion and volition conditions, we will be informed by the results of the pilot experiment. Specifically, given the score of pilot subjects in the volition condition we can determine the maximum predicted change allowed with respect to the suggestion condition. For example on a 0-3 scale of experienced control (0 = no control, 3 = complete control), the volition condition in the pilot study scored 2.0, so the suggestion condition could experience up to 2 rating units of less control (as it is expected to be smaller than the mean of the volition condition). The maximum difference between conditions is thus estimated as about 2 for the new experiment, and the SD of the half normal can be set as max/2 = 1 rating unit (Dienes, 2014). For expectations (both questions), the SD was set at 1.4 by this process, and the SD for four items assessing subjective experiences as meaningless was set at 30.

We will have three outcome neutral tests to ensure that our experiment is able to test the proposed question. All of these tests have to provide evidence favouring the alternative hypotheses to allow us to carry on with the main analyses. We will test the presence of the Stroop interference effect while ignoring the influence of the type of the control. We will test that the experienced degrees of control is higher in the volition than the suggestion conditions. Finally, we will assess whether the suggestion reproduced the word blindness effect by reducing the extent of Stroop interference in the suggestion condition compared to the no suggestion condition.

The crucial test of the experiment will be the comparison of the suggestion and volition conditions in terms of the extent of Stroop interference. Thus, we will base our final conclusion on this statistical test. In addition, we will run a further analysis to control for the effect of expectations, conditional on the test of difference in expectations between the volition and suggestion conditions. If the evidence does not reach ⅓ to support the claim that the beliefs about the efficiency of suggestion and volition are identical, we will conduct a secondary test. We will use a regression model with the difference in the interference score between conditions (suggestion vs. volition) as the dependent variable and the difference for expectations (suggestion vs. volition) as independent variables (if none of the expectation measures provide evidence for the null then the outlined analysis will be done as a multiple regression with both of the measures as predictors in the model). To conduct the crucial analysis while partialling out the effect of expectations, we will test the intercept of the regression line against zero. By this, we can examine the difference between the suggestion

and volition effects while controlling for the effect of expectations. The parameters of this Bayes factor analysis will be the same as the one testing the main question of the study.

The following are not the main point of the experiment and are thus of secondary interest. We will test whether post-hypnotic suggestion and volitional request produce the same subjective responses in exactly the same way as was done in the pilot. We will estimate hypnotic depth for no suggestion, suggestion and volition conditions, and for the hypnotic induction and the moment of de-induction with 95% CIs assuming a uniform prior over the scale range. To explore whether these conditions and time points differ in hypnotic depth, we will calculate the Bayes factor for the following comparisons: difference between induction and de-induction, induction and suggestion, de-induction and suggestion, suggestion and volition conditions. We will model H1 with a half-normal, and SD of 0.86 rating unit based on the difference between suggestion and volition conditions in the pilot (we will use the difference between the volition and suggestion condition means after adjusting it according to the lengths of the new and old scales).

To estimate the convergent validity of the self-report measures of involuntariness, we will calculate the correlation and 95% CIs of the "level of control" and "experienced nature of meaninglessness" items on the difference scores of the volition and suggestion conditions. We can assess whether people changed the conscious status of the intention to imagine by the difference between volition and suggestion conditions in the experienced nature of meaninglessness item (i.e. experienced as imagination vs perception). As "imagination" is not mentioned in the volition instructions (unlike in the pilot), this tests whether subjects report a change that was not directly instructed, but should still occur according to cold control theory. As this item has a 4-point scale as the degree of control scale does, we will test with the same model of H1 (i.e. SD = 1 unit). We will calculate the correlation and 95% CI between the extent to which subjects can reduce the interference in the suggestion and volition conditions.

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Appendix A. Protocol of the Pilot Experiment

This is an example protocol in which the order of the condition was: (1) Suggestion, (2) No suggestion, (3) Volition. Note that the order of these conditions was counterbalanced across participants.

1. Instructions and consent form

Start script and provide the participant with the consent form

2. Practice

5 minutes of practice Stroop. Ends up with a screen asking to wait for the experimenter.

3. Induction, suggestion and test of suggestion

(O). Induction by Eye Closure.

(1). Now, please seat yourself comfortably and rest your hands in your lap. That's right. Rest your hands in your lap. Now look at your hands and find a spot on either hand and just focus on it. It doesn't matter what spot you choose; just select some spot to focus on. I will refer to the spot you have chosen as the target. That's right... hands relaxed... look directly at the target.

I am about to help you to relax, and meanwhile I will give you some instructions that will help you to gradually enter a state of hypnosis. Please look steadily at the target and while staring at it, keep listening to my words. You can become hypnotized if you are willing to do what I tell you to, and if you concentrate on the target and on what I say. You have already shown your willingness by coming here today, and so I am assuming that your presence here means that you want to experience all that you can. Just do your best to concentrate on the target -- pay close attention to my words, and let happen whatever you feel is going to take place. Just let yourself go. Pay close attention to what I tell you to think about; if your mind wanders, that will be okay; just bring your thoughts back to the target and my words, and you can easily experience more of what it's like to be hypnotized.

Hypnosis is perfectly normal and natural, and follows from the conditions of attention and suggestion we are using together. It is chiefly a matter of focusing sharply on some particular thing. Sometimes you experience something very much like hypnosis when driving along a straight highway and you are oblivious to the landmarks along the road. The relaxation in hypnosis is very much like the first stages of falling asleep, but you will not really be asleep in the ordinary sense, because you will continue to hear my voice and will be able to direct your thoughts to the topics that I suggest. What is important here today is your willingness to go along with the ideas I suggest and to let happen whatever is about to happen. Nothing will be done to embarrass you.

(2) Now take it easy and just let yourself relax. Keep looking at the target as steadily as you can, thinking only of it and my words. If your eyes drift away, don't let that bother you... just focus again on the target. Pay attention to how the target changes, how the

shadows play around it, how it is sometimes fuzzy, sometimes clear. Whatever you see is all right. Just let yourself experience whatever happens and keep staring at the target a little longer. After awhile, however, you will have stared long enough, and your eyes will feel very tired, and you will wish strongly that they were closed. Then they will close, as if by themselves. When this happens, just let it happen.

(3) As I continue to talk, you will find that you will become more and more drowsy. When the time comes that your eyes have closed, just let them remain closed.

You will find that you can relax completely, but at the same time sit up comfortably in your chair with little effort. You will be able to shift your position to make yourself comfortable as needed without it disturbing you. For now, just relax more and more. As you think of relaxing, your muscles will actually begin to relax. Starting with your right foot, relax the muscles of your right leg..... Now the muscles of your left leg..... Just relax all over. Relax your right hand... your forearm... upper arm... and shoulder.... That's right.... Now your left hand.... and forearm.... and upper arm.... and shoulder.... Relax your neck, and chest.... more and more relaxed.... completely relaxed.... completely relaxed.

(4) As you become relaxed, your body will feel deeply at ease.... comfortably heavy. You will begin to have this pleasant feeling of heaviness and comfort in your legs and feet.... in your hands and arms.... throughout your body.... as though you were settling deep into the chair. Your body feels comfortable and heavy.... Your eyelids feel heavy too, heavy and tired. You are beginning to feel very relaxed and comfortable. You are breathing freely and deeply, freely and deeply. You are becoming more and more deeply and comfortably relaxed. Your eyelids are becoming heavier, more and more heavy and difficult to keep open.

(5) Staring at the target so long has made your eyes very tired. Your eyes may hurt from staring and your eyelids feel very heavy. Soon you will no longer be able to keep your eyes open. Soon you will have stood the discomfort long enough; your eyes are tired from staring, and your eyelids will feel too tired to remain open. Perhaps your eyes are becoming moist from the strain. You are becoming more and more relaxed and comfortable. The strain in your eyes is getting greater and greater. It would be a relief just to let your eyes close and to relax completely, relax completely. The strain in your eyes will eventually be so great that you will welcome your eyes closing of themselves, of themselves.

(6) Your eyes are tired and your eyelids feel very heavy. Your whole body feels heavy and relaxed. You feel a pleasant warm tingling throughout your body as you become more and more deeply relaxed ... deeper ... deeper ... more relaxed ... completely relaxed and drifting down into a warm pleasant state of relaxation. Keep your thoughts on what I am saying; listen to my voice. Your eyes are getting blurred from straining. You can hardly see the target, your eyes are so strained. The strain is getting greater, greater and greater, greater and greater. Your eyelids are heavy. Very heavy. Getting heavier and heavier, heavier and heavier. They are pushing down, down, down. Your eyelids seem weighted and heavy,

pulled down by the weight .... so heavy ... your eyes are blinking, blinking .... closing, closing ...

Your eyes may have closed by now, and if they have not, they would soon close of themselves. But there is no need to strain them more. You have concentrated well on the target, and have become very relaxed. Now we have come to the time when you may just let your eyes close. That's it, eyes closed now.

(7) You now feel very relaxed, but you are going to become even more relaxed. It is easier to relax completely now that your eyes are closed. You will keep them closed until I tell you to open them or until I tell you to become alert ... You feel pleasantly, deeply relaxed and very comfortable as you continue to hear my voice. Just let your thoughts dwell on what I'm saying. You are going to become even more relaxed and comfortable. Soon you will be deeply hypnotized, but you will have no trouble hearing me. You will remain deeply hypnotized until I tell you to awaken later on. Soon I shall begin to count from one to twenty. As I count, you will feel yourself going down further and further into a deeply relaxed, a deeply hypnotized state... but you will be able to do all sorts of things I ask you to do without waking up... One... you are going to become more deeply relaxed and hypnotized.... Two... down, down deeper, and deeper... Three... Four... more and more deeply hypnotized.... Five... Six... Seven... you are sinking deeper and deeper into hypnosis. Nothing will disturb you... Just let your thoughts focus on my voice and those things I tell you to think of. You are finding it easy just to listen to the things I tell you. Eight... Nine, Ten... halfway there... always deeper... Eleven... Twelve... Thirteen... Fourteen... Fifteen... although deeply hypnotized you can hear me clearly. You will always hear me distinctly no matter how deeply hypnotized you become. Sixteen... Seventeen... Eighteen... deeply hypnotized. Nothing will disturb you. You are going to experience many things that I will tell you to experience... Nineteen... Twenty. Deeply hypnotized now! You will not wake up until I tell you to. You will wish to remain relaxed and hypnotized and to have the experiences I describe to you.

Even though you are deeply relaxed and hypnotized, I want you to realize that you will be able to write, to move, and even to open your eyes if I ask you to do so, and still remain just as hypnotized and comfortable as you are now. It will not disturb you at all to open your eyes, move about, and write things. You will remain hypnotized until I tell you otherwise... All right, then....

Very soon you will be playing a computer game. When I clap my hands once, meaningless symbols will appear in the middle of the screen. They will feel like characters of a foreign language that you do not know, and you will not attempt to attribute any meaning to them. This gibberish will be printed in one of four ink colours: red, blue, green or yellow. Although you will only be able to attend to the symbols ink colour, you will look straight at the scrambled signs and crisply see all of them. Your job is to quickly and accurately depress the key that corresponds to the ink colour shown. You will find that you can play this game easily and effortlessly. When I clap my hands twice, you will regain your normal reading abilities.

[Clap to activate: "Now you see meaningless words on the screen]

[Show an example word and ask the participant to open her eyes and read out loud the following question with the answer options]

How strongly do you experience the word as meaningless?

1) The meaning of the word on the screen is completely clear to me
2) The meaning of the word on the screen is a little unclear
3) The meaning of the word on the screen is unclear
4) The meaning of the word on the screen is completely unclear

[If the participant has chosen 1 or 2 then read the following script otherwise jump it through]

"Notice how as you look at the word on the screen, you can look at it with the meaning fading to the background of your mind. We have found even when people consciously experience some meaning after this suggestion, they still process the words differently at a deeper level. You know you are capable of not reading meaningfully, remember how you have zoned out while reading a book."

[Clap twice to deactivate: "Now you see meaningful words on the screen"]

[Ask the participant to close her eyes]

Stay completely relaxed and pay close attention to what I'm going to tell you next. In a moment I shall begin counting backwards from twenty to one. You will awaken gradually, but for most of the count you will remain in the pleasant, relaxed state that you are now in. By the time I reach "five" you will open your eyes, but you will not be fully aroused. When I get to "one", you will be fully alert, in your normal state of wakefulness. You probably will have the impression that you have slept, because you will have difficulty in remembering all the things I have told you and all the things you did or felt, since you started looking at the target. In fact, you will find it so much of an effort to recall any of these things that you will have no wish to do so. It will be much easier simply to forget everything until I tell you that you can remember. You will remember nothing of what you did or felt from the time that you started looking at the target, until I say to you: "Now you can remember everything!" You will not remember anything you did until then. After you open your eyes you will feel fine. I shall now count backwards from twenty, and at "five", not sooner, you will open your eyes but not be fully aroused until I say "one". At "one" you will be awake ... Ready, now: 20...19...18... 17... 16... 15... 14... 13... 12... 11... 10, halfway... 9... 8... 7... 6... five... 4... 3... 2... 1. Wake up! Wide awake! Any remaining drowsiness which you may feel will quickly pass.

From now you won't feel hypnotised at all, but the suggestion will powerfully affect you when it is activated by the clap."

4. Suggestion condition

[Say the following]

[Clap to activate suggestion: "Now you see meaningless words on the screen"]

[Get the expectancy rating. Read out loud the question and provide the participant with the text format. Explain in detail if the participant has a question (same procedure for all of the other self-report measures)]

[Start the Stroop task]

[Ask about the subjective experience]

[Ask them to recall the meaning of the words]

[Ask about the depth of hypnosis]

[Ask about the level of control]

[Ask about how did they produce the effect of meaninglessness]

[Clap twice to deactivate suggestion: "Now you see meaningful words on the screen"]

5. No suggestion condition

[Say the following]

"For this part of the experiment no suggestion has been activated. It is important that you make no attempt to make the words seem like gibberish or word of foreign language. We would now like you to respond to the colour of the word on the screen as quickly and as accurately as you can"

[Get the expectancy rating]

[Start the Stroop task]

[Ask about the subjective experience]

[Ask them to recall the meaning of the words]

[Ask about the depth of hypnosis]

[Ask about the level of control]

6. Volition condition

[Say the following]

"Highly hypnotisable individuals such as you have been shown to be able to eliminate the interference from the irrelevant word when under the influence of the post-hypnotic suggestion and even when the suggestion is given without hypnosis. We would like you to voluntarily strongly and clearly imagine the irrelevant words as gibberish, words of a foreign language so that no meaning can be taken from them. This is not a hypnotic suggestion and we have not hypnotised you for this part of the task. You'll notice we have not initiated a suggestion by clapping or giving any other cue. You have the ability to do that anytime you please, under your control, as effectively as you just did. Please now voluntarily remove

meaning from the words. You can do this so that it is under your control, just by exercising your imagination. You can be aware it is your imagination at the same time as it produces powerful effects."

[Have the participants look at a Stroop stimulus on the screen and ask them to make the word seem meaningless and then meaningful again. Tell them they can turn the control on and off.]

[Get the expectancy rating.]

[Start the Stroop task]

[Ask about the subjective experience]

[Ask them to recall the meaning of the words]

[Ask about the depth of hypnosis]

[Ask about the level of control]

[Ask about how did they produce the effect of meaninglessness]

[Finish]

7. Debrief and thank the participant

Appendix B. Items of the Pilot Experiment

Expectations
How strongly do you expect to experience the words as at least somewhat meaningless?

1. I know the meaning of the words on the screen will be completely clear to me
2. I have a little confidence that the meaning of the words on the screen will in some way be unclear
3. I am somewhat sure that the meaning of the words on the screen will in some way be unclear
4. I am fairly sure that the meaning of the words on the screen will in some way be unclear
5. I am almost certain that the meaning of the words on the screen will in some way be unclear
6. I am certain that the meaning of the words on the screen will in some way be unclear

Subjective experience questions
On what percentage of the trials:

1. Was the meaning of the words on the screen completely clear to you?
2. Were you aware of only an unclear meaning of the words on the screen?
3. Were you just aware of the colour and had no idea of what script the words were written in?
4. Were the words on the screen written in a clear yet completely meaningless script?

Recalling the meaning of the words
If you were aware of any words, can you recall them?

Depth of hypnosis scale
How deeply hypnotised were you during that game (Stroop task)?

1. Normal state
2. Relaxed
3. Hypnotized
4. Deeply hypnotized

Level of control
How much control did you have over how meaningful the words appeared to you?

1. I had no control
2. I had some control
3. I had almost complete control
4. I had complete control

Experienced nature of meaninglessness
How did you produce the effect of meaninglessness?

1. The script appearing meaningless was just me imagining it was meaningless

2. The script appearing meaningless was me perceiving the script as really meaningless

Appendix C. Instruction in the Volition condition of the Pre-registered Experiment

"Highly hypnotisable individuals such as you have been shown to be able to eliminate the interference from the irrelevant word when under the influence of the post-hypnotic suggestion and even when the suggestion is given without hypnosis. Notice that when a hypnotic suggestion is given it is always you who creates the response; thus you can achieve the full effect of a suggestion any time you wish. We would like you to voluntarily, strongly and clearly create the experience that the irrelevant words are gibberish, words of a foreign language so that no meaning can be taken from them. You have the ability to do that anytime you please, under your control, as effectively as you did it during the hypnotic induction. This is not a hypnotic suggestion and we have not hypnotised you for this part of the task. You'll notice we have not initiated a suggestion by clapping or giving any other cue. Please now voluntarily remove meaning from the words. You can do this so that it is under your control, just by exercising your every-day capacity to consider the world in different ways, while still knowing how the world really is. You can have complete control over the strategy you used hypnotically and use it without being hypnotised and produce the same powerful effects."

Appendix D. New items of the Pre-registered Experiment

Expectations 2.

How strongly do you expect that naming the colour of the words will be somewhat easy?

1. I know that naming the colour of the words on the screen will be hard to me
2. I have a little confidence that naming the colour of the words on the screen will in some way be easy
3. I am somewhat sure that naming the colour of the words on the screen will in some way be easy
4. I am fairly sure that naming the colour of the words on the screen will in some way be easy
5. I am almost certain that naming of the words on the screen will in some way be easy
6. I am certain that naming of the words on the screen will in some way be easy

Depth of hypnosis

On a scale from 0 to 5, to what degree did you enter a hypnotic state during the game? 0 means your general state of consciousness was just the same as normal, 1 means you were slightly hypnotized and 5 means you entered very deep hypnosis?

Normal State 0 – 1 – 2 – 3 – 4 – 5 Deep hypnosis

Experienced nature of meaninglessness

How did it seem the effect of meaninglessness came about?

The script appearing meaningless was me perceiving it as meaningless	1 – 2 – 3 – 4	The script appearing meaningless was me imagining it as meaningless