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Zoltan Dienes[1], Pete Lush[1], Bence Palfi[1], Warrick Roseboom[1], Ryan Scott[1], Ben Parris[2], Anil Seth[1,3], & Max Lovell[1].

[1]University of Sussex

[2]University of Bournemouth

[3]Canadian Institute for Advanced Research, Azrieli Program on Brain, Mind, and Consciousness

Correspondence:

Zoltan Dienes

dienes@sussex.ac.uk

School of Psychology

University of Sussex

Brighton

BN1 9QH

UK

Abstract

We first review recent work from our laboratory, which construes hypnotizability as an example of a more general trait of capacity for phenomenological control, which people can use to create subjective experiences in many non-hypnotic contexts where those experiences fulfill people's goals. Second, we review recent work, which construes phenomenological control as a specifically metacognitive process, where intentional cognitive and motor action occurs without awareness of specific intentions (cold control theory). In terms of the reach of phenomenological control, we argue that various laboratory phenomena, namely vicarious pain, mirror-touch synesthesia, and the rubber hand illusion are to an unknown degree a construction of phenomenological control. The argument can of course be extended in principle to other findings. In terms of the reach of cold control, we present a new theory of intentional binding and show how intentional binding can measure the absence of conscious intentions in the hypnotic context. We obtain no evidence that cold control confers abilities beyond the changes in the metacognitive monitoring it postulates, and we explore the negative correlation between mindfulness and cold control viewed as a lack of mindfulness of intentions.

People have to varying degrees the ability to change what they experience: They can make normally voluntary actions feel involuntary (the illusion of involuntariness; cf. Polito, Barnier, & Woody, 2013); they can make imagination feel like perception (hallucination; McGeown, Venneri, Kirsch, Nocetti, et al., 2012); and they can make pretense feel like belief (delusion; cf. Connors, Barnier, Langdon, & Coltheart, 2015). Further, people have the capacity to control all these subjective experiences in ways consistent with their plans and goals (e.g. Lynn & Sivec, 1992; Sheehan & McConkey, 1982). We call this individual difference the capacity for phenomenological control. Phenomenological control is the ability to control subjective experience so that a constructed counterfactual state of affairs appears real. It is not a new concept. We as a community have been calling it hypnotizability (in the context of hypnotic inductions) or suggestibility. But "hypnosis" refers to sleep, which is unrelated to phenomenological control (e.g. Banyai & Hilgard, 1976); and "suggestibility" implies being manipulated contrary to one's real intentions, a gullibility that is little related to hypnotic response (e.g. Coe, Kobayashi, & Howard, 1973; Moore, 1964). So in our laboratory, we have begun to refer to hypnotic suggestibility in a more general context as the capacity for phenomenological control and, correspondingly, hypnotic response as an example of phenomenological control.

We will review recent work in our laboratory that falls into two themes. First we review evidence that phenomenological control may be a pervasive feature of response in many psychological experiments. All experiments have demand characteristics, and certain people can use those demand characteristics to create relevant phenomenology (Orne, 1962). Thus, the finding that subjects have genuine experiences, and the corresponding physiological responses, is entirely consistent with the idea that demand characteristics associated with the experimental paradigm produce the phenomena investigated. We will review some key examples (reported in Lush, Botan, Scott, Seth, et al., 2019).

Second, we propose a theory of phenomenological control (including its expression in a hypnotic context as hypnotic response), namely cold control theory (Dienes & Perner, 2007). According to cold control theory, phenomenological control is produced by an intention one is not aware of. We will review the difference between the use of conscious and unconscious intentions in terms of a cognitive measure, intentional binding, presenting a new theory of intentional binding to complement cold control theory. We can thereby indicate when and how intentional binding relates to the conscious status of intentions and hence to phenomenological control (Lush, Roseboom, Cleeremans, Scott, et al., 2019). We will consider what intentions could be used when phenomenological control seems to exert powerful effects on processes that are difficult to control, as indexed by the Stroop effect, in apparent conflict with cold control theory (Raz, Shapiro, Fan, & Posner, 2002). We will consider the difference between conscious and unconscious intentions in terms of their effectiveness in influencing the Stroop effect, as a test of cold control theory (Palfi, Parris, McLatchie, Kekecs, et al., 2018). Finally, we will consider the relation of, on the one hand, mindfulness, construed as being aware of mental states, including intentions, and, on the other hand, cold control, construed as being unaware of a relevant intention (see also Raz & Lifshitz, 2016). Specifically we consider preliminary work on the causal effect of mindfulness training on the capacity to have unconscious intentions, and hence experience phenomenological control. For studies not yet published we will give brief indication of the key effects found.

The reach of phenomenological control

Martin Orne coined the term “demand characteristics” when thinking about the determinants of the behavior of people in hypnosis experiments , and generalized the concept to any experimental paradigm in psychology. He wrote, “It became clear from extensive interviews with subjects that

response to the demand characteristics is not merely conscious compliance. When we speak of "playing the role of a good experimental subject," we use the concept analogously to the way in which Sarbin (1950) describes role playing in hypnosis: namely, largely on a nonconscious level" (Orne 1962 p. 779). That is, participants will often strive to fulfil the role of a good subject by creating genuine experiences, without realizing they are doing so, in order to accomplish what they believe the experiment requires of them. That participants are likely to create genuine experiences to fulfil the demand characteristics of experimental paradigms outside of the hypnotic context follows from many theoretical approaches to hypnosis (e.g. Barber, Spanos, & Chaves, 1974; E. R. Hilgard, 1977; Kirsch, 1985; Lynn, Rhue, & Weekes, 1990). Kirsch and Council (1989) and Michael, Garry, and Kirsch (2012) pointed out how important this point could be for understanding the results of psychology experiments generally. We believe the possibly dramatic implications of this point have been insufficiently appreciated. We consider the implications for vicarious pain, mirror touch synaesthesia, and the rubber hand illusion, respectively.

To investigate the role of the capacity for phenomenological control to produce these phenomena we measured hypnotic suggestibility with the Sussex-Waterloo Scale of Hypnotizsability (SWASH; Lush, Moga, McLatchie, & Dienes, 2018; see also Palfi, Moga, Lush, Scott, et al.,2019). This is a scale of hypnotic response, because it is defined as such to participants and a hypnotic induction is given. In order to measure phenomenological control without begging the question of altered states, or having results colored by people's false beliefs about hypnosis, it would be desirable to have a scale that measured phenomenological control on its own terms. Wilson and Barber (1978) presented the Creative Imagination Scale, which has no induction. However, "creative imagination," as a term, does not neatly describe the ability of people to alter their subjective experience (as opposed to say, enjoying writing novels) (see also McConkey, Sheehan, & White, 1979). Following in the footsteps of Wilson and Barber, we will create a version of SWASH in which there is no induction, and it is presented to participants as an exercise in using their imagination to alter their subjective experience (the Phenomenological Control Scale). We measure hypnotic suggestibility as an index of the capacity for phenomenological

control. Bear in mind that we do not believe that the phenomena we review below were produced by participants simply being compliant, gullible or suggestible in a broad sense (though this may be a component of the effect); rather, they actively exercised their capacity for phenomenological control in order to fulfil their aims of experiencing the phenomena the situation called for. In the first two examples (vicarious pain and mirror touch synaesthesia), the SWASH was administered in a completely different context by different experimenters than the context in which vicarious pain and mirror touch synaesthesia were measured (indeed, at the time it was not envisioned that the data sets would be compared). Thus, the relation between the measures will not itself have been produced by demand characteristics (cf. Council, Kirsch, & Hafner, 1986). Rather, we argue all measures reflect at least in part a common way of responding to demand characteristics.

Vicarious pain. Vicarious pain perception (or mirror-pain) is a phenomenon in which physical pain observed in others is reported as felt by the observer (Fitzgibbon, Giummarra, Georgiou-Karistianis, Enticott, et al., 2010). Lush, Botan, et al (2019) combined databases of participants screened for vicarious pain on the Vicarious Pain Questionnaire (VPQ; Botan, Fan, Critchley & Ward, 2018; Grice-Jackson, Critchley, Banissy & Ward, 2017) with a database of participants screened for hypnotizability using the SWASH at Sussex University; 404 participant's scores were matched. The SWASH score is an average subjective rating (0 no experienced effect of suggestion to 5, maximal effect). To measure vicarious pain, participants watched 16 short video clips of people experiencing physical pain (e.g. falls, sports injuries, injections). The total pain score was the number of videos from 0-16 for which participants reported a bodily sensation of pain. Lush et al. found hypnotizability predicted total pain response, b = 1.25 videos/unit SWASH, 95% CI [.8, 1.7], r = 0.27. The strength of this relation is approximately the same as the correlation of an individual hypnosis scale item with the rest of the scale with the item removed (taking the median over all items, correlation for objective scoring .22; for subjective scoring, .54; Lush et al, 2018). That is, the pain participants' felt in the vicarious pain paradigm may have arisen because they saw this as a situation in which they are meant to feel pain; and those with the capacity for phenomenological control could then create that pain as a genuine experience with corresponding

neural or physiological correlates (cf. Derbyshire, Whalley, Stenger, & Oakley, 2004). The same people may well have felt vicarious pain in everyday life, outside the laboratory context, for the same reasons. For example, a person may value empathic concern, and therefore when they see people in pain express that empathic concern by their capacity for phenomenological control. Just as in the hypnotic or laboratory context, a person can do this without being aware that they themselves are creating the experience.

Mirror touch synesthesia. In mirror touch synaesthesia, seeing someone being touched elicits a report of tactile sensation in the observer (Banissy & Ward, 2007). To measure mirror touch synaesthesia, participants watched 14 video clips including depictions of touch to a human (Ward, Schankenberg & Banissy, 2018). The mirror touch score is the number of videos for which participants felt sensations on their skin. Lush, Botan, et al. (2019) combined databases of participants screened for mirror touch synaesthesia (Ward et al., 2018) with a database of participants screened for hypnotizability using the SWASH at Sussex University;154 participants matched. Lush, Botan, et al. (2019) found that hypnotizability predicted mean number of mirror touch responses (out of 14), b = 0.83 videos per unit SWASH, 95% CI [.30, 1.37], r = .24. That is, at least part of the touch sensations that people felt may have been created as genuine experiences by the participants using their capacity for phenomenological control.

Rubber hand illusion. In the rubber hand illusion (Botvinick & Cohen, 1998), the sight of a rubber hand being brushed at the same time as feeling brushing on the real hand results in reports of a change in location of the subject's hand toward the rubber hand and changes in subjective reports of ownership[1]. Lush, Botan, et al. (2019) measured the rubber hand illusion on 353 participants and also tested them on SWASH. The rubber hand illusion was measured by stroking a rubber hand and a hidden real hand of a participant simultaneously; the participant then indicated the felt position of his or her actual hand, which drifts towards the rubber hand (drift measured in cm's, 0- 60cm). The rubber hand illusion increased with hypnotizability, b = .58 cm per unit SWASH, 95% CI [.17, .98],

[1] 1 The effect seems to be saying something so striking about how we construct our bodily self that the paradigm is well used: A search on Google Scholar with the quoted phrase "rubber hand illusion" yielded about 5,010 results, 5 August 2019.

r = 0.15. The raw relationship is large given the mean amount of drift is 1.05 cm. Further, the correlation of SWASH with subjective ratings of the rubber hand illusion was 0.29, 95% CI [.19, .38]. We also measured people's expectation that they would experience the rubber hand illusion (on a -3 to +3 scale). We found that people reported strong expectations that they would do so, and these expectations correlated with the extent to which they felt the illusion (b= 0.33 rating units/unit expectancy, 95% CI [.20, .47]). That is, there were clear demand characteristics readily perceived by participants. Moreover, Lush (2020) used the "pre-experimental inquiry" method of Orne (1962) to show the extent of the demand characteristics: Participants who had not taken part in a rubber hand experiment were told the procedure~~,~~ and asked to predict what would happen. Participants strongly expected real subjects to respond more strongly to synchronous than asynchronous stroking and to respond more strongly to the key subjective outcome measures rather than those used in previous research as control statements. Those subjects in an actual experiment capable and motivated to turn those demands into actual experiences may well do so. And indeed, the strength of relation between subjective experience on the rubber hand illusion and hypnotizability is about the same magnitude as the relation between any scale item on SWASH on the rest of the scale. That is, while we do know the extent to which phenomenological control plays a role in the rubber hand illusion, it remains open that the exercise of phenomenological control is a complete explanation of the extent to which people experience the illusion.

In summary, phenomenological control may be a pervasive way in which demand characteristics are turned into subjective experience, convincing both experimenter and participant of the reality of a phenomenon that may in fact be perhaps wholly constructed by the way the paradigm is presented. Dienes and Perner (2007) argued that in evolutionary terms people acquired the capacity for phenomenological control precisely to convince themselves and others of the reality of a particular phenomenon – namely, spirit worlds, by appearing to self and others to be possessed. To what extent phenomenological control plays a role in any experimental paradigm is of course an empirical issue that can be addressed by manipulating demand characteristics and measuring individual differences in capacity for phenomenological control. Work still needs to be done in determining just how much vicarious pain, mirror touch synesthesia and the rubber hand illusion are

expressions of phenomenological control and how much involve other mechanisms. We have not ruled out other mechanisms also being at work, the correlations are only suggestive; however, given the prior plausibility of phenomenological control being at least partly involved, the possibility that it explains everything should be considered. And work still needs to be done on many other phenomena to explore the contribution of phenomenological control, bearing in mind the process applies not only to the experimenter's laboratory but also to everyday life (cf. Bell, Oakley, Halligan, & Deeley, 2011; Bryant, Guthrie, Moulds, Nixon et al., 2003; J. R. Hilgard, 1979). Life is a series of situations with requirements (Schank, & Abelson, 1977; Searle, 2003), requirements that may be met in part by the exercise of phenomenological control. The network of plans and intentions that leads to a specific experience of phenomenological control may be a mix of conscious and unconscious states: For example, the desire to experience numbness in one's arm to deal with guilt may be conscious or unconscious, and the person may or may not be aware of the reasons for the desire. Quite how phenomenological control works is a question to which we now turn.

The reach of cold control

The views of Hilgard (1977) and Spanos (1986) represented the main opposing theoretical camps of a golden age of hypnosis research, when many key ideas and phenomena were established (for later theoretical and empirical development, see e.g. Lynn, Green, Polizzi, Ellenberg, et al., 2019; Nash & Barnier, 2008). Despite seeing themselves as opposing camps, Hilgard and Spanos expressed some common views: They postulated that the key mechanism by which hypnotic responses happen involved the subject strategically acting on intentions but being unaware of those intentions (see e.g. Hilgard, p 232; Spanos, p 490). Dienes and Perner (2007) took that common core and asked how far could we go if this core was the only defining mechanism of hypnotic response (and hence, more generally, of phenomenological control). That is, hypnotic response may consist in intending to perform the cognitive or motor action required for successful response, while remaining strategically unaware of that intention, a process Dienes and Perner called cold control

(see also Lynn et al., 1990, for a similar approach). The claim is not vacuous. Cold control asserts that what makes a response hypnotic is purely meta-cognitive (Dienes, 2012). Anyone can raise an arm. But the reason an arm rising in response to a hypnotic suggestion is hypnotic is because one is strategically unaware of the intention to raise it, despite sustained reflection (as shown e.g. by responding when being challenged, Lynn, Nash, Rhue, Frauman, et al., 1984; Spanos, Radtke, & Bertrand, 1984), so it appears to rise by itself. Crucially, one has the inaccurate thought that one did not intend it. A motor action, where one is strategically unaware of the intention to produce it, gives rise to the illusion of involuntariness; perceptual imagination, where one is strategically unaware of the intention to imagine, gives rise to hallucination; and pretense, where one is strategically unaware of the intention to pretend, gives rise to delusion.

If hypnotic response, and phenomenological control, more generally, is a matter of metacognition of intentions, then relations should hold between the metacognition of intentions, on the one hand, and hypnotic response and hypnotizsability, on the other (cf. Lush, Naish, & Dienes, 2016; Terhune & Hedman, 2017). We have recently explored those relations in three main ways. First, we have explored the relation between hypnotic response and a putative implicit or objective measure of the sense of agency, called intentional binding. Second, we have explored if hypnotic response involves gaining abilities compared with non-hypnotic response; the claim of cold control theory is that the only processes that differ between hypnotic and non-hypnotic response are meta-cognitive ones, so there should be no differences in non-metacognitive abilities. And third, we have explored whether training people to be mindful, and hence more metacognitively aware of their intentions, would reduce their ability to respond hypnotically (see also Dienes et al., 2016 for other relevant evidence on the relation between metacognition of intentions and hypnotic response). Here we focus on recent evidence from our laboratory regarding cold control.

Intentional binding. Is there a cognitive measure sensitive to whether an action is performed by way of a conscious intention? Lush, Roseboom, et al (2019) argue for a model indicating how intentional binding can indirectly act as such a measure. Intentional binding refers to the compression of the perceived interval between the reported times of actions and their outcomes (Haggard, Clark &

Kalogeras, 2002) and has been taken as a measure of sense of agency (e.g. Haggard, 2017), with some controversy (e.g. Buehner, 2012; Suzuki, Lush, Seth, & Roseboom, 2019)[2]. In the paradigm, the participant presses a button (the action) that is followed 250ms later by a tone (the outcome). The time of the action and the outcome are also reported on separate trials. The basic effect is that when the outcome and the action both occur, the estimated time of each is pulled towards the objective time of the other. The change in the estimated timing of the outcome is called "outcome binding" and the change in the estimated timing of the action is called "action binding."

Why might these changes occur? Lush, Roseboom, et al. propose that people may have prior knowledge that button presses produce their outcomes very rapidly afterwards, maybe say in a 100ms. Given this knowledge, evidence for the time of either event can be used to refine the time estimate of the other event by Bayesian cue combination. That is, the estimate of the time of the outcome, for example, will be pulled towards the time of the action ("outcome binding"), and the degree to which that happens will depend on the precision of the evidence for the time of each event. The more precise the evidence for the time of the action, the more the estimate of the time of the outcome will be pulled towards the action (i.e. the greater the outcome binding will be). Conversely, the more precise the evidence for the time of the action, the less the estimate of the action will be pulled towards the outcome (i.e. the less the action binding will be).

What does this have to do with conscious versus unconscious intentions? We add the assumption that conscious rather than unconscious states have properties more accessible to further processing (e.g., Cleeremans & Jimenez, 2002). For example, conscious rather than unconscious intentions will have greater precision in the information about their own timing; and an intention being conscious will thereby help in more precisely timing an action. Thus, consciously intended actions will have greater outcome binding and less action binding than actions with only unconscious intentions (note we predict opposite effects on the different binding components, unlike other theories of binding; see Moore, & Obhi, 2012, for a review of theories). Our model explains how intentional binding

[2] 1 Because of its use as an implicit measure of sense of agency, the paradigm has been well used: A search of Google Scholar with the quoted term "intentional binding" yielded about 1,300 results, 5 August 2019.

can be a measure of sense of agency in a specific sense; namely, it can be sensitive to the presence of conscious intentions, as mediated by their effect on the precision of action timings, and this expresses itself in action and outcome binding in opposite ways. Yet it does this by taking into account people's knowledge of causal relations (Buehner, 2012), so the model can accommodate both researchers who regard intentional binding as a measure of sense of agency (e.g. Haggard, 2017) and those who regard it primarily as a measure of perceived causal relation (Buehner, 2012).

According to cold control theory, a hypnotic response involves unconscious intentions. Lush, Roseboom, et al. (2019) conjectured that hypnotizability may involve trait differences in the tendency to have conscious intentions. We tested 35 high hypnotizable and 35 low hypnotizable participants on intentional binding. Our results supported the hypothesis: Compared to low hypnotizable participants, high hypnotizable participants' judgements of the timing of intentional actions were more variable, supporting the claim that highs are habitually less precise in action timing than lows. Crucially, highs' action binding was stronger compared with lows (and numerically lower outcome binding, but the evidence was insensitive, based on Bayes factors). Further, the relative precision of action, rather than outcome judgments, predicted action and outcome binding in opposite ways, just as theoretically expected. In sum, our findings support the conjecture that the trait tendency to be less aware of intentions is related to hypnotizability.

As the fundamental mechanism for hypnotic response according to cold control theory is being unaware of intentions, a hypnotically performed action should produce more action binding and less outcome binding. Lush, Caspar, Cleeremans, Haggard, et al. (2017) asked high hypnotizable participants to press a button voluntarily (active condition), or to press the button posthypnotically in a way that felt involuntary (posthypnotic condition), or to let their finger be pulled down for them (passive condition). There was less outcome binding in the passive rather than active condition, consistent with the postulated role of conscious intentions in enhancing outcome binding. Crucially, the posthypnotic condition also involved less outcome binding than the active condition, consistent with the postulated lack of conscious intentions in the posthypnotic condition. For action binding, the evidence was insensitive, as indexed by Bayesian analysis, so counted neither for nor against

the theory. Further, the precision for action timing judgments was lower for posthypnotic than voluntary action, consistent with the role of conscious intentions in specifically changing action precision[3].

Hypnotic ability to reduce the Stroop effect. According to cold control theory, phenomenological control entails doing the acts one could normally do, but being unaware of the intention to do them. However, an experimental finding, the word blindness effect (Raz, Shapiro, Fan & Posner, 2002; Parris, Dienes & Hodgson, 2012, first used the term) suggests that highs can acquire abilities through hypnosis that they do not possess when responding non-hypnotically. The word blindness suggestion is that the subjects will see words as meaningless characters, or as words of a foreign language, while they are engaged in a color naming Stroop task. Various independent laboratories have documented that when this suggestion is given to high hypnotizable participants, they can decrease Stroop interference (measured by the difference in response times between the incongruent and neutral trials) compared to their own performance in a non-hypnotic condition (see Palfi et al, 2017). That is, highs appear to acquire better control when they use phenomenological control than when they do not. It might be thought that cold control theory could be protected from refutation if it were shown that the word blindness suggestion had comparable effects without a hypnotic induction. Indeed Raz, Kirsch, Pollard and Nitkin-Kaner (2006) obtained substantial reduction in Stroop interference with the word blindness suggestion whether or not an induction was given (see also Parris & Dienes, 2013). However, no induction is needed for people to use phenomenological control (Kirsch, Mazzoni, & Montgomery, 2007; see also the previous section on the reach of phenomenological control). So the challenge to cold control theory remains. Subjects

[3] Acton precision was indexed by measuring the within- participant standard deviation of action timing judgements – the higher the within-participant SD, the lower the precision. The within-subject SD which was higher for posthypnotic (133.5 ms) than voluntary action (81.7 ms), 95% CI on difference: [10.7, 92.8]. A Bayes factor calculated with H1 modelled on the difference in action timing SD between voluntary and passive action in medium hypnotiszbles (12.6 ms) showed sensitive evidence for an increase in action timing SD in posthypnotic compared to voluntary action in high hypnotizables who reported post-hypnotic experience of involuntariness, $t(9) = 2.85$, $p = .019$, $B_{H(0,.13)}$, = 6.08. A Bayes factor indicates moderate evidence for H1 over H0 when above about 3 (Dienes, 2014). There was no evidence one way or the other for whether the posthypnotic condition (133.5 ms) was different from the passive condition (113.5ms), $t(9) = 1.51$, $p = 0.17$, $B_{H(0,.13)}$, = 0.61. Bayes factors below 1/3 are moderate evidence for H0 over H1, Thus, the theory currently makes no prediction about a binding difference between the posthypnotic and passive conditions.

may have used their capacity for phenomenological control whether or not an induction was used. Thus, the word blindness effect presents a challenge for any theory that states the exercise of phenomenological control does not give one any special abilities beyond a change in subjective experience.

Perhaps in order to fulfil the requirement of believing the words are not meaningful, subjects realize they need to control Stroop interference, and to do so they use a simple strategy. For example, they could blur the eyes or look to one side. Raz, Landzberg, Schweizer, Zephrani, et al. (2003) provided evidence against the use of the blurring strategy by applying the drug cyclopegia to the eyes, which hinders the ability to change visual focus. When the words were put in focus with lenses, the word blindness effect was still obtained. This finding is intriguing. However, there was no manipulation check to show that blurring was rendered impossible. Video recordings reportedly showed no attempts to look away. However, there was no quality check of what angular distance from initial fixation the researches could detect. Thus, we thought the notion of simple strategies could be explored further.

We (Palfi, Parris, Collins, & Dienes, 2019) instructed people outside the hypnotic context to engage in a range of strategies while performing the Stroop task to see if we could replicate the effect of the word blindness suggestion without giving the suggestion. Fifty-seven participants were asked in different blocks of the Stroop task to blur their eyes, look at the top right-hand corner of the screen, focus on the last letter of each word, and maintain goal focus by repeating “display color”. The first two strategies, blurring and looking way, reduced Stroop interference as much as the word blindness suggestion, for the full range of hypnotizability (measured by the SWASH in a different experiment). For example, participants reduced Stroop interference by 65 ms by looking away and by 33 ms for blurring (the evidence was insensitive for the other strategies); by comparison, in the same laboratory, Palfi et al. (2018) found a word blindness effect of 34 ms. If people were engaging in such simple strategies when fulfilling the requirements of the word blindness suggestion, cold control theory is not in trouble. It would just be a matter of using these strategies, which anyone can use, and not knowing one is intending to do so.

Just when we thought we had solved the mystery, a closer look at the data revealed otherwise. A remarkable aspect of the effect of the word blindness suggestion is that it lowers reaction times to specifically incongruent stimuli. However, RTs seemed to increase for all stimuli types for people using one of our instructed strategies versus no strategy. There was evidence for no decrease in RTs for incongruent stimuli. We preregistered a follow up experiment; 35 participants used only the strategies we had strongest evidence for (blurring and looking away), and indeed we found evidence that reaction times increased for incongruent trials (by 31ms and 47ms for blurring and looking away, respectively), rather unlike the effect of the word blindness suggestion (e.g., a reduction of 78ms in incongruent RTs was observed by Palfi et al., 2018, pilot). We also tested another model on existing word blindness suggestion data: maybe for the suggestion, people simply sped up, thereby condensing the Stroop effect (cf. Pratte, Rouder, Morey, & Feng, 2010). But this did not fit either.

A remaining option is that the strategy consists in just what the suggestion asks subjects to do. Namely, imagining a pretend world in which the script is meaningless itself resets the top-down control mechanisms so that Stroop interference is reduced. In that case, voluntarily imagining this world would be as effective as the word blindness suggestion in reducing the Stroop effect. The reduction in the Stroop effect would then be interesting, but not a consequence of phenomenological control per se. It would be a consequence of imagining the situation as being a certain way. That is, the crucial test of cold control theory is comparing subjects using phenomenological control to create a perceived world, on the one hand, with implementing the same pretense as a voluntary strategy experienced as pretense or imagination, on the other. Palfi et al. (2018) have a Stage I Registered Report[4] accepted to conduct this crucial test of cold control theory. Highs performed the Stroop test under three conditions: no suggestion condition; with the word blindness suggestion (suggestion condition); and also a volition condition in which participants were told to voluntarily imagine the words as meaningless (being told "to voluntarily strongly and clearly imagine the irrelevant words as gibberish … You can do this so that it is under

[4] That is, our introduction, method and analytic pipeline have been set in stone as agreed by reviewers; publication is in principle accepted for the final results, given they are sensitive enough, regardless of which direction they go.

your control, just by exercising your imagination. You can be aware it is your imagination at the same time as it produces powerful effects."). We have not finished running all participants, but preliminary findings with 36 highs are as follows. First, as intended, participants experienced more control over the meaningfulness of the words when they responded to the volitional request than when they responded to the suggestion (2.1 vs 1.5 on a 0-3 scale of degree of experienced control). Moreover, participants experienced the meaninglessness of the script in the volition condition mostly as imagination, whereas they experienced it in the suggestion condition mostly as perception (1.78 vs 1.30 on a 0-3 scale, where {0,1} indicates a perceptual experience and {2,3} an imaginary one). The Stroop interference effect for the baseline condition was 99 ms; for the suggestion condition 67 ms. There was evidence for this difference ($t(35) = 2.20$, $p = .035$, 95% CI on difference [3, 62 ms], $B_{H(0, 30)} = 5.56$[5]). That is, we obtained the word blindness suggestion effect. Now we are left with the crucial question: what happens to the Stroop interference in the volition condition? It was 75 ms. While similar in size to the suggestion condition (67 ms), the data are thus far non-evidential in supporting either the claim of no difference between suggestion and volition conditions or the claim of a difference, $t(35) = 0.66$, 95%, $p = 0.51$, CI [-24, 40 ms], $B_{H(0, 30)} = 0.65$. So we continue running participants until Bayesian sensitivity is achieved. So far, cold control theory has escaped refutation. Cold control theory would be corroborated if Bayesian evidence for H0 is obtained; refuted, at least in simplest form, if Bayesian evidence for H1 is obtained.

Mindfulness and hypnotic response. How is mindfulness related to phenomenological control? On the one hand, both seem to involve changing the control of one's mind, perhaps in part via attentional regulation, and both can engender changes in subjective experiences (see Raz & Lipshitz, 2016, for various approaches to the relation between hypnosis and meditation). According to cold control theory, however, phenomenological control is precisely not being mindful of

[5] This B is a Bayes factor; if it is less than 1/3 there is moderate evidence for H0 over H1; and if greater than 3, moderate evidence for H1 over H0 (see Dienes, 2014). Because it is close to 1, there is not much evidence either way. We will continue running until it is either over 3 or less than 1/3, or we reach 60 participants. See Palfi et al. (2017) for further description and its preregistration. Following a review in Parris, Dienes and Hodgson (2013), we modeled the expected size of the word blindness effect as about half the overall interference effect.

specific intentions, so there is a conflict between mindfulness and phenomenological control (Semmens- Wheeler & Dienes, 2012). Lush (2019) tested 412 people in our SWASH database on various questionnaires, including a well-known mindfulness questionnaire, the FFMQ (Baer, Smith, Hopkins, Krietemeyer, et al., 2006). The questionnaires were completed in a different context from the hypnosis screening, by a different experimenter, which is a methodological improvement on our previous work examining the relation between mindfulness and hypnotizability, in which we found a negative correlation (Dienes, Lush, Semmens-Wheeler, Parkinson, et al., 2016). The FFMQ assesses five facets of mindfulness. Of these, specifically 'acting with awareness' (AA), appears to measure awareness of intentions (e.g. "I do jobs or tasks automatically without being aware of what I'm doing"). Indeed, Lush (2019) found that AA specifically correlated with hypnotic response. We estimated the slope for acting with awareness as a decrease of 0.13 rating units of subjective score for SWASH (on a 0-5 Likert scale) for a one Likert unit change in AA (95% CI [.02, .24]; r = -.12). This negative relation is consistent with the claim that one way of being high in phenomenological control is by being habitually low in awareness of intentions (cf Lush, Roseboom, et al's, in press, work on intentional binding, discussed above). This result is correlational (and allows plenty of cases where a person is high on both constructs or low on both: One can be a mindful high). To test causality, an experimental intervention is important.

Cavanagh, Strauss, Cicconi, Griffiths, et al. (2013) showed that a two-week online mindfulness intervention produced a change in FFMQ of 0.14 Likert units compared to a waiting list control. In a separate study we based a new intervention on theirs, but introduced a distinction between being mindful of mental states (one intervention) vs being mindful of the world (an active control intervention) (see Dienes et al., 2016, for the background and plan of the experiment). The mental states condition involved exercises in being aware of one's mental states over a two-week period, and access to a website with supporting materials. The world condition was similar in all respects except participants practiced being mindful of the world, and the supporting materials explained mindfulness accordingly. Being mindful of the world, without being mindful of mental states, should not be in tension with phenomenological control, according to cold control theory, because

phenomenological control involves not being mindful of specifically a mental state (an intention).

Below we briefly indicate some of the relevant results[6].

	AA	
control	0.10 (0.12)	n = 33
world	0.16 (0.10)	n = 39
mental state	0.45 (0.12)	n = 45

Table 1

Change in acting with awareness (AA) in 0-5 Likert units from pre-test to post-test. Participants were randomly assigned to a waiting list control, testing separated two weeks apart; a mindfulness of world practice for two weeks; or a mindfulness of mental states intervention for two weeks. Standard errors in parentheses.

Consistent with the hypothesis that the mental state intervention increases mindfulness of intentions, the mental state group increased in AA compared to the waiting list control, $t(76) = 2.06$, $p = .043$, $B_{H(0,\ 0.14)} = 3.29$; and compared to the world group, though the evidence was weak, $t(72) = 1.86$, $p = .067$, $B_{H(0,0.14)} = 2.71$. The mental state group increased AA by 0.35 Likert units more than the control group. Thus, we would expect a change in hypnotic response of 0.35 x -0.13 = -0.05 SWASH subjective units in the mental state group compared to the control group. (The -0.13 SWASH units per AA units is based on Lush, 2019.) Did the change in mindfulness of mental states produce the predicted change in hypnotic response? The data for the change in subjective hypnotic response from pre-test to post-test are shown in Table 2.

	SWASH	

[6] 1 Analysed as intention-to-treat, following Cavanagh et al (2014). For the raw data and hypnotic script see: https://osf.io/9np64/ The websites are: http://www.lifesci.sussex.ac.uk/home/Zoltan_Dienes/mindfulness./ (for world) and http://www.lifesci.sussex.ac.uk/home/Zoltan_Dienes/mindfulness../ (for mental states).

control	-0.23 (0.13)	n = 33
world	-0.07 (0.11)	n = 39
mental state	-0.05 (0.12)	n = 45

Table 2

Change in SWASH subjective response in 0-5 Likert units from pre-test to post-test. The intervention was either nothing (waiting list control, testing separated two weeks apart); a mindfulness of world practice for two weeks; or a mindfulness of mental states intervention for two weeks. Standard errors in parentheses.

The amount by which hypnotic response reduced in the mental states condition vs the control condition was -0.18 (SE = 0.18), $t(60) = 1.00$, $p = .32$, $B_{H(0,.05)} = 0.79$, which is insensitive (that is, no conclusion follows)[7]. Indeed, based on the error variance in these data we can estimate we would need about 3,000 participants in total to have a 50% chance of getting good evidence for an effect should there be one of the size anticipated[8]. Although we did not obtain good evidence one way or another, we have learned that looking for a change in mindfulness causally changing hypnotic response will need a massive effort, only available to those who use institutions such as, for example, the psychological accelerator (https://psysciacc.org/). The correlational evidence, however, reveals a small and negative relation between the relevant mindfulness facet and hypnotic responsiveness. Thus, cold control theory has successfully pointed to which aspect of mindfulness is potentially negatively related to hypnotic response[9].

Discussion

We have attempted to sketch two directions for the consciousness research community to

[7] Using the same logic for the comparison of the mental states with world group, the expected change in SWASH is 0.29 AA units × 0.13 SWASH units/AA unit = 0.038 SWASH units. There is no evidence one way or the other for a difference between the two intervention groups in SWASH, sample difference = -0.02, SE = 0.16, $t(82) = 0.12$, $p = 0.90$, $B_{H(0, .038)} = 0.95$.

[8] See https://www.youtube.com/watch?v=10Lsm_o_GRg for this calculation, and its generalization in Palfi and Dienes (2019, version 3, table 2).

[9] Though this was not pre-registered. A confirmatory study would be useful.

consider in at least part of its future research endeavor: First, to address the full reach of phenomenological control; and second, to consider how simple theories of phenomenological control, like cold control, could be tested and brought into contact with a range of literatures. The two directions stand alone, yet are complementary. One may consider the reach of phenomenological control while being agnostic about theory; one certainly need not buy into specifically cold control theory. In exploring the first direction, referring to the individual difference capacity as the capacity for phenomenological control may not clarify anything for the hypnosis community, who already understand that the trait involves the ability to alter subjective experience according to plans and goals. However, reaching the non-hypnosis community is a different matter. Informing them that an important research finding, such as the rubber hand illusion, may in part just be a product of suggestion may imply the finding is simply biased responding, compliance, or involves gullibility, or coercion, or they may believe that the claim that it is suggestion could be refuted by showing physiological correlates to the phenomenon (as if suggestion did not produce physiological correlates). And indeed suggestion may be a misleading word. The subjective experiences can be created by the subject for their own purposes, without there being an authority to suggest them as such. A 'capacity for phenomenological control' puts the trait in a positive light, which allows us to show our participants in a positive light too.

The first direction asks us to consider the full range of phenomena that may be constructed from demand characteristics and consider their correlation with the capacity for phenomenological control, measured, for example, by hypnotic suggestibility. This approach may apply to correlates of hypnotizability that have been used to indicate the skills or processes that hypnotizability consists of. For example, Martin, Sackur, and Dienes (2017) showed that the correlation of frequency of reversals of the Necker cube and hypnotizability was a product of demand characteristics; it wasn't so much a skill that explained why people might be more hypnotizable as the reverse; it was hypnotizability that explained why people may change their experience of the Necker cube.

In the first section, we argued that the rubber hand illusion is in part a construction of phenomenological control, as an opposing theory to one postulating just the involvement of specific

mechanisms underling feelings of body ownership (Lush, Botan, et al., 2019). For example, if the rubber hand illusion is produced by phenomenological control, there is no need to postulate a specific cross-modal cue integration mechanism that produces feelings of ownership. On the other hand, in the second section, we argued that Bayesian cue combination was the process underlying intentional binding, as a way of supporting a theory of hypnotizability (Lush, Roseboom, et al., 2019). Why could not the altered experiences of time in intentional binding be a product of phenomenological control? This is an excellent question. In response, we point to two findings: That the rubber hand illusion was expected by participants, and those expectations predicted their response (Lush et al., 2019); and, conversely, the degree of outcome and action binding depended counter-intuitively on the relative precision of action timing (in opposite ways), as consistent with the Bayesian cue combination theory (Lush, Roseboom et al., 2019). We do not think these considerations settle the matter, however. Future research should determine how clear the demand characteristics are in the case of intentional binding. Demand characteristics expressing themselves through phenomenological control is such a simple theory that it should be a default explanation in any relevant case until its limitations are shown for that case.

We argued that people should consider simple theories and showed in one case how such theories might make contact with a range of literatures and be quantitatively tested. For example, we showed how a correlational study could estimate an effect that then can be used to define a predicted effect size for a causal intervention study. When one can model the rough size of effect expected on H1, Bayesian evidence can be obtained for H0 and against H1; or for H1 and against H0 (Dienes, 2014). While p values can often approximate our needs for making the second claim (i.e. for H1 by getting a significant result), they cannot for the first, i.e. for getting evidence for H0 (which is not in fact indicated by a non-significant result). And p values do not tell us when data are simply insensitive and so do not count against a theory at all. Bayes factors are very useful to determine this (see the study reviewed above on the effects of a mindfulness intervention; also for the comparison of different hypnotic inductions, Martin & Dienes, 2019). While cold control theory interests us because it is simple in that it claims that the only difference between an ordinary action

and a hypnotic one is meta-cognitive, it is not the only simple theory of hypnotic response, or of phenomenological control more generally. Even simpler is response expectancy theory (Kirsch, 1985), according to which hypnotic response (and one could generalize to phenomenological control more generally) is directly caused by the expectation that it will happen.

In the Palfi et al. (2018) test of cold control, we obtained evidence for equivalent expectations in the suggestion and volition conditions (expectations both for subjective experiences of meaninglessness and for exerting control over interference); hence the study is simultaneously a test of response expectancy and cold control theories: Both cold control and response expectancy theory are corroborated if the Stroop interference is reduced equivalently in both conditions, and refuted if they are not. One reason we would still put cold control theory in the running is that it is consistent with the active nature of hypnotic response (e.g. Kirsch, Burgess, & Braffman, 1999; Tobias & Kihlstrom, 2010). There are other theories of hypnosis to be considered as well (See Nash & Barnier, 2008, for review). Recently, Martin and Pacherie (2019) proposed an intriguing model of hypnotic motor responses based on predictive processing theory. Dienes and Martin (2019) briefly indicate a possible simple test of this theory.

The prediction of cold control theory that phenomenological control does not entail being able to perform acts one could not do otherwise seems challenged by a number of findings beyond the word blindness effect. These findings all point to an effect of hypnosis on overcoming automatic processes. We now comment on some of these findings to indicate briefly how they may be addressed, though in all cases they be pointers to good ways of attacking cold control theory in future.

Lifshitz, Aubert Bonn, Fischer, Kashem, et al. (2013) provided evidence that the McGurk effect, a putatively highly automatic process, could be overcome by posthypnotic suggestion. Remarkably, however, Getz (2019) presents evidence that the McGurk effect is a "product of individual differences and task demands." The role of phenomenological control in producing the McGurk effect needs further exploration. Iani, Ricci, Gherri and Rubichi (2006) found a posthypnotic suggestion for focused attention could substantially reduce the flanker compatibility effect. However, the posthypnotic suggestion did this by increasing reaction time to compatible trials rather than reducing reaction time

to incompatible trials, a pattern that consistent with overall changes in reaction time modifying compatibility effects (Pratte et al., 2010). Polito, Barnier, and Connors (2018) found that a hypnotic suggestion for more randomness in producing a binary output did not increase random responding but a hypnotic suggestion for the subjects' actions being controlled by an alien did, thereby allowing subjects to overcome the habits that led to non-random responding. What this shows is that subjects can overcome a habit given the right strategy; it was not shown that hypnosis added any new abilities.

Terhune, Cardeña, and Lindgren (2010) presented a case study where a person's synesthesia was amenable to cognitive control at a late perceptual stage when responding to a posthypnotic suggestion. However, it was not shown that posthypnotic suggestion enabled anything beyond the person's normal abilities. Cohen Kadosh, Henik, Catena, Walsh, et al. (2009) found that suggestion for digit-colo~~u~~r synesthesia rendered an achromatic digit harder to detect against a background colo~~u~~r which was the same as the suggested synesthetic colo~~u~~r. However, becoming less capable of performing an action as the situation requires is quite consistent with cold control theory. Anderson, Seth, Dienes, and~~&~~ Ward (2014) tested whether suggested synesthesia could enhance performance. They investigated whether a hypnotic suggestion for digit-colo~~u~~r synesthesia facilitated subjects' ability to detect targets in an embedded figures test. We had previously shown that natural digit-colo~~u~~r synesthetes were better at this task than controls. Despite our hypnotic subjects achieving comparable subjective experiences as natural synesthetes, the suggestion did not facilitate objective performance, consistent with cold control theory.

Our laboratory, along with all the work at the Sackler Centre for Consciousness science, has recently moved to preregistering all studies, using registered reports more often than in the past, and to providing data transparently at the point of submission of all empirical papers (see Allen & Mehler, 2019, for evidence for advantages of going to open science). Further, our laboratory has a policy of a "*B* for every *p;*" that is, we use use Bayesian analyses in order to be able to make symmetric inferences about both H0 and H1 (Dienes & McLatchie, 2018); we have illustrated the usefulness of Bayes factors for hypnosis research in this review. For example, in the final study we reviewed, examining the effect of causal manipulation of mindfulness, if one just considered the

non-significance of the intervention, one might have been tempted to conclude that the result counted against the theory; but it did not.[10] We have found that adopting the reform agenda has helped us be careful in specifying and testing theories (cf Seth, & Hohwy, 2019).

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[10] One can also use equivalence testing or inference by intervals in order to get evidence against H1 (e.g. Greenwald, 1975); but here we need to have objective reasons for specifying a minimally interesting effect size in order to infer good evidence for an interval H0. Note in our intervention study that we had objective reasons for specifying a predicted effect size (which allows Bayes factors to be used), but not for a minimally interesting effect size (which allows equivalence testing). We have found this state of affairs (good reasons for specifying predicted effect sizes but not for minimal interesting effect sizes) to be quite typical in our research, so pragmatically we use Bayes factors as tools for obtaining evidence for H0.

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