# The Contrasting Role of Higher order Awareness in Hypnosis and Meditation

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Thesis (by papers) submitted for the degree of Doctor of Philosophy

University of Sussex

September 2012

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## DECLARATION

I hereby declare that this thesis has not been submitted, either in the same or different form, for this or any other University for a degree.

Rebecca Semmens-Wheeler

## Acknowledgements

*"No duty is more urgent than that of returning thanks."*

*(James Allen)*

Writing this thesis has not only been a voyage of intellectual knowledge and discovery, but also one of personal and emotional challenge and exploration. I have many people to whom I feel much gratitude and appreciation, people who may not know that they have contributed and those to whom it will be clear that they have. I don't have the space here to name everyone individually, but suffice it to say that no-one has been forgotten in my heart and mind. Here I would like to name a few individuals and acknowledge the particular contributions they have made over the past four years.

Firstly: Zoltan Dienes, my supervisor. I have been very fortunate to have received the guidance of an excellent, rigorous and thorough scientist and someone whom I strongly value as an individual, too. There have been times when I resented the rigour, but ultimately it has paid off and I have learnt huge amounts about how to be an effective researcher; thank-you. I am also grateful to Jamie Ward, my second supervisor, and to Dora Duka, and Peter Naish, with whom I have collaborated. They have all provided kind and helpful advice and support, which I found invaluable; thank-you.

*"As for friendship, it is probably true that you have never – or only very fleetingly – experienced the nature of real friendship, and have never been anyone's friend. Real friendship is very rare indeed, and if you haven't experienced it, neither have a lot of other people, including many who would like to think they have. The fact that real friendship is so rare should not make us cynical, of course, but only more determined to develop real friendship, and be a real friend, ourselves."*

*~ Sangharakshita*

I have been blessed and fortunate to have experienced the kindness, patience, love and support of many people in my life and throughout my doctoral studies. I would like to start my thanking Tina, Gary and Andy, the "Rhombus of Love". Tina, thank-you for your inspiring clarity and straightforwardness, delivered with love and positive intention. Gary, thank-you for always being there; even when you couldn't find the words, I knew you cared. Andy, you made the rhombus complete, and your witty status updates lightened many a dark moment during thesis writing. Clio, my office mate and leading member of the 2C2 club, you would make a great Queen of England and there is simply no accounting for birth right. You have also made a great friend in the office and I am grateful to the times you've offered hugs and support when I felt I couldn't get this far. Thanks, too, to Clare Jonas for the best pep talks ever, which included references from 'The Thick of It'.

I would also like to offer special thanks to Dharmavajra, Vidyadasa and Vimokshadaka for their on-going support, friendship, interest in my research and for their help in collecting data from meditators at Madhyamaloka and the Brighton Buddhist centre. Also huge thanks go to Carolyn, for proof-reading the nearly-final version – wow! Finally I would like to thank three people who have helped me invaluably, and whom I don't know how I would have done this without. Alice: thank-you for your support, guidance, empathy and sharing your skill and talent as a therapist. I will miss our meetings and have benefitted hugely from our journey together. Thank-you and I wish you all the best. Malcolm, "My Lovely Darling", you have shared your home and your heart with me; you have stood behind me and pushed me up the hill, encouraging me and boosting my self-confidence, showing your faith in me when I felt I couldn't take another step and you have demonstrated enormous love and patience, for which I will always be grateful. I am looking

forward to spending time together without my laptop and being able to have conversations that aren't almost exclusively about my thesis!

Ali, my best friend. You once sent me this poem by Ruth Bebermeyer:

*I never feel more given to*
*than when you take from me-*
*when you understand the joy I feel*
*giving to you.*
*And you know my giving isn't done*
*to put you in my debt,*
*but because I want to live the love*
*I feel for you.*
*To receive with grace*
*may be the greatest giving.*
*There's no way I can separate*
*the two.*
*When you give to me,*
*I give you my receiving.*
*When you take from me.*

*I feel so given to."*

I love you with all my heart and I am so happy we're friends and I can't wait to spend more time with you again now that I'm finished this immense task, in which you have held me throughout. You are one of life's treasures, and I have been so fortunate to find you.

*Thank-you to all these wonderful people, and more!*

## Overview of Research

Two key questions underpin the research presented here. Firstly, how does altered higher order awareness contribute to hypnotic experience? Secondly, how do meditation and hypnosis differ in terms of the role of higher order awareness? These questions are addressed here in the form of four papers. In the first paper I review the literatures of hypnosis and meditation in order to consider the similarities and differences between meditation and hypnosis in terms of the role of attentional skill and the neural underpinnings of each. I then draw conclusions regarding the contrasting role of higher order awareness and metacognition in meditation and hypnosis. Paper two explores higher order awareness in hypnosis by comparing the effects of alcohol, compared to placebo, on hypnotisability and associated frontal lobe executive functioning. Paper three compares meditation and hypnosis by investigating differences in higher order thoughts, mindfulness, absorption and perceptual encoding style as revealed by self-report measures. The final paper takes a broader look at higher order awareness and its relation to the experience of agency and involuntariness in hypnotic suggestion using a Libet type paradigm.

## Background and Introduction to the Research Questions

Hypnosis is an intriguing phenomenon. Our usual experience is of feeling in control of our own willed actions and of experiencing an accurate perception of reality. These are the two key features of experience that hypnosis alters. An example of involuntariness in hypnosis is the rigid arm suggestion, in which it is suggested to a subject that their arm is stiff and rigid, as though tightly splinted. Successful responding to this task requires that the subject is unable to bend their arm without considerable effort, despite trying hard to do so (in most cases, but see Comey & Kirsch (1999) for a discussion of individual differences in the degree of effort made.) How can they simultaneously stiffen their arm and remain so unaware that they themselves are doing so that they cannot bend it? This is the 'classical suggestion effect', as identified by Weitzenhoffer (1980). Another key feature of hypnotic experience is the belief in an alternatively suggested reality, such as perceiving (or strongly imagining; see Comey & Kirsch, 1999) only two balls when three are presented in full view (a suggestion in the Waterloo-Stanford Group Scale of Hypnotic Susceptibility; Bowers, 1993). A subject successfully responding to this suggestion will honestly deny the existence of the third ball. So striking and bizarre are the apparent effects of hypnotic suggestion that they have been attributed either to faking or to dramatic shifts in first order states. By contrast, meditation, which has frequently been compared with hypnosis (e.g. Holroyd, 2008) aims to increase the practitioner's sense of self-agency (Shaw, Gromala & Song, 2010) and enhance the accuracy of perception (e.g. Goleman & Schwartz, 1976; Kamalashila, 2012).

In this chapter I will firstly describe what hypnosis is, how it is measured, and argue that hypnosis is not a case of 'faking it'. Next, I will emphasise the role of

metacognition and associated brain regions in hypnotic experience, demonstrating that hypnotic responding does not necessarily require any alterations in first order mental states. Finally, I will discuss how meditation can be used to explore awareness of one's mental states in hypnosis.

*What is hypnosis; is it real, and how does it happen?*

Hypnosis is a change in subjective perception of sense of agency/involuntariness in response to situational demands, such as being given suggestions by another person, 'the hypnotist'. Kihlstrom describes these experiences as being "associated with a degree of subjective conviction bordering on delusion, and an experienced involuntariness bordering on compulsion" (Kihlstrom, 2008, p. 21). An individual's susceptibility to such hypnotic responses is very stable, with test-retest reliability over twenty-five to thirty years of about .75 (Piccione, Hilgard & Zimbardo, 1989). Around 10% of the population are highly susceptible to hypnosis (known as 'highs'), responding to most hypnotic suggestions in a standard scale of hypnotic susceptibility (e.g. the Harvard Group Scale of Hypnotic Susceptibility, Form A - HGSHS:A; Shor & Orne, 1962) and the Waterloo Stanford Group Scale of Hypnotic Susceptibility, FORM C - WGSC; Bowers, 1993); roughly 10% are low susceptible ('lows'), responding to none or only very few suggestions, and the remainder are moderately susceptible (mediums), somewhere in-between highs and lows.

But are those who claim to be responding to hypnotic suggestions really experiencing conviction bordering on delusion or involuntariness bordering on compulsion? Or are they simply simulating what they believe hypnotic experience to be?

Several studies have distinguished highs from simulators. For example, Kirsch et al (1989) found that highs, unlike simulators, who were faking, continued to respond to suggestions even when the experimenter had left the room. Additionally, highs pass lie detector tests whereas fakers do not (Kinnunen et al, 1994). Furthermore, neuroimaging data differentiate true hypnotic responders from simulators, with highs showing activation in brain regions consistent with true experience of the suggestion and simulators showing differential patterns of neural activation (Oakley 2008; Ward et al 2003). Having established that hypnosis is indeed a real phenomenon, we can go on to consider other theories.

The cold control theory of hypnosis (Dienes & Perner, 2007) draws out a common theme from the two normally contrasting major approaches to hypnosis: the socio-cognitive approach (e.g. Spanos, 1986) which describes hypnotic responding in terms of everyday psychological principles and the dissociation approach (e.g. Hilgard, 1977; Woody & Bowers, 1994), which explains hypnosis as the result of dissociation between executive control and the contention scheduling (habit) system. Both of these approaches can be interpreted in terms of alterations in metacognition (cognition about cognition; see Beran, Brandl, Perner, & Proust, 2012, for a recent review).

Specifically, cold control theory posits that hypnotic responding represents the experience of performing an action without being aware of the intention to do so. For example, in a situation labelled as 'hypnotic', demand characteristics can lead one to have expectations about how they will respond when given a hypnotic suggestion, and these expectations can directly trigger the hypnotic response, as in the placebo effect (Kirsch, 1985). Alternatively, demand characteristics and expectations may lead to a lack of awareness of intentions so that one's actions are falsely attributed to hypnosis, a failure of

metacognition. According to dissociation theories, control and monitoring processes are fractionated, so that one stream is controlling actions and the other, which has separated off, is unaware of the controlling stream, and thus the behavioural source is misattributed to an external source.

*Neural concomitants of metacognition*

Metacognition has been variously linked to the mid-dorsolateral prefrontal cortex (DLPFC). Lau & Passingham (2006) determined two masking conditions in which people could discriminate two different shapes. The difference was in whether people were consciously aware of seeing the shape or if they felt that they were just guessing. Functional magnetic resonance imaging (fMRI) revealed that the brain region that differentiated reports of guessing versus awareness of seeing the shape was the left DLPFC. Rounis et al (2010) created condition in which subjects' first order perceptions of seeing were equivalent. When they applied repetitive transcranial magnetic stimulation (rTMS) to the DLPFC, subjects' awareness of seeing was disrupted. The DLPFC has also been associated with a lack of awareness when subjects are administered alcohol, which is known to impair the region (Wendt & Risberg, 2001). Sayette, Reichle & Schooler (2006) found that subjects tended to mind-wander more when they were given alcohol. Furthermore, while subjects' reported more mind-wandering episodes when probed, they reported fewer self-caught mind-wandering episodes, suggesting that although they were more prone to zoning out, they were less aware of when they were doing so, i.e. they were metacognitively impaired.

If hypnotic responding arises from deficits in metacognition, then disrupting the DLPFC should increase hypnotic susceptibility. Dienes & Hutton (2012) tested this hypothesis by applying rTMS to the left mid-DLPFC and the vertex (a sham site used as a control) in a blind study. Subjects were given suggestions to experience magnetic hands, arm levitation, rigid arm and taste hallucination and were asked to rate the strength of their experience on a 6 point scale (0-5). Results showed that rTMS increased subjective hypnotic responding by on average a third of a rating point, providing support for the role of metacognition in hypnosis.

*Meditation, Metacognition and Hypnosis*

Having considered that reduced metacognition might play a role in hypnotic responding, we could also consider meditation, which is said to involve training in metacognitive skills, such as mindfulness (e.g. Teasdale, 1999; Thompson, 2006; Wallace, 1999). Although meditation has been frequently compared with hypnosis, (e.g. Holroyd, 2008), the role of metacognition seems to be a distinguishing factor. Several studies have shown that meditation practice increases mindfulness, as measured by self-report scales (e.g. Shapiro, Oman and Thoresen, 2008; Walach, Buchheld, Buttenmüller, Kleinknecht & Schmidt, 2006; Zeidan, Gordon, Merchant & Goolkasian, 2010). Self-report scales may not be very convincing, as there will be pressure on people who have been practicing for years to be mindful to say, to others or themselves, that they are mindful. However, there are other indications. Zeidan, et al (2010) also demonstrated that meditation training improves metacognition. Subjects were... In another study, meditators were able to reduce the attentional blink (Slagter, Lutz, Geichar, Francis, Nieuwenhuis, Davis and Davidson, 2007), bringing a

normally unconscious process to consciousness, an apparent feat of metacognition. Although there are many claims that meditation increases mindfulness and metacognition, there is a paucity of empirical literature to support this theory, and it remains to be seen whether or not meditation and hypnosis can indeed be distinguished on the basis of differences in higher order awareness.

## Summary of Research Questions Addressed in the Four Papers

### Paper 1: The Contrasting Role of Higher Order Awareness of Higher Order Awareness in Hypnosis and Meditation

Meditation and hypnosis have been compared on numerous occasions over the past few decades (e.g. Delmonte, 1984; Heide, Wadlington and Lundy, 1980; Holroyd, 2003; Lifshitz, Campbell & Raz, 2012; Van Nuys, 1973; Yapko, 2011), yet it remains to be concluded precisely what the core differences and similarities are. For example, both meditation and hypnosis have been associated with high levels of absorption (e.g. Wilson and Barber, 1983; Davidson & Goleman, 1977), imaginative capacity (e.g. Lynn & Rhue, 1986; Spanos & Barber, 1974) and altered states of consciousness (e.g. Hilgard, 1977; Gruzelier, 1988, but see Kirsch & Lynn, 1995), and both can be used for self-regulation, for example, pain management (e.g. Derbyshire, Whalley and Oakley, 2009; Kabat-Zinn, Davidson and Houshmand, 1985). Paper 1 is a review of meditation and hypnosis, in which we consider these overlapping constructs, as well as the core differences. Essentially, we conclude that, while meditation and hypnosis are comparable in their applications to pain, stress and other clinical uses, they appear to differ fundamentally in the mechanisms by which these aims are achieved: hypnosis can be viewed as a form of self-deception in which a reduction of higher order awareness is experienced, whereas the primary goal of meditation is see through deluded mental states, i.e. to increase higher order awareness. However, there remain a number of potential methodological confounds such as demand characteristics within both meditative and hypnotic contexts. Furthermore, there is need for

precise definition of the terms meditation and hypnosis whenever they are experimentally investigated, because a number of phenomena are referred to by the same names, as we discuss.

**Paper 2: Alcohol Increases Hypnotic Susceptibility**

There are two broad normally-opposing approaches to the role of the frontal lobes in hypnotic responding. One approach suggests that hypnotic responding occurs as a result of a state of 'hypofrontality' (Dietrich, 2003), either through frontal lobe exhaustion following intensive concentration during an induction process (Gruzelier, 1998) or through dissociation of the supervisory attentional system (executive system) from the contention scheduling (habit) system (Woody & Bowers, 1994; see Woody & Sadler, 2008, for a review of dissociation theories).

Other approaches posit that frontal lobe executive functioning is required in order for hypnotic suggestions to be successfully performed. For example, Hilgard's neo-dissociation theory requires that the 'executive ego' is split into two streams, one which is unaware of the other (the 'hidden observer') but that nonetheless each of these streams remains independently intact (Hilgard, 1977). Several studies have suggested that executive functioning is required to overcome persistent first-order mental states of pain (Crawford, Knebel & Vendemia, 1998) and to overcome pre-potent responses (e.g. Bertrand and Spanos, 1985; Raz et al, 2002; Spanos et al, 1982).

Cold control theory (Dienes & Perner, 2008) highlights the role of metacognition in these different theories. The theory postulates that hypnotic subjects are able to strategically

avoid higher order thoughts (HOTs) of intending. Some studies have located the mid dorso-lateral prefrontal cortex (DLPFC) as a likely candidate as the 'seat of metacognition' (Fleming, Weil, Nagy et al, 2010; Lau & Passingham, 2006; Rounis et al, 2010). It is known that alcohol impairs the DLPFC (Wendt and Risberg, 2001). Sayette et al (2006) also found that subjects were more prone to mind-wandering without being aware that they were doing so following alcohol administration. Dienes & Hutton (2012) recently found that administering repetitive transcranial magnetic stimulation (rTMS) to the region increased hypnotic responding and so we administered alcohol or a placebo to medium susceptible participants in an attempt to test the above theories by diminishing metacognition via the effects of alcohol on this region.

After giving subjects alcohol or a placebo, we carried out manipulation checks to ensure that subjects in the alcohol condition had received enough to impair their frontal lobe functioning. We gave each subject a series of hypnotic suggestions, and found that alcohol increased the subjective responses of those who had received alcohol, compared to those who had received a placebo, and this effect persisted above and beyond the effects of response expectancy, which also influenced the subjective responses of both groups of subjects.

The findings from this study support theories that postulate a deficit in frontal lobe functioning in hypnotic responding. However, we cannot conclude strongly regarding the role of metacognition, as alcohol affects a large region of the frontal lobes aside from the DLPFC (Kähkönen et al, 2003), and so in future we would need to test the effects of alcohol on hypnotic suggestibility while also measuring metacognition/higher order awareness.

## Paper 3: The Contrasting Role of Higher order Awareness in Hypnosis and Meditation

The cold control theory of hypnosis (Dienes & Perner, 2007; Dienes, 2012) emphasises the role of metacognition in hypnosis. Specifically, it postulates that hypnosis arises from a strategic lack of metacognition, i.e. an avoidance of higher order thoughts (HOTs), particularly of intending. If this is true, then highs should report having fewer HOTs than lows. Meditation, in contrast to hypnosis, can be viewed as a form of training in metacognitive skills, such as mindfulness (e.g. Teasdale, 1999). We therefore predicted that meditators would have greater higher order awareness than highs and that on this basis they should be relatively unsusceptible to hypnosis. As predicted, meditators were less hypnotisable than non-meditators, a difference that could not be explained by expectancies or attitudes towards hypnosis.

In order to investigate the differences in hypnotisability we gave highs, lows and meditators a task that involved either attending to or trying to ignore a sequence of images while looking directly at them. We probed subjects at random intervals over a 15 minute period and asked them to report whether they were conscious of seeing the image or zoning out, and whether or not they had been aware of zoning out if this had been the case. We obtained several measures from this task: HOT coupling, which was the total number of HOTs reported across the ignore and attend conditions; meta-awareness, which was the proportion of zoning out incidences for which the subject was aware that they had been zoning out; HOT control, which was the number of times they were able to ignore the image in the ignore condition plus attend to them in the attend condition; meditation, which was the degree to which they were able to attend to the images in the attend condition and

ironic control, which was the number of times subjects were able to avoid HOTs of the image in the ignore condition.

Meditators had greater levels of HOTs (HOT coupling) than lows and highs and were poorer at ironic control, as though their mindfulness practice rendered them less able to avoid HOTs about the world. (Of course, we don't know if the meditation practice was responsible, or the sort of person who takes up or sticks with meditation.) A Bayes factor analysis indicated that HOT coupling and meta-awareness may mediate the differences between meditators and non-meditators, although our data were insensitive and more is needed to further investigate this possibility.

This question of the effects of differences in higher order awareness was also considered from a different angle. Subjects completed self-report measures of mindfulness, perceptual encoding style, absorption, thought suppression and cognitive failures, as well as the relationships between these constructs. Two factors emerged: internal absorption and external awareness. The findings indicated that higher hypnotisability was related to more internally absorbed cognitive style associated with a greater tendency to more automatic top-down processing, while lows and meditators were more mindful than highs had a more external perceptual encoding style, related to a slower, bottom-up processing style.

In sum, the findings from this study indicate that differences in hypnotic suggestibility could be accounted for, at least in part, by differences in higher order awareness of the world or by first order perceptual encoding styles. However, further data needs to be collected and additional variables, such as individual differences in dissociation (see Terhune et al, 2001) could be explored simultaneously.

**Paper 4: Awareness of Action in Hypnosis and Meditation**

Disruptions in self-agency are a core feature of hypnotic suggestions, which are typically experienced as being involuntary. It has already been demonstrated that hypnotically suggested ideomotor movements are experienced as being more similar to passive than to normal (non-hypnotically suggested) voluntary actions (e.g. Blakemore et al, 2003; Haggard et al, 2004), yet previous studies have only used moderate to highly suggestible individuals and so it is not possible to distinguish genuine hypnotic effects from demand characteristics.

In order to address this issue, low hypnotisable subjects were used as simulators in this study. We compared highs' and lows (simulators) and meditators' errors of judgment of the time at which they actually made a finger movement passively, voluntarily or following a hypnotic suggestion. We also compared meditators, as they have shown differences from highs and lows in various measures (see papers 1 and 3).

We replicated Haggard et al's (2004) findings that highs' experienced hypnotically suggested movements as occurring later and as being more involuntary, than normal active movements. The differences in highs' judgment errors compared to simulating lows' also suggested that this effect is genuine and not a result of demand characteristics. We were unable to draw firm conclusions with regard to meditators and are planning to collect more data.

# The Contrasting Role of Higher Order Awareness in Hypnosis and Meditation

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*(Journal of Mind-Body Regulation, 2012)*

*Abstract*

Meditation and hypnosis might be regarded as involving similar processes and skills. For example, both meditation and hypnosis are associated with high levels of absorption and imaginative capacity, and both can be used for self-regulation. Research has also shown that meditation improves attentional functioning, and that hypnotic response can involve attentional strategies. However, we argue that hypnosis and mindfulness meditation are essentially different. Crucially, hypnotic experience results from a lack of awareness of mental states (specifically, of intentions); by contrast, mindfulness meditation aims to develop accurate meta-awareness. Hypnosis is a form of self-deception; meditation a way of getting to know your mind. We discuss the empirical relation of both meditation and hypnosis to higher order awareness of mental states, and suggest further research.

## *Introduction*

Comparisons are frequently made between hypnosis and meditation (e.g. Delmonte, 1984; Holroyd, 2003; Van Nuys, 1973; Yapko, 2011). Both typically involve some physical relaxation, for example; however deep relaxation is not a necessary nor even a necessarily helpful component of either (e.g. Banyai and Hilgard, 1976; Hanh and Nquyen, 2006). So care is needed to disentangle contingent similarities from core ones, and we will attempt in this review to do so. Both hypnosis and meditation are involved in self regulation - but self regulation can be performed in different, even opposing, ways. In this review, we highlight similarities and differences between meditation and hypnosis, arguing that they are essentially different. First we indicate what is meant by hypnosis and meditation. Then we consider the relation between the two implied by different theories of hypnosis, in terms of the role of executive systems (attention and metacognition) in hypnosis according to those theories. Next, we consider the empirical evidence for the role of attention and metacognition in each of meditation and hypnosis. Finally, we consider evidence more directly relating meditation and hypnosis. We will argue that at their core, meditation and hypnosis are opposites.

## *What is hypnosis?*

The word hypnosis can either refer to a state that follows a hypnotic induction (cf. Barnier and Nash 2008); or else to the suggested distortions of perception or sense of involuntariness that some people can create according to the requirements of the situation (e.g. Dienes, 2012). In the first sense, hypnosis is a state, a way of being; in the second, it is a way of doing (responding to suggestions). Hypnosis as a state could be just a particular

pattern of phenomenology (attention absorbed inwards or outwards, time going faster or slower, self-talk increased or decreased, and so on; see e.g. Pekala and Kumar, 2007), or, in addition, according to some theories, a global change in how information is processed that causally affects response to suggestions (e.g. impairment of the executive system; Jamieson and Woody, 2007). Responding hypnotically involves a specific motor or cognitive action accompanied by an altered sense of volition or reality. For example, a person can hold their hands out, imagine they are magnets and feel their hands move together seemingly by themselves. The act of the hands moving together is mundane; what makes it hypnotic is the sense that it happens by itself. Or a person can, on request, change the colour of an object from say red to green, with the hallucinated colour seeming external and real. Imagining an object in a counterfactual colour is mundane; what makes the cognitive act hypnotic is the sense of reality that accompanies the act of imagination. These acts constitute hypnotic responding whether or not the person is in a hypnotic state. It is important to bear the distinction between acts and states in mind in comparing hypnosis to meditation: Putative hypnotic and meditative states can be compared; or else hypnotic and meditative actions can be compared. Nonetheless, the two uses are related. For example, on "state" theories of hypnosis, if an induced state did not increase response to hypnotic suggestion even slightly, the state would not be a hypnotic state. Conversely, on "non-state theories" of hypnosis, the state is itself just a response to a suggestion (to experience that state, however it is conceived by the subject). Researchers have not settled on a consistent use of the word 'hypnosis' (Kirsch et al, 2011) and the word 'meditation' can also be used to encompass a wide range of practices (Lutz, Dunne and Davidson, 2007).

Typically, hypnotic suggestibility is measured by giving subjects a hypnotic induction then giving a series of suggestions. The more suggestions a person passes, the more hypnotisable they are. Several predictors of hypnotisability have been found, including response expectancy (Kirsch & Braffman, 1999; Raz, 2006), absorption (Wilson & Barber, 1983; Tellegen & Atkinson, 1974), fantasy proneness (Wilson and Barber, 1982) and imaginative involvement (Spanos & Barber, 1974). While significant correlations have been found, they are often only moderate, with reliable correlations between hypnosis and absorption typically around 0.2 - 0.3 (Kihlstrom, 2003), for example, and are often smaller when hypnotisabilty and putative correlates are tested in a different context (e.g. Council, Kirsch & Hafner, 1986, but see Nadon, Hoyt, Register & Kihlstrom, 1991). The most reliable and replicable correlate of suggestibility after an induction is responding to suggestions without being given a hypnotic induction (around 0.7, e.g. Hilgard & Tart, 1966; Braffman & Kirsch, 1999).

Thus, hypnotic responding can be distinguished from a special altered state of hypnosis (see Raz, 2011, for discussion). Although some do claim that hypnosis is a state (e.g. Crawford, 1994), there is no established theory of a hypnotic state or states. For example, while hypnotic induction has the potential to slightly enhance hypnotic suggestibility and produce a stronger neural response than without an induction (Derbyshire, Whalley & Oakley, 2009)[1], an induction is not necessary for highs to successfully respond to hypnotic suggestions (Kirsch & Braffman, 2001). Raz et al (2006) found that although highs were able to reduce Stroop interference following hypnotic suggestion for printed words to become meaningless, a hypnotic induction made no real

[1]Although note recent as yet unpublished data from the same lab found a stronger neural response for suggestion without an induction rather than with it, Derbyshire, personal communication, 6 June 2012

difference to the effect. McGeown et al (2012) found that highs were able to successfully drain or add colour from a coloured or grayscale stimulus with and without hypnotic induction, whereas lows were unable to perform the suggestion in either condition. Subjective ratings of hypnotic depth correlated with activation in the colour processing region (i.e. left fusiform) in the colour adding condition and in frontal and parietal regions (associated with recruitment of attentional resources) in the draining condition. However, the enhancement seen following hypnotic induction was slight, and highs were able to effectively perform the suggestion even without any hypnotic induction or feeling that they were in any way in a hypnotic state. In sum, there is a hypnotic way of acting (acting cognitively or behaviourally such that the sense of reality or volition is distorted according to task requirements) that can occur either in or out of a hypnotic state.

*What is meditation?*

Meditation can be described as a complex family of training practices in attention, emotional regulation (Lutz, Slagter, Dunne & Davidson, 2008) and metacognitive awareness (Thompson, 2006), which (aim to) contribute to the development of a more veridical experience of the world. Meditation practice in the shorter term, in particular mindfulness-based training, is also used (as hypnosis is) for the treatment of stress (Miller, Fletcher & Kabat-Zinn, 1995), depression (Ramel, Goldin, Carmona & McQuaid 2004; Teasdale et al, 2000), addiction (Bowen et al, 2006) and pain management (Kabat-Zinn, Davidson & Houshmand, 1985). Just as hypnotic responding can be distinguished from a hypnotic state, meditative (mindful) activity might be viewed as distinct from a meditative

state. Such mindful activities can be everyday occurrences, so long as one is fully present and aware of the sensations of the action. For example walking, making tea, eating a raisin or cleaning one's teeth can be performed mindfully. (Mindfully eating a raisin is an exercise in mindfulness based stress reduction courses; Kabat-Zinn, Segal, Williams, & Teasdale 2002.)

It is important to distinguish between the various styles of meditation, particularly as some of the terms used in modern psychology and neuroscience are the same as those translated from Buddhist texts, but refer to different constructs (Lutz et al, 2007). There is no single clear and simple definition of meditation as there are many types from different traditions (including those from different religions, as well as within Buddhism). However, Lutz et al (2007) have drawn out some fundamental assumptions that can be made about meditation as a whole. First of all, meditation practices must be learned. They are designed to inhibit undesirable traits (e.g. negative cognitive or emotional patterns) and enhance or cultivate desirable ones (e.g. non-reactivity). Many meditation practices achieve these by focusing on an aspect of one's experience, commonly the breath. Other practices involve developing an open and non-judgmental awareness of one's emotions and cognitions and/or cultivating particular thoughts of feelings, such as those of compassion. Following on from this, it can be predicted that meditation will produce specific states. Indeed, evidence has shown that compassion meditation leads to improvements in affective regulation (Lutz, Brefczynski-Lewis, Johnstone & Davidson, 2008) and other studies have demonstrated superior attentional performance in meditators than controls and novice meditators (e.g. Moore & Malinowski, 2009; Wenk-Sormaz, 2005; Slagter, Lutz, Geichar, Francis, Nieuwenhuis, Davis & Davidson, 2007). Another feature of meditation practice is that improvements can be seen over time and are reflected in changes in the brain. For example,

structural differences have been seen in experienced meditators, who had greater cortical thickness in the right anterior insula (associated with interoception; Critchley, Wiens, Rotshtein, Öhman & Dolan, 2004, integration of cognition and emotion and adaptive decision-making, Damasio, 1996) than controls (Lazar, Kerr, Wasserman, Gray, Greve, Treadway, et al 2005). Crucially, cortical thickness in the insular cortex was correlated with cumulative meditation experience. Practice effects can be also seen in the aforementioned improved attentional performance of experienced meditators. Brefczynski-Lewis, Lutz, Schaefer, Levinson & Davidson (2007) reported greater activation in the insula and in frontal parietal regions during concentration meditation. These areas are involved in sustained attention and monitoring and making attentional adjustments (Vincent, Kahn, Snyder, Raichle & Buckne, 2006; Eckert, Menon, Walczak, Ahlstrom, Denslow, Horwitz & Dubno, 2009). In meditation such monitoring is used to detect and signal mental drowsiness or over-excitability, which lead to a loss of concentration.

For the purposes of investigation and comparison of meditation types, three main categories (focused attention, open monitoring and lovingkindness) have been described by Lutz et al, drawing on practices within the Buddhist traditions (2007; 2008; see Box 1). One prevalent meditation technique, which is used across Buddhist and other religious or spiritual traditions is focusing one's attention on the breath. This practice initially involves focusing on the breath to develop *śamatha* (concentration/sustained attention and resilience to distracting thoughts and emotions) and *vipaśyanā*, which refers to the clarity of perceiving the nature of that which is being attended. Śamatha may be practiced with a range of attentional objects other than the breath (shapes, colours, body parts, etc) in order to develop a calm sustained attention. Similarly, vipaśyanā involves a range of practices to see how phenomena (including mental states) come and go, and how certain ones tend to

lead to certain others. The practitioner, through continually checking where the mind is focused (self-monitoring), begins to develop *samprajanya*, which can be translated as meta-awareness (Lutz, Dunne and Davidson, 2007) or 'clear knowing' (Anālayo, 2010). Meta-awareness, and specifically mindfulness, is a common component across all different meditation styles. Mindfulness can be defined as the practice of bringing awareness to the present moment with non-judgmental acceptance (Brown and Ryan, 2003). In sum, meditation fundamentally involves the development of attentional and metacognitive processes. Intriguingly, such processes have also been fundamental to the main theories of hypnosis.

*Theoretical relation of hypnosis to meditation*

Theories of hypnosis can be classified according to the role of executive system in hypnosis, i.e. with that system responsible for metacognition and attentional regulation. Metacognition refers to processes that monitor or control thoughts and attention (Fernandez-Duque, Baird, and Posner, 2000): Cognition about cognition (see Box 2). Some theories of hypnosis postulate a disturbance in executive systems, others an enhancement. Given that meditation involves special attentional and metacognitive abilities, theories of hypnosis that postulate impaired attentional or metacognitive processing suggest hypnosis is the opposite from meditation. Theories that postulate that hypnosis involves no special attentional or metacognitive abilities suggest hypnosis is orthogonal to meditation. Finally, overlap is suggested by theories that postulate hypnosis also involves special attentional abilities.

Several theories have explained hypnosis in terms of a deficit in frontal lobe executive function. According to Hilgard's neo-dissociation theory (1977) the 'executive ego' is split in two conscious streams, one which controls the hypnotic responses, and the other which is unaware of this control. In dissociated control theory (Woody and Bowers, 1994) hypnosis is described as a weakening of frontal lobe function so that the supervisory attentional system (i.e. executive system, Norman and Shallice, 1986) is rendered unable to control behaviour, which is thus controlled by the contention scheduling or habit system (hence the feeling of involuntariness). Hence, behaviour is directly triggered by hypnotic suggestion. Gruzelier's (1998) neurophysiological theory also explains hypnosis in terms of diminished attentional abilities. The purported greater attentional abilities of highs leads to a highly concentrated state, which causes exhaustion of the frontal lobes and thus leads to inhibition of executive frontal lobe functioning that contributes toward hypnotic response and experience. These theories imply hypnosis is not conducive to mindfulness; responding hypnotically essentially involves a lack of mindfulness.

Socio-cognitive theories (e.g. Sarbin and Coe, 1972; Spanos, 1986, 1991) do not postulate any deficit in attention regulation; in fact, hypnotic responses are explained in terms of attentional and other strategies (for example, hypnotic pain relief may be produced partly by distraction). By the same token, above-average attentional abilities are not used to explain hypnotic response either; hypnotic behaviour is seen as being fundamentally similar to other more mundane forms of social behaviour, with anyone capable of producing hypnotic responses if they have the right expectations, beliefs, purposes, and attributions. Although hypnosis may involve neither enhanced nor diminished attentional abilities on this account, it does involve an attributional error, a failure of metacognition, in

attributing one's actions not to oneself but to the hypnotist or a special hypnotic state. Once again, these theories postulate an inherent contradiction between responding hypnotically and being mindful.

In contrast to the above accounts, Crawford (1994) suggests that highs are able to respond hypnotically due to their superior sustained attentional abilities. Relatedly, James Braid, the person who coined the term hypnosis, claimed that successful hypnotic response occurs because highs maintain a persistent uncontradicted image of the required result (a theory revived by Baars, 1998). According to this theory, hypnotic response involves especially good attentional and inhibitory abilities. Actions happen automatically by sustained thoughts about the actions, and there is no inherent contradiction with mindfulness.

In sum, theoretically, the role of attentional ability in producing hypnotic response is controversial. We will consider the actual evidence for a role of attention in hypnotic response below. But a theme common to some of the theories is that hypnosis involves a failure of metacognition. In Hilgard's (1977) dissociation theory and also in Spanos' (1986) socio-cognitive theories, subjects intend to perform various actions without being aware of the intention. That is, hypnosis is essentially a form of self-deception. This idea was taken up by Dienes and Perner (2007) as a suggestion for the simplest theory that might explain hypnosis – hypnotic response consists of nothing more nor less than intending to perform some motor or cognitive act while thinking one is not intending the action[2] (see Box 4).

[2] It is not merely the absence of accurate HOTs that make an intentional action hypnotic, but the presence of the inaccurate HOT that one is not intending the action (Dienes, 2012). If it were just the absence of HOTs of intending, then every absent minded performance of an intentional action would count as hypnotic, and a creature, perhaps a dog, not capable of HOTs of intention would be permanently responding hypnotically! If

The Dienes and Perner account draws on Rosenthal's (2004) higher order thought (HOT) theory of conscious awareness (see Box 3). HOT theory claims that a mental state is a conscious mental state when we are conscious of being in that mental state, i.e. when we have a higher order thought about being in the state. Thus, hypnosis involves having unconscious intentions. The subject exerts intentional control without having accurate HOTs about those intentions; thus hypnosis is constituted by "cold control". Hypnosis is a purely meta-cognitive phenomenon in which inaccurate higher order thought is produced (Dienes, 2012) – a strategic failure of metacognition. In sum, in terms of metacognition, theories have either postulated hypnosis involves an impairment of metacognition (e.g. Dienes and Perner, 2007; Hilagrd, 1977; Spanos, 1986), or postulate no special relation of hypnotic responding to metacognition (e.g. Baars, 1988). We now consider the actual evidence for the relation between each of meditation and hypnosis and attention and metacognition.

*Attention in hypnosis and meditation*

Both meditation and hypnosis have been claimed to involve enhanced attentional skill, particularly in sustained attention (e.g. Ås, 1963; Buttle, 2011; Davidson and Goleman, 1977; Gruzelier, 1998; Karlin, 1979; Lutz, Slagter and Dunne, 2008; Raz, 2005; Slagter et al, 2007, 2009; Tang, Ma, Wang, Fan, Feng, Yu, et al, 2007; Valentine and Sweet, 1999). Recent research has shown that attentional skills can be trained by meditation practice (see Lutz et al, 2008 and Austin, 2006, for reviews.) The relation of

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inaccurate HOTs are required, it is only an animal which possesses mental state concepts of intention that could in principle respond hypnotically (by believing they did not intend the action).

attentional skill to hypnosis is more controversial (e.g. Dienes et al 2009; Jamieson and Sheehan, 2002). We consider meditation and hypnosis in turn.

Meditation can be narrowly viewed as a form of attention training (Bishop et al, 2006). Lutz et al (2009) found that intensive meditation enhanced attentional stability. Meditators were compared before and after a three month intensive meditation retreat, during which they practiced open monitoring, focused attention and loving kindness meditation for 10-12 hours per day. Subjects in the control condition received a one hour meditation training session before each experimental session and meditated for 20 minutes per day for one week before each testing session. Both groups were asked to perform two versions of a dichotic listening task: the open monitoring version, in which they were asked to identify deviant tones in both ears, and the focused attention version, in which they were asked to identify a deviant tone in the one attended ear, whilst ignoring tones in the other ear. Using EEG, they found that meditators showed increased theta-band phase consistency compared to pre-training and to controls, consistent with sustained attention and on-line cognitive control. Meditators also showed reduced variability in neuronal processing regardless of whether or not the tone was deviant, in line with claims that focused attention meditation develops the monitoring faculty, and so one remains vigilant to distractions while retaining a stable focus, as well as enhanced ability to disengage from distraction. Slagter et al (2007) found that subjects in one study using an attentional blink paradigm demonstrated similar detection of T1 (the first target) and increased detection of T2 (the second target), compared to baseline and controls, following three months of intensive meditation training, indicating meditation practice produced a more optimal distribution of attention. On the Stroop task, expert meditators versus controls showed decreased Stroop

interference (Moore and Malinowski, 2009; Wenk-Sormaz, 2005). Further, meditators reported higher level of mindfulness (on the Kentucky Inventory of Mindfulness Scale) and mindfulness was linked to fewer errors on the Stroop task (Moore and Malinowski, 2009)

The studies to date consistently point in the direction of good attentional skills in expert rather than novice meditators, though a general problem in the field is accounting for motivational differences between experts and controls. When experts know they are selected for the study based on being experts, they may work harder to meet the demands of the situation, or produce expected responses just because they are expected (response expectancy; Kirsch, 1985; 1997). A frequent control in the hypnosis field is to select high and low hypnotisables for further testing without subjects knowing the basis on which they are being selected (Council, Kirsch, and Hafner, 1986) but many studies on the effects of meditation or mindfulness training have not taken this into account. A recent study, however, tried to disentangle motivational effects by comparing a control group with other groups that received a financial incentive, mindfulness based stress reduction training (MBSR) and non-mindfulness based stress reduction training (NMSR). They found that while some attentional improvements (sustained, visual and temporal attention) can be accounted for by an increase in attentional effort, only the group who received MBSR training showed improvements on sustained selective attention, suggesting that MBSR training had an effect above and beyond motivation and non-specific stress reduction (Jensen, Vangkilde, Frokjaer and Hasselbalch, 2012).

The above studies compared experts and novices in meditation; the comparable studies in hypnosis are those comparing high and low hypnotisables. Evidence of superior attentional abilities in highs rather than lows is mixed and the issue remains unresolved

(contrast e.g. Crawford et al, 1993 with Dienes et al, 2009). Studies using the Stroop test have produced conflicting findings, with either no significant difference between highs and lows or with differences in either direction. Without hypnotic induction or suggestions being used, most studies have found no significant difference between highs and lows on Stroop interference (Aikens and Ray 2001; Egner et al 2005; Kaiser et al 1997; Kallio et al 2001). Dixon, Brunet & Laurence (1990) and Dixon and Laurence (1992) found significantly more Stroop interference in highs than lows; however, Rubichi et al (2005) found significantly less Stroop interference in highs rather than lows. On a related task Iani et al (2006) found that highs and lows without an induction were not detectably different in terms of the effect of irrelevant flanking items on the classification of a central letter. While procedural differences (e.g. responses given as button presses vs. vocalization) may account for the different results, the pattern allows only nuanced claims about attention and hypnotisability. A component of attention is the ability to inhibit irrelevant information. On a negative priming task, in which subjects are instructed to attend to some stimuli and ignore others, Dienes et al (2009) found with 180 subjects the correlations between hypnotisability and negative priming or between hypnotisability and latent inhibition were close to zero, with upper limits of about 0.20. Similarly, Varga et al (2011) with 116 subjects found no significant correlations between hypnotisability and reaction time measures of sustained, selective, divided or executive attention. In sum, the consistent findings that expert meditators are superior to novices in attention are not in general matched by evidence for highly hypnotisables being better at attention tasks than lows.

While highs do not seem especially good at attentional tasks when asked to simply perform them, when they are given a relevant strategy, they can outperform lows whether

or not they had been given a hypnotic induction (Raz et al, 2006). Specifically, when highs are given the suggestion that words will appear to them as meaningless, the Stroop effect can be substantially reduced (e.g. Parris, Dienes, and Hodgson, in press; Raz et al 2002; Raz et al 2003; see also Iani et al 2006). Similarly, Iani, Ricci Baroni and Rubichi (2009) found that hypnotic suggestion reduced interference from irrelevant spatial stimuli in highs, but not lows in a Simon-like (spatial interference) task. The suggestion that reduces the Stroop effect has been shown to be just as effective whether or not a hypnotic induction is given (Raz et al 2006; contrast Iani et al 2006), so appears not to depend on being in a special state, but on having a certain ability. The effect appears non-existent to weak in lows (Parris and Dienes, submitted; Raz and Campbell 2011). Thus, paradoxically, asking highs to be less mindful (i.e. to act hypnotically) enables them to perform better on the same attention tasks (Stroop) that meditators appear to improve upon by meditation training. We do not have a resolution to the paradox that both being more mindful (meditation) and less mindful (hypnosis) improves Stroop, but it is a problem on which we are currently working.

In terms of what happens to attentional ability after a hypnotic induction, Gruzelier and Warren (1993) found that highs performed worse on letter fluency (particularly associated with activation in the dorsolateral prefrontal cortex; DLPFC) and finger tapping dexterity but improved on design fluency (a measure of planning and cognitive flexibility) following a hypnotic induction. The reduction in performance on the letter fluency task was replicated by Kallio et al (2001) and Wagstaff, Cole and Brunas-Wagstaff (2007). However, Wagstaff et al also found that subjects who reported greater hypnotic depth (strongly correlated with hypnotic suggestibility) demonstrated better performance on a

phonemic fluency test during hypnosis than during the non-hypnotic condition. Egner et al (2005) found evidence using neuroimaging techniques that there is a dissociation of frontal executive and conflict monitoring systems. They used EEG to examine functional connectivity and event-related fMRI to image highs and lows while they performed on a task measuring attentional conflict resolution (the Stroop task) following a hypnotic induction. There was an increase in gamma band coherence (associated with concerted attentional focus) in lows and a decrease in highs, along with an increase in ACC activation, consistent with poorer efficiency of conflict monitoring in highs (although no difference in Stroop performance was observed). The (albeit checkered) evidence for a general reduction in attentional functioning after hypnotic induction contrasts to claims about meditation (though little research has tested people in versus out of a "meditative state"). It may be that the act of producing feelings of an altered state takes up capacity, and thus leaves less capacity for other tasks.

One interesting marker of attention to task is activity in the default mode network (DMN). The DMN is associated with mind-wandering and self-referential thought and reduced activation is usually seen when focusing or paying attention during goal-directed and externally oriented tasks (Christoff, Gordon, Smallwood, Smith and Schooler 2009; Uddin, Kelly, Biswal, Xavier Castellanos, and Milham, 2009). Further, activity tends to be lower during high rather than low cognitive load (Uddin et al, 2009). Consistent with the claim that an induction encourages highs to pay attention to the hypnotist and/or specific strategies, McGeown et al (2009) found activity in the anterior DMN (ventromedial prefrontal cortex and DLPFC) was reduced following hypnotic induction during rest periods between suggestions in highs. Lows, on the other hand, showed reduced activity in

areas related to alertness, probably in response to the relaxation induction used. Deeley et al (2012) conducted a similar study, scanning subjects during passive viewing condition, however no suggestions were provided. Reduced activity was seen in the DMN and anterior cingulate cortex and increased activity in prefrontal attentional systems after hypnotic induction, compared to pre-induction. Furthermore, subjects reported greater levels of self-reported attentional absorption, which was inversely related to activity in the DMN. The results of McGeown et al and Deeley et al support the notion that an induction informs subjects to pay attention to whatever strategies are needed to maintain a feeling of being hypnotised.

A number of studies have also shown decreased activation in the DMN in meditators during concentration (FA), mettā bhavana (loving kindness) and choiceless awareness (OM) meditation, compared to non-meditators (Brewer et al, 2011). This may reflect high cognitive load in these styles of meditation. In support of this conjecture, another study that investigated activity in the DMN in meditators doing a different type of meditation gained the opposite results: greater activation in mid frontal brain regions overlapping the DMN during meditation practice (Travis et al, 2009). Subjects were performing transcendental meditation (TM), which is reported to be a simple, easy and non-demanding task. Thus, work on DMN activity has shown that hypnosis and meditation generally involve acts of paying attention, but this is consistent with meditation, which is explicitly associated with mental training, involving especially good attentional abilities and hypnotic responsiveness requiring only average attentional abilities.

In sum, both hypnosis and meditation involve paying attention, but whereas experienced meditators have better attentional skills than novices, hypnotisability appears

unrelated to attentional skill, and the induction of a hypnotic state may even be associated with impoverished attentional skills (though contrast Iani et al, 2006).

*Meta-awareness and the Dorsolateral Prefrontal Cortex*

A fundamental difference between hypnotic suggestion and meditation is that hypnosis often involves an altered or distorted experience of reality. The purpose of meditation for long-term practitioners, on the other hand, is to stimulate change and development towards seeing reality more clearly (Kamalashila, 1992), partly by developing meta-awareness, or accurate higher order thoughts (HOTs).

Accurate HOTs, i.e. awareness of mental states, has been linked to the dorsolateral prefrontal cortex (DLPFC) (Lau and Passingham, 2006). Lau and Passingham found two masking conditions in which people could discriminate one of two shapes to an equal degree but differed in the extent to which they were aware of seeing the shapes rather than just guessing about them. That is, the DLPFC was not linked to the first order mental state of seeing, but to awareness of seeing. Further, when Rounis et al (2010) disrupted the area with theta burst TMS, subjects' self-reported awareness of seeing was disrupted even when first order perception was titrated to be the same with and without TMS. That is, the disruption Rounis et al found was purely related to HOTs. We might expect to see differences between highly hypnotisables and meditators in the dorsolateral prefrontal cortex (DLPFC). Specifically, we might expect less activation in highs and greater activation in meditators.

If the DLPFC is responsible for accurate higher order thoughts in general, disrupting the region with rTMS or alcohol should make it harder to be aware of intending to perform an action. Given that people who are highly hypnotisable seem to have less

accurate HOTs, disrupting the function of the DLPFC should make it easier to subjectively respond to a hypnotic suggestion (according to cold control theory)[3].

Dienes and Hutton (submitted) tested this with TMS. Subjects gave ratings on a 0-5 scale of the extent to which they experienced the response, for four suggestions (magnetic hands, arm levitation, rigid arm and taste hallucination). Overall, rTMS to the DLPFC rather than vertex increased the degree of hypnotic response by about a third of a rating point on average. Further, subjects did not differ in their expectancy that they would respond in the two conditions, so the rTMS had an effect on hypnotic experience above and beyond expectancies. A further study conceptually replicated the effect, but this time using alcohol, which has been shown to particularly affect the DLPFC (Wendt and Risberg, 2001). We recently explored the effect of alcohol on hypnotic response with Theodora Duka at Sussex University. Medium hypnotisables were assigned to either an alcohol or placebo alcohol condition and were then tested on nine suggestions and various frontal tasks. Alcohol indeed disrupted frontal function and crucially, alcohol increased hypnotic response by one scale unit compared to placebo, on the same scale as used in the TMS study. Although both the TMS and alcohol would have affected regions of the brain outside the DLPFC, the evidence is consistent with cold control, hypnosis as self-deception. The evidence is also consistent with other theories that postulate hypnosis involves diminished executive control (Woody and Bowers, 1994) or metacognitive control (Jamieson and Woody, 2007). Either way, the increase of hypnotisability following disruption of the

[3] Cold control theory makes a more precise set of predictions. Namely, if the frontal lobes are impaired sufficiently that the relevant cognitive or motor action cannot be performed with conscious intentions then the same action cannot be performed as a hypnotic suggestion (Dienes and Perner, 2007). However, if the impairment allows the relevant actions to be performed, but is targeted to impair HOT accuracy, then hypnotic performance will be facilitated. Thus far at least, in making these predictions, cold control theory has remained one step ahead of the data.

dlPFC supports the distinction between hypnosis and meditation, during which increased activation is seen in the DLPFC.

In contrast to findings in the hypnosis literature, several studies have shown increased activation in the DLPFC, among other areas, in meditation practitioners during and after meditation practice (Brewer et al, 2011; Farb et al, 2007; Kosaza et al, 2008; Lazar, 2009). For example, Brefczynski-Lewis et al (2007) used fMRI to compare experienced and novice meditators and found greater activation in the DLPFC. Concordantly, it has been claimed that meditators are better at giving self-reports than non-meditators (Kabat-Zinn, 2011). In sum, the differential activation seen in the DLPFC during meditation and hypnosis seems to support the suggestion that hypnosis and meditation differ in metacognitive capabilities subserved by the DLPFC (Dienes, 2012; Woody and Sadler, 2008).

*Meditation is Hotter than Hypnosis*

One apparent similarity between hypnosis and meditation is that both seem to involve absorption. Like high versus low hypnotisables, expert versus novice meditators score more highly on absorption as measured by the Tellegen absorption scale (TAS) (Davidson, 1976). We have since replicated this finding in our lab at Sussex University (in an as yet unpublished study), and found that absorption also correlated positively with self-reported mindfulness as measured by the Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith and Allen, 2004). Although the phenomenological states of hypnosis and meditative absorptions (*dhyanas* in Sanskrit) appear to be similar in some respects (Holroyd, 2003), the feeling of absorption involved in both hypnotic and meditative states may reflect different processes, as we now discuss.

Although absorption and hypnosis appear to be related, we need to take care in our understanding of what precisely absorption is (particularly as some of the items in the Tellegen Absorption Scale appear to lack face validity; see Council, Kirsch & Hafner, 1986). The subjective sense of being absorbed could represent four distinct modes of mental processing. Firstly, one could be mind- wandering without being aware that one was doing so, thus one could believe one was or had been absorbed in the main task (cf Schooler, 2006). Particularly when engaging in open-ended imaginative activity, such mind wandering may not show in any obvious way, and indeed may blend with the imaginative activity itself. Secondly, there could be thoughts distracting the mind, but there is meta-awareness of this distraction, allowing disengagement from the distraction to take place. Thirdly, irrelevant thoughts may be present, but attention is neither attached to nor averted from them; the mind is not distracted. Finally, one could actually be single-mindedly or one-pointedly thinking about the object of thought (see Taylor, 2002). The first state of absorption is only apparent absorption; it appears to be absorption because of a lack of accurate HOTs (call it cold absorption) In meditation, one aims to progress through these states, becoming aware of the mental chatter that usually pervades our minds, letting go of thoughts and entering the *dhyanas* (absorptions, in which one becomes aware of more subtle thoughts and sensations; see Austin, 2006 and Holroyd, 2003 for more in-depth description). Meditation and mindfulness practice involve training in the development of second-order awareness (Teasdale, 1999; Wallace 1999). This could be described as a state of absorption that involves meta-awareness (Lutz, Dunne and Davidson, 2007) and is a goal state of meditation. We could call meditative absorption 'HOT' absorption (absorption with HOTs), reflecting a state of absorbed attention in which one remains meta-aware of the contents of one's consciousness as opposed, possibly, to hypnotic absorption: 'cold'

absorption (absorption without HOTs), in which one has less meta-awareness of the contents of one's consciousness and thus may more easily create inaccurate HOTs about their experience.

We have tested the hypothesis that highs have fewer accurate HOTs than meditators and controls at Sussex by asking subjects to keep looking at images while trying to either a) remain at all times aware of seeing the image (meditation task; cf. Van Nuys, 1973) or b) not consciously see the image for 15 minutes (ignore task; compare Wegner's, 1994, 'white bear' ironic control task, where people are asked to not think of a white bear). Subjects were asked at random intervals (roughly once a minute) whether they were just that instant before aware of seeing the image. Because people remained physically looking at the images there was a persistent first order visual representation of each image; but to what extent did people have accurate higher order thoughts about seeing it? The difference between a) and b) in reports of seeing the image was taken as measuring control in having accurate HOTs, and the total number of reports of seeing the image in both a) and b) as measuring coupling of HOTs to first order states, i.e. the tendency to have an appropriate HOT given that a first order state exists. We found that highs had poorer HOT coupling than lows, i.e. less accurate higher order thoughts across both tasks (Dienes, 2012, and Semmens-Wheeler and Dienes, 2011). This greater propensity to mind-wander meant highs were marginally better at ironic control than lows (and non-significantly worse at meditation). This apparent weak coupling may allow highs to decide in appropriate contexts to forgo higher order thoughts of intending in order to respond hypnotically to suggestions. In contrast, we found that meditators were poor at ironic control compared to highs, a finding which could be explained by the fact that they had significantly more HOTs than both lows and highs. (It is intriguing to find meditators bad at a mental control

task!) Thus it seems unlikely that meditators would experience hypnotic suggestion through a lack of HOT coupling and we might even expect that they would not be very hypnotisable.

Consistent with the evidence that highs are not absorbed in an undistracted way, hypnotic responding itself does not require attending "one-pointedly" to one idea. Zamansky and Clark (1986) asked subjects to engage in imagery inconsistent with the hypnotic suggestions given (e.g. for a rigid arm suggestion, to imagine a different world in which their arm is bending). Highs were just as responsive to suggestions (e.g. that the arm is unbendable) when engaged in imagery inconsistent with the suggestion as when having consistent imagery, even as they concurrently reported the imagery. That is, their arm remains unbent, even as the subjects described an image of the arm bending. Thus, the theory that highs attend to one idea in order to achieve hypnotic response is false. Hypnotic response will tolerate not only mind wandering but also contradictory ideas. By contrast, the absorption in meditation can be specifically directed at making the mind hold to one idea without distraction.

Shaw (2006 p 98), based on the descriptions of meditation in the Pali cannon, describes how the meditator gradually acquires the feeling of control of entering, sustaining and leaving absorbed states - in contrast to the lack of control a hypnotised subject may feel (indeed, needs to feel in some way for a response to be hypnotic). In a related way, Gombrich (1996 p 163) emphasizes the self-control and self-awareness cultivated in Buddhism as an antithesis to spirit possession. Dienes and Perner (2007) identified spirit possession as the same natural kind as hypnosis (i.e. as a case of cold control).

Mindfulness versus self-deception are general principles defining the nature of meditation and hypnosis in broad brush stroke; of course specific hypnotic and meditative

experiences may draw on the other in detail. For example, vajrayana meditation (Gyatso, 2005) involves coming to see imagination as reality, but this does not take away from the fact that meditation must involve cultivation of mindfulness generally to be Buddhist meditation at all (even such cultivation will always leave scope for inaccurate higher order thoughts; cf Shaw, 2006, p 66, points 2, 4, 5, 6, and 7 for mistaken beliefs the Buddha apparently had about his mental states, e.g. recalling past lives.[4]). Just as an episode in a hypnotic context may involve some cognitive activities being consciously controlled in a mindful way (Dienes, 2012; Yapko, 2011) so meditation may involve inaccurate higher order thoughts. Nonetheless, if a person were aware and mindful of all intentions they would have failed to respond hypnotically; and a meditator misrepresenting a mental state would have failed to be mindful. Where each succeeds in its goals, meditation is hotter than hypnosis.

*Directly comparing meditation and hypnosis?*

So far we have compared meditation and hypnosis indirectly. We will now consider directly the relationship between meditation and hypnosis. First we consider the correlation between success at meditating and responding to hypnosis, then whether training can improve meditation and hypnosis, and finally the hypnotisability of people who meditate extensively.

[4] Accurate higher order thoughts depend as much on having a good theory of mental states as on cultivating the process of noticing mental states - just as accurate observation of the world depends crucially on good theory (consider telescopes) (cf Hurlburt and Schitzgebel, 2007, and Petitmengin, 2009, for a discussion of the capabilities and limits of introspection). In Bayesian terms, accurate beliefs about one's mental states are improved by having good priors. Because of this, empirical results from experimental psychology may inform good meditation practice (and vice versa).

Van Nuys (1974; also Spanos, Rivers, and Gottlieb, 1978) found that performance on a meditation task significantly predicted hypnotisability. Subjects carried out a meditation task, which involved subjects pressing a button whenever they experienced an intruding thought. (Note that subjects were not probed, but were asked to report whenever they noticed thoughts, i.e. when they had a HOT.) Based on our discussion with hot and cold absorption (i.e. absorbed attention with and without meta-awareness, respectively), there is an obvious methodological problem with the Van Nuys task. The task may not have really been measuring the number of intrusive thoughts, but the awareness of such thoughts arising. Thus, another way of interpreting the results could be to say that it was the lack of awareness of intrusive thoughts i.e. a lack of meta-awareness that predicted hypnotisability (see Smallwood and Schooler, 2006 for description of meta-awareness and mind wandering). On this account highs may even have more intrusive thoughts than lows (as found by Bryant and Idey, 2001, on a self-report questionnaire). When we determined on-line number of intrusive thoughts by probes, as described above (Dienes, 2012, and Semmens-Wheeler and Dienes, 2011), allowing the measure of intrusive thoughts to be separated from meta-awareness (as per the methodology of Smallwood and Schooler, 2006), hypnotisability was not associated with concentration on the task in our data (hypnotisability was non-significantly associated with more intrusions, $r$ = .21, 95% CI [-.09, .51], the confidence interval ruling out the size of effect Van Nuys obtained, i.e. $r$ about -.3)

Without training, hypnotic suggestibility is relatively stable, with test-retest correlations ranging from 0.64 to 0.82 (Barnier and McConkey, 2004). So far a number of attempts have been made to enhance subjects' hypnotic suggestibility, with some success (e.g. Cooper, Banford, Schubot, and Tart, 1967; Diamond, 1972; Engstrom, Perry and Hart,

1970). Apparently successful attempts have involved changing subjects' beliefs, expectations and attitudes to hypnosis in a single session (e.g. the Carleton Skills Training Package, see Gorassini, 2004; see also Wickless and Kirsch, 1989, and contrast Benham, Bowers, Nash, and Muenchen, 1998). These training schemes contrast dramatically with the extensive attentional training required to make progress in meditation. Brief meditation training has not yet been found to increase hypnotic ability (e.g. Heide, Wadlington and Lundy, 1980).

What is the effect of extensive meditation training on hypnotic response? We compared scores of twelve expert meditators on the Waterloo Stanford Group Scale of Hypnotic Susceptibility (WGSC; Bowers, 1998) with scores of over 500 screened subjects in the University of Sussex database; our preliminary findings show that meditators, passing on average 3/12 suggestions, were less susceptible than the average of all subjects in the database combined (average 5.5 suggestions). Furthermore, in an as yet unpublished study at Sussex we found that highly hypnotically suggestible individuals ('highs') scored significantly lower on measures of mindfulness, which is associated with meditation experience (Semmens-Wheeler and Erskine, 2009). The correlation between hypnotisability and mindfulness was -.38. The tendency for meditators for be less hypnotisable than non-meditators may reflect poor attitudes and low expectations on the part of meditators about hypnosis; we are directly testing this possibility now. We predict that meditators will score low on hypnotisability even after controlling for beliefs and expectations, precisely because they have cultivated having accurate higher order thoughts.

*Conclusion*

There are certainly some areas of overlap between meditation and hypnosis, yet this relationship may turn out to be orthogonal or opposed, particularly with regard to meta-awareness. We have argued that the essential nature of hypnotic response, that which makes it hypnotic at all, is a strategic self-deception with respect to ones intentions (Dienes, 2012; Hilgard, 1977; Spanos, 1986; Spanos and Gorassini, 1999); by contrast, an essential component of meditative practice is mindfulness, seeing plainly what is there. However, it is important to take into account response expectancy both theoretically and methodologically, as it can explain some effects in both meditation and hypnosis. For example, if one expects that either meditation or hypnosis will impair or enhance performance on a particular task, then one is likely to conform to to this belief (Kirsch, 1997). In clinical practice, techniques called hypnotic or mindful may overlap (Lynn, Das, Hallquist, and Williams, 2006), but we need to be careful which specific activities we call hypnotic. Just calling relaxation or the use of imagination or a suggestion for improvement 'hypnotic' does not make it so. As we said in the introduction, to turn cognitive activities into hypnotic responses, those activities must involve distortion in the sense of voluntariness or reality. Further, similar clinical outcomes may be produced by opposite strategies, for example, analgesia may be produced by seeing pain for exactly what the experience is (Salomons and Kucyi, 2011), or by using cognitive strategies of distraction and reinterpretation (strategies one intended without knowing, Dienes, 2012). As urged by Lynn et al and Yapko (2011), research exploring whether hypnosis and mindfulness are useful as complimentary integrated clinical strategies is important. Future studies could

explore metacognition and cognitive flexibility (e.g. cognitive set-shifting ability) in meditators and high hypnotisables and also provide more in-depth analysis of phenomenological experience (Pekala, 1982, 1991).

*Box 1. Meditation Styles*

The different meditation styles can be categorized as: 'focused attention' (FA); 'open monitoring' (OM) and non-referential compassion meditation. These different meditation styles have overlapping effects, but do recruit different regions of the brain (Lutz et al, 2007). FA meditation tends to be practised in stages beginning with breath counting and progressing to focus on the point of entry of the breath into the body, for example. OM meditation, also known as 'open presence' or 'just sitting' emphasizes the development of meta-awareness, where there is no such thing as distraction but all experience is part of the meditation and the goal is to neither avert nor attach one's mind to any experience in particular but to become more familiar with one's mental tendencies and habits. The third style is referred to by Lutz et al as 'non referential compassion'. However, this is a narrow term for what is a set of meditations called the 'Brahma viharas' (Sanskrit for 'divine abodes'), which essentially aim to develop greater awareness of emotions and to cultivate an attitude of *mettā* (loving-kindness); *karuna* (compassion); *mudita* (sympathetic joy) and *upekha* (equanimity).

Visualization practices are also used to cultivate desired qualities and fall partially into the category of FA meditation, yet they go beyond concentration on a simple object. This is commonly done through use of *sādhana*, which is meditation on a text describing

various features (shape, insignia, colour and other attributes) of a Buddha (enlightened being) or Bodhisattva (a person who is on the brink of enlightenment but who holds back out of compassion for all beings). The aim of *sādhana* practice is to create single-pointed, undistracted focus of the mind on the qualities of this being in order to cultivate them in oneself (Sangharakshita, 2001).

Other practices involve using what are known as supports to concentration (*kammathanas*), which include the four brahma-viharas, meditation on the decomposition of a corpse and the Ten Impurities (various disgusting aspects of bodily experience). These practices are designed not only to develop one-pointed concentration, but also to relinquish attachment to the body by realizing its transitory, impermanent nature (Sangharakshita, 2001) and by breaking down the illusion of separate selfhood, with the aim of promoting greater compassion and non-attachment.

*Box 2. Metacognition*

Metacognition is most broadly construed as cognition about cognition and encompasses monitoring and control processes (see Beran et al, 2012, for an overview of current debates). Nelson and Narens (1990) described a conceptual framework that has been influential for thinking about metacognition. Cognitive processes can be divided into object-level and meta-level. Object-level processes are basic cognitive processes such as perception, encoding or retrieval. Meta-processes monitor object-level processes and control them. For example, when given a memory task, a "feeling of knowing" is a type of metacognitive monitoring that may lead to initiating search processes (metacognitive

control). Metacognitive monitoring is constituted both by non-conceptual affective signals, such as feelings of knowing (consider 'tip of the tongue' states), as well as by conceptual theories concerning how one's mind works (cf Koriat, 2007).

Meditation can be seen as a process of cultivating both metacognitive monitoring and control (e.g. sustaining attention, eliminating certain sorts of thoughts). Teasdale (1999) distinguished between metacognitive knowledge and metacognitive insight. For example, we may "know" that we are one day going to die and we will cease to have a point of view (metacognitive knowledge) yet we probably do not have a felt sense of this fact (metacognitive insight). One of the aims of meditation is to increase metacognitive insight so that one begins more and more to experience thoughts as just thoughts rather than thinking about them as facts that accurately reflect reality. This should, in theory, allow one to have a more veridical experience of the world through overcoming the delusion of thoughts as facts. For example, a thought that one is a failure and worthless could have an associated metacognitive insight that this belief is not factual. This is precisely how mindfulness meditation is used to help individuals overcome depression.

In the context of hypnosis, many theories of hypnosis can be construed as metacognitive, that is, theories about the way object-level processes can be monitored and controlled by meta-level processes. For example in Hilgard's (1977) neo-dissociation theory, both control and monitoring processes were important in a uniquely hypnotic way, with either control or monitoring fractionated (see also Woody and Sadler, 2008). Similarly, Spanos' (1986) sociocognitive theory construed hypnosis as an error in monitoring (attributing the causes of our actions to hypnosis rather than our intentions) (cf

Lynn et al 2008). Similarly, cold control theory pinpoints hypnotic response as caused by a specific metacognitive process: Thinking one does not have an intention when one does.

*Box 3. Higher order thoughts*

According to HOT theory, a mental state is a conscious mental state when we are conscious of being in that mental state (Rosenthal, 1986, 2002). To be conscious of anything being present, for example, a ball in front of you, you need to be in a mental state representing that "there is a ball in front of me". To be conscious of seeing a ball in front of you, therefore you need to be in a mental state representing "I see a ball in front of me". That is, you need to be in a mental state about a mental state: A higher order state. The thought asserting that "I am seeing a ball in front of me" is a higher order thought. Seeing "there is a ball in front of me" is a first order state: Its content is just about the world. It is only by virtue of a second order thought such as thinking "I see that there is a ball in front of me" that we are conscious of the first order mental state of seeing and seeing then becomes a conscious mental state.

A second order thought becomes conscious by virtue of a third order thought; for example, it is by thinking "I am aware that I am seeing that there is a ball in front of me" that one becomes consciously aware of seeing the ball. With second order thoughts we become conscious of mental states; with third order thoughts we become consciously aware, i.e. we introspect (Rosenthal, 2002).

Higher order thoughts are metacognitive in that they monitor other mental states. In fact higher order thought theory provides one way of defining what "meta" and "object" level mean. Object-level processes are cognitive processes whose content is just about the world. Meta-level processes must have content which is at least partly about mental states.

Higher order thoughts are particular metacognitions, namely, thoughts asserting that one is in a contemporaneous mental state.

*Box 4. Cold control theory*

Cold control theory (Dienes and Perner, 2007) explains hypnotic responding as executive control (e.g. intending to perform a motor or cognitive action, e.g. lifting an arm, imagining something present) while having inaccurate higher order thoughts of intending ("I am not intending to lift my arm/imagine a pink elephant"). On this account, a person has no first order abilities in responding to a hypnotic suggestion that they did not have already. The difference between a hypnotic and non-hypnotic action is that performing the action hypnotically makes it feel like it is happening by itself. For example, an intention to lift one's arm is usually accompanied by a higher order thought, e.g. "I am intending to lift my arm," but this is not the case in hypnosis, according to cold control theory. (It is cold control because there is no accurate HOT.)

While cold control theory sees hypnosis as intrinsically involving self-deception, such self-deception can be benign or even useful. Hypnosis involves creating illusions of reality or automaticity according to situational requirements; that is, hypnotic responding is "goal directed striving" (White, 1941), where the hypnotic response is consistent with the overall goals and intentions of the subject. Thus, hypnosis is like a metacognitive game: A meta-cognitive strategy of relinquishing metacognition (specifically accurate metacognition concerning a specific intention) in order to have the experiences a situation calls for (e.g. pain going away by itself as one imagines a dial being turned; being possessed by a great spirit) (Dienes, 2012). Our contrast of hypnosis with meditation is not to deny the potential usefulness of hypnosis.

# Alcohol Increases Hypnotic Susceptibility

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**Abstract**

One approach to hypnosis suggests that for hypnotic experience to occur frontal lobe activity must be attenuated. For example, cold control theory posits that a lack of awareness of intentions is responsible for the experience of involuntariness and/or the subjective reality of hypnotic suggestions. The mid-dorso-lateral prefrontal cortex and the ACC are candidate regions for such awareness. Alcohol impairs frontal lobe executive function. This study examined whether alcohol affects hypnotisability.

We administered 0.8mg/kg of alcohol or a placebo to thirty-two medium susceptible participants. They were subsequently hypnotised and given hypnotic suggestions.

All participants believed they had received some alcohol. Participants in the alcohol condition were more susceptible to hypnotic suggestions than participants in the placebo condition.

Impaired frontal lobe activity facilitates hypnotic responding, which supports theories postulating that attenuation of executive function facilitates hypnotic response, and contradicts theories postulating that hypnotic response involves enhanced inhibitory, attentional or other executive function.

Key words: Cold control theory, Hypnosis, Higher order thought theory, Dorsolateral prefrontal cortex, Alcohol

## *1. Introduction*

Hypnotic suggestions give rise to a wide range of interesting experiences and behaviours. Typically these involve a sense of involuntariness, such as in the case of one's arm apparently rising by itself. Alternatively they may comprise the experience of an entirely convincing yet fabricated subjective reality, such as the experience of a mosquito on one's hand (e.g. McConkey, 2008). There may be different underlying mechanisms and thus contributing factors involved in different types of hypnotic suggestions, and individuals may create the experience in different ways (e.g. see Barnier & Woody, 2008; Terhune, Cardeña and Lindgren, 2011). As such, a number of theories have been developed in an attempt to explain hypnotic phenomena. Hypnosis can be construed either as a special state or as a way of responding to suggestions (Kirsch et al, 2011). In terms of the latter, hypnotic responding is a way of responding in which the sense of volition or reality has been deliberately distorted (whether or not one is in a special state). In terms of the former, it is a state that may facilitate such responding.

Although several studies have examined the effects of drugs, including cannabis, psilocybin, diazepam and nitrous oxide on hypnotisability (Kelly, Fisher and Kelly, 1978; Sjoberg and Hollister, 1965; Whalley and Brooks, 2009), surprisingly none has yet investigated the relationship of alcohol to hypnotic suggestibility. Yet, as we now describe, theories of hypnosis often postulate a role of the frontal lobes in hypnotic responding, and alcohol primarily disrupts frontal lobe functioning.

A number of theories have emphasised the role of the frontal cortex and associated executive functions, such as attention. One broad approach posits that hypnotic phenomena

arise from a state of hypofrontality (see Dietrich, 2003) and diminished executive functions such as attention. For example, Woody and Bowers (1994) postulate that hypnotic induction leads to impairment of executive functions, causing actions to be controlled by contention scheduling (i.e. habit). Woody and Sadler (2008) review a number of ways in which executive control mechanisms may be disrupted in order to produce hypnotic response. Similarly, Gruzelier (1998, 2006) has proposed that hypnosis results from a state of frontal lobe exhaustion and diminished attentional abilities resulting from extreme concentration during hypnotic induction. Gruzelier and Warren (1993), Kallio, Revonsuo, Hamalainen, and Markela (2001), and Farvolden and Woody (2004), found that hypnotic induction reduced letter fluency in high rather than low hypnotisables, although similar effects were not detected on other frontal tasks. Thus, responding hypnotically may involve a specific form of hypofrontality. If these theories are true then alcohol should increase hypnotic responding.

Other theories would predict that the alcohol-induced frontal lobe impairment would reduce hypnotic responsiveness. The theories of both Spanos (e.g. 1986) and Hilgard (e.g. 1986) rely on the functioning of the frontal lobes for hypnotic response to be achieved. Spanos (e.g. Bertrand and Spanos, 1985; Spanos et al, 1982) has demonstrated that hypnotic behaviour can involve overcoming pre-potent responses, which necessarily involves executive functioning. Hilgard's theory relies upon two intact but dissociated executive functions. In fact, Hilgard (1986) argued that maintaining the two dissociated streams itself took executive capacity, because the hypnotic rather than non-hypnotic performance of one of two simultaneous tasks involved more dual task interference (see also Wyzenbeek and Bryant, 2011; Tobis and Kihlstrom, 2010). Similarly Crawford,

Knebel, and Vendemia (1998) argue that frontal lobe executive functions are required for hypnotic analgesia. Therefore, since alcohol impairs executive function, alcohol should decrease hypnotic susceptibility by these approaches.

A more recent theory has highlighted the role of metacognition in hypnosis. The cold control theory of hypnosis (Dienes, 2012; Dienes and Perner, 2007; also see Barnier et al, 2008) explains hypnotic phenomena as the result of a strategic lack of awareness of the intention to perform a particular action. In other words, to respond hypnotically, the subject performs an action while thinking that they were not intending to perform that action: hypnosis essentially involves the lack of accurate higher order thoughts (HOTs) of intending. (Hence 'cold control': intentional control without HOTs.) Take, for example, the hypnotic suggestion that one's arm is stiff and rigid as if splinted, so that it cannot bend. In order to perform the suggestion successfully, the subject might intend to contract the antagonistic muscles of the arm simultaneously to prevent it from bending. The hypnotic aspect is the experience of involuntariness, and cold control posits that this occurs by way of avoiding HOTs of intending, which thus lead to the inaccurate HOT, "my arm has become stiff and rigid by itself and I cannot bend it." Similarly, suggestions for analgesia or amnesia may involve distraction away from pain or the to-be-forgotten material. However, the hypnotic component is the ability to deceive oneself about having intended to do so; that is, by cold control theory this is done by avoiding accurate HOTs of intending. Note that on this theory hypnotic experience does not involve any alteration in first-order abilities (i.e. abilities with the function of dealing only with the world), but is achieved purely metacognitively. Thus, according to cold control, impairment of frontal function would enhance hypnotic response in virtue of the role of the frontal lobes in metacognition.

Higher order thoughts of seeing have been linked to the dorsolateral prefrontal cortex (DLPFC). Lau and Passingham (2006) using fMRI found that the brain region that distinguished reports of "seeing" rather than of "guessing" for equivalent perceptual discrimination was the DLPFC; thus, the DLPFC was not linked to the first order mental state of seeing, but to awareness of seeing. In another study, subjects' self-reported awareness of seeing was disrupted when theta burst TMS was applied to the area, even when first order perception was held constant with and without TMS (Rounis et al, 2010). That is, the disruption found was purely related to HOTs, and not first order perception. Fleming, Weil, Nagy et al (2010) also found the individual differences in the accuracy of higher order thoughts about perceiving correlated with grey and white matter volume in the same region.

The neural substrate of accurate higher order thoughts may well extend beyond the DLPFC. The monitoring and cognitive control functions of the anterior cingulate cortex (the ACC) make it a likely co-candidate region for the production of HOTs. Indeed, Woody and Szechtman (2011) found that in highly hypnotisable participants there were greater levels of activation in the ACC during auditory hallucination compared to imagination of the same sounds. That is, the ACC may be involved in determining whether internally generated sensory representations are just that – imagination – or else misrepresented as perceptions.

Alcohol impairs both the DLPFC (Wendt and Risberg, 2001) and the ACC (Ridderinkhof et al, 2002). Consistent with the claim these areas are involved in accurate metacognitive awareness, Sayette, Reichle, and Schooler (2009) found that alcohol compared to placebo decreased people's awareness that they were mind wandering. The

DLPFC and ACC not only have executive monitoring functions but also control functions. Thus, the effect of alcohol on these areas can also be shown by the effect of alcohol on tasks that test inhibition of pre-potent response (like the Stop Signal Task, SST; Fillimore and Weafer, 2004), or the ability to resist perseveration (like the letter fluency task; Peterson, Rothfleisch, Zelazo and Pihl, 1990). For example, Marinkovic et al (2012) reported reduced activation in ACC bilaterally during the incongruent condition on the colour Stroop task. Similarly, Gundersen et al (2008) observed decreased activation in ACC and cerebellum during a working memory task following alcohol consumption. With a different variant of a working memory task, Paulus et al (2006) found less activation in the DLPFC in participants who consumed alcohol rather than placebo.

In sum, alcohol impairs control and monitoring functions subserved by the DLPFC and ACC. According to theories postulating that hypnosis involves disruptions in executive control mechanisms (e.g. Woody and Sadler, 2008), alcohol should increase hypnotic responsiveness. According to cold control theory, as alcohol impairs the areas responsible for metacognitive monitoring, alcohol should make it harder to have accurate higher order thoughts of intending, and thereby facilitate hypnotic response. On the other hand, theories that emphasize that hypnotic response involves extra executive capacity (e.g. Hilgard, 1986) predict that alcohol should impair hypnotic responding.

It is well known that alcohol produces effects of an altered state of consciousness, i.e. drunkenness, and this may lead to increased expectations of hypnotic responding. Expectancy is a strong predictor of hypnotic response (Braffman and Kirsch, 1999), and indeed, according to response expectancy theory, is the final psychological mechanism by which hypnotic response is achieved (Kirsch, 1985). Theories that postulate some form of

diminished frontal lobe functioning, such as cold control theory, predict that the effect of alcohol on hypnotic susceptibility will be observed above and beyond any effects of response expectancy.

The main aim of the study was to determine the effect of alcohol on hypnotic suggestibility, specifically measuring the central element to successful responding: the sensation that actions and experiences "happen by themselves". We administered real or placebo alcohol to medium susceptible participants before they received a series of hypnotic suggestions. (Note: although suggestions typical of susceptibility scales were used, no attempt was made to assess an individual's objective responsiveness, only the feeling of automaticity). Participants rated how strongly they experienced each suggestion. As a manipulation check, the effect of the alcohol on frontal function was determined by the letter fluency task and stop signal task. Before responding to hypnotic suggestions, participants also rated how strongly they expected to respond in order to control expectancy effects.

## *2. Methods*

### *2.1Participants*

Participants in this study were thirty-two undergraduate and postgraduate students aged between 18 and 39 years ($M$ =22, $SD$ = 5.62) recruited from the University of Sussex hypnosis screening database. Participants scored in the medium range (4-8 suggestions passed out of 12) on the Waterloo-Stanford Group Scale of Hypnotic Susceptibility, Form C (WSGC; Bowers, 1998). Medium-susceptible participants were selected in order to allow for either an increase or a decrease in hypnotic suggestibility. If alcohol were to

decrease hypnotic suggestibility then we might see a floor effect in lows, and if it were to increase it, then we might see a ceiling effect in highs. For study inclusion, minimum alcohol consumption as assessed with the Alcohol Use Questionnaire (AUQ; Mehrabian and Russell, 1978) of 10 units per week and maximum alcohol consumption of 40 units per week was defined. (One unit equals 8 g ethanol.) All participants were in good health, had a body mass index of between 18 and 28, and were not pregnant or breastfeeding. Participants included were not heavy smokers (>20 cigarettes per day) and were able to abstain from smoking for the duration of the test session. Volunteers with current symptoms of mental illness or neurological disease, a history of severe mental illness, drug or alcohol abuse or altered metabolism of alcohol (e.g. impaired liver function or gastroenteritis) were excluded from the study. Ethical approval was received from the University of Sussex ethical committee. Informed consent was obtained from each participant before commencing with the study. All thirty-two participants completed the study (12 males). Participants were remunerated with course credits or £5 per hour for their participation in the study.

*2.2 Design*

Participants were randomly allocated to an alcohol or placebo condition according to a double blind between-subjects design and administered either an alcohol or placebo beverage. Participants were told that they were to receive a high or low dose of alcohol. The drinks were prepared by a laboratory assistant and administered to the participants by the researcher, who was blind to whether or not alcohol or placebo was being administered.

*2.3 Materials*

*REY auditory verbal learning test (RAVLT)*

To assess whether the two groups differed in verbal learning and memory abilities, each participant completed the REY auditory verbal learning test (RAVLT; Rey, 1964), in which the experimenter read aloud 15 words at a rate of one per second. Participants were required to wait two minutes and then recall as many words from the list as possible.

*Letter Fluency Task*

Participants were asked to produce as many words as possible starting with the letters F and S (in a counterbalanced order across conditions) within one minute. Proper nouns and variants of words already given counted as errors. This task was administered to assess the effects of alcohol on participants' monitoring function, which is required in this task to avoid perseverations. It was scored by subtracting the score of the post-drink test from the score of the pre-drink test to establish that alcohol had impaired the frontal lobe functioning of participants in the alcohol compared to placebo condition.

*Drunkenness Scale and VASs for alcohol effects*

These scales were used to measure the participants' subjective ratings on general feelings of drunkenness and more specific experiences. The drunkenness scale requires participants to indicate how drunk they feel on a scale from 1 (I feel no effect of alcohol) to 9 (So drunk

the room is spinning)[5]. The subjective effects visual analogue scales (VASs; Loeber and Duka, 2009) required participants to indicate the degree to which they experienced each of light-headedness, contentment, stimulation, pleasant glow, irritability, alertness and relaxation, by marking a corresponding line labeled from 1 (I feel no effect of alcohol) to 10 (I feel a strong alcohol effect).

*Hypnotic suggestions*

A total of nine hypnotic suggestions were made to participants following the second word fluency task, approximately forty-five minutes after alcohol administration was finished[6]. The suggestions covered both motor and cognitive types, as well as direct and challenge types (Barnier & Woody, 2008). The suggestions were (in order delivered): that they had a sour taste in their mouth; that their outstretched hands were attracted to each other, making them move together (magnetic hands); to feel that their outstretched right arm was weighed down by holding an imaginary heavy object that they could not keep it up (heavy arm); that a mosquito had landed on their hand and was tickling it; that their arm was so stiff and rigid that they could not bend it (rigid arm); to see two balls out of three placed in front of them (negative hallucination); that their arm was so heavy they could not lift it (arm immobilisation); to forget everything that had happened since they were hypnotised until told that they could remember (post-hypnotic amnesia) and to feel a strong urge to move seats when a clipboard was handed to them.

[5] 1, Feel no effect of alcohol; 2, Feel the first effects of alcohol; 3, Slightly tipsy; 4, Feeling warm; 5, a bit disinhibited; 6, Very merry; 7, Beginning to feel uncoordinated; 8, Very drunk; hard to focus properly; 9, So drunk the room is spinning and I feel sick.

[6] Nine suggestions were used, rather than twelve, as in the WGSC (Bowers & Woody, 1993), in order that all suggestions were completed before the alcohol was metabolised and the blood alcohol level dropped.

*Expectancy Ratings*

Explicit expectancy ratings were recorded using E-Prime 2.0. Before each hypnotic suggestion was made, participants were asked to report whether or not they expected to experience the suggestion. For example, "If you were given a hypnotic suggestion that your arm would feel so heavy that you would not be able to hold it up, do you expect that your arm would feel heavier than normal." They responded by pressing 'Y' for yes and 'N' for no on a computer keyboard. They were then asked how confident they were about this expectancy (on a scale of 1 to 4[7]).Yes/no responses were combined with confidence ratings to give a directional "explicit expectancy" scale, ranging from -4 (indicating a strong expectancy not to respond to a suggestion) to +4 (indicating a strong expectancy that one would respond to the suggestion). Additionally, reaction times for yes/no responses were recorded and used as a measure of unconscious expectancy (when explicit ratings are partialled out).

Subjective Hypnotic Response Ratings

Following each suggestion, participants were asked to rate how strongly they experienced the suggestion (on a scale of 0 to 5). For example "On a scale from 0 to 5, how strongly did you feel your hand becoming heavy (where 0 means you felt your arm was no more heavy than normal and 5 means you felt your arm becoming heavy as though you had a heavy object in your hand, pulling it down.).

[7] 1. I am completely guessing, I have no idea whether I would or wouldn't
2. I am more or less guessing, but I have some feeling I was right
3. I am pretty sure I am right
4. I am completely certain

*Stop Signal Task (SST)*

The SST was administered at the end of the session to check that participants were still generally influenced by alcohol, as response inhibition tends to be impaired under alcohol's influence (Loeber and Duka, 2009; Fillmore & Weafer, 2004). The SST, from the CANTAB (Cambridge Cognition, Cambridge, UK; http://www.camcog.com), assesses response inhibition performance. In each trial, an arrow (go-stimulus) was presented on the screen and the participant was required to press the left or the right button of a two-choice response box as quickly as possible to indicate if the arrow was either right-facing or left-facing. In 25% of the trials, an auditory stop signal (a beep sound) was presented at a variable delay after the go-stimulus. The subject was instructed to withhold their motor response on presentation of the stop signal. Five blocks of 64 trials were presented. The main variable was Stop Signal reaction time (SSRT) a measure of response inhibition (Robbins, 2007), which takes into account reaction time on go trials and is calculated from the length of time between the go stimulus and the stop stimulus when the participant is able to successfully inhibit his or her response in the latter 50% of trials. High SSRT indicates impaired inhibitory motor control.

*2.4 Procedure*

Participants were instructed not to drink alcohol for at least 12 hours before the start of the test session. On the day of testing zero blood alcohol concentration was ensured before the start of testing. Baseline breath alcohol concentration was measured using a breathalyser

(Lion Alcolmeter SD-400, Lion Laboratories LTD., UK) and participants completed the Subjective Effects visual analogue scale (VAS) and the drunkenness scale. The Rey Auditory Verbal Learning Test (RAVLT; Rey, 1964) and letter fluency task were administered to control for any pre-manipulation differences between the two groups.

Participants in the alcohol group were given an alcohol dose of 0.8g/kg. For a 70kg person this is equal to about 56g of pure alcohol. This is equivalent to approximately 2.5 pints of lager or 5 glasses of wine (Weissenborn and Duka 2003). The alcohol beverage consisted of 90% v/v alcohol diluted with tonic water (Schweppes® Indian Tonic Water) to make up a drink of 500 ml which was mixed with Angostura Bitter® to mask the taste of the alcohol. The placebo beverage consisted of 500 ml tonic water and Angostura Bitter® only. Drinks were divided into 10 portions, and participants consumed the ten portions at 3 min intervals in the presence of the experimenter. Participants were breathalysed fifteen minutes after alcohol consumption and then completed another set of the Subjective Effects Visual Analogue Scales (VAS; Loeber and Duka, (2009) and a 9 point drunkenness scale in order to obtain a subjective rating of how 'drunk' they felt. Participants were next given a brief hypnotic induction and nine suggestions. They were asked about their expectancy before each suggestion and subjective response after each suggestion. Following this they were breathalysed before completing the letter fluency task and finally the stop signal task.

## *3. Results*

### *3.1 How blind were subjects to condition?*

Subjects were told at the end of the experiment that there had been two conditions: alcohol and placebo. Subjects were then asked if they thought they had received alcohol; 86%

thought they had. 73% of those in the placebo condition and 100% of those in the alcohol condition, $\chi^2(1) = 5.8$, $p$=.08). A *t*-test indicated that those who believed they had received alcohol rated their drunkenness higher ($M$=3.4, *SD=2.1)* than those who did not ($M$=0.25, *SD=0.5),* $t(30)$=2.98, $p$=.006. Participants who believed they had received alcohol also rated their experience of "pleasant glow" higher than those who believe they had not ($M$=5.7, $SD$=1.4 and $M$=3.9, $SD$=2.8, respectively), $t(30)$=2.14, $p$=.002. Further, when scores on the scales were averaged both before and after administration of alcohol or placebo, not only did alcohol change subjective feelings, from 2.82 (SD = 0.49) pre-administration to 5.04 (0.79), post administration, t(13) = 7.17, p <.001, d = 3.37, but so did the placebo, from 3.25 (0.75) to 3.81 (0.80), t(13) = 3.25, p = .006, d = 0.72. Nonetheless the change produced by alcohol (0.94, SD = 1.04) was detectably different from the change produced by placebo (0.29, SD = 0.73), t(26) = 2.94 p = .035 1-tailed, d = 0.45. Participants who had alcohol reported feeling significantly more lightheaded, t(30) = 3.21, p=.003, d = 1.13 (see Table 1), and more intoxicated, t(30) = 13.23, p<.001, d = 1.84 (see Table 1) compared to those who had placebo.

Table 1. Mean subjective mood ratings (SEM) after administration of alcohol or placebo

| VAS | Placebo | Alcohol | |
|---|---|---|---|
| Drunkenness | 1.34 (.19) | 4.25 (.23)* | $t(30) = 13.23$, $p<.001$, $d = 2.59$ |
| Light-headed | 1.93 (.53) | 4.5 (.61)* | $t(30) = 3.21$, $p=.003$, $d = 1.12$ |
| Pleasant Glow | 4.73 (.34) | 6.12 (.49) | $t(30) = 2.51$, $p=.018$, $d = 0.89$ |
| Irritable | 0.50 (.21) | 1.59 (.44) | $t(30) = 2.14$, $p=.040$, $d = 0.78$ |
| Relaxed | 5.73 (.41) | 6.15 (.29) | $t(30) = 0.83$, $p=.411$, $d = 0.30$ |
| Alert | 4.70 (.43) | 4.5 (.39) | $t(30) = 0.35$, $p=.733$, $d$ |

| | | | |
|---|---|---|---|
| | | | = 0.12 |
| Stimulated | 4.73 (.27) | 4.91 (.46) | $t(30) = 0.32$, $p=.749$, $d = 0.12$ |
| Contented | 6.17 (.35) | 6.12 (.50) | $t(30) = .08$, $p=.938$, $d = 0.938$ |

* Significant after controlling for familywise error at the .05 level (Hochberg's, 1988 sequential Bonferroni).

In sum, while there was a placebo effect, subjects also had some knowledge about condition, and thus it is important to control expectancies in determining alcohol's effect on hypnotic response.

*3.2 Was enough alcohol administered to affect frontal lobe functioning?*

Blood alcohol levels (BAC) at 45 minutes ranged from 0.55 *promille w/volume* to 0.96 *promille w/volume* in the alcohol group. No participant of the placebo group had a detectable BAC (derived from the breath alcohol level; BrAC) or BrAC.

As expected, alcohol impaired performance on tests of frontal lobe functioning. The alcohol group's decline in performance on the word fluency task ($M = 3.18$, $SD = 2.58$) was greater than the placebo group's ($M = 0.33$, $SD = 1.45$) $t(30) = 2.69$, $p = .014$, $d = 0.87$. Kallio et al (2004) found a hypnotic induction reduced letter fluency by 30%, similar to the 23% reduction alcohol produced in the current study (from 14.24 to 10.91): That is, we have administered sufficient alcohol to reduce frontal function by the order of magnitude relevant for effects on hypnotic response.

The alcohol group's reaction times ($M = 255.66$, $SD = 122.96$) on the stop signal task were also longer than those of participants in the placebo condition ($M = 161.09$, $SD = 61.5$, $t(30) = 2.69$, $p = .012$, $d = .97$, further indicating alcohol's effect on frontal functioning.

*Table 2. Mean scores on tests of frontal lobe function (SEM)*

| | Placebo | Alcohol | |
|---|---|---|---|
| Letter fluency pre | 15.733 (1.08) | 14.24 (1.01) | $t(30) = 1.01$, $p = .32$ |
| Letter fluency post | 15.53 (0.71) | 10.94 (0.65) | $t(30) = 4.75$, $p < .001$ |
| SST post | 161.09 (15.88) | 255.57 (29.82) | $t(30) = 2.69$, $p < .012$ |

*3.3 Did alcohol affect hypnotic response?*

Table 3 shows the mean subjective response for each suggestion separately. When responses were averaged over suggestions, the alcohol group ($M$ = 2.81, $SD$ = 0.71) responded subjectively more to hypnotic suggestions than the placebo group placebo group ($M$ = 1.96, $SD$ = 0.75, $t(30) = 3.27$, $p = .003$, $d$ = 1.16) (on a scale that went from 0 to 5). This is the key result of the study.

The effect of alcohol on hypnotic suggestibility was assessed performing an ANCOVA on post-drink subjective hypnotic ratings for each group with baseline hypnotic suggestibility, as measured by the WGSC, was as a covariate. An ANCOVA was performed between the alcohol group (adjusted M = 2.70, *SEM* =.19) and the placebo group (adjusted M = 1.96, *SEM* = 0.19) with subjective hypnotic ratings (WGSC) as a dependent variable and baseline as a covariate to check if baseline differences in the group could explain the effect of alcohol/placebo condition on hypnotic suggestibility. The difference in hypnotic suggestibility was significant, $F(1, 27) = 7.81$, $p$=.009, indicating that alcohol had an effect on hypnotic responding, over and above any initial group differences.

A significant positive correlation was found between expectancy and subjective response to suggestion overall, Pearson's $r$ = .55, $p$ <.001. So was the effect of alcohol just based on expectancy? The alcohol group ($M$ = 0.56, $SD$ = 0.91) and placebo group did not differ significantly in their expectancy ratings ($M$ = 0.11, $SD$ = 1.28), $t(30) = 1.16$, $p$ = .26, $d$ = 0.40, (on an expectancy scale that went from -4 to +4)[8]. Crucially, when expectancy

[8] In order to determine if this non-significant result was sensitive a Bayes Factor was used to compare the alternative hypothesis (that expectancy was higher for the alcohol rather than placebo group) to the null hypothesis. A Bayes Factor greater than 3 indicates strong evidence for the alternative over the null; less than a 1/3 indicates strong evidence for the null over the alternative; and anything in between indicates the data are insensitive (Dienes, 2011). First we need to specify what sizes of effect the alternative hypothesis predicts. The raw regression slope of hypnotic response on expectancy was 0.43 ($t$ = 3.58, $p$ =.001). The

was put in as a covariate, the difference between the groups in hypnotic suggestibility remains (adjusted means: alcohol group $M$ = 2.73, $SEM$ = 1.7; placebo group $M$ = 2.03 $SE$ = *1.6*), $t(29) = 3.57$, $p$ =.002).

### *3.4 Direct and Indirect Measures of Expectation*

Direct and indirect measures of expectancy were taken. Before each hypnotic suggestion was made, participants were asked to report whether or not they expected to experience the suggestion and how confident they were about this expectancy (on a scale of 1 to 4) as a direct measure, and the reaction time for the yes/no response was taken as an indirect measure. We would expect that subjects with more confidence in 'no' responses would be less hypnotically suggestible, and vice versa for 'yes' responses. In order to examine the effect of these direct and indirect measures of expectancy on subjective ratings (hypnotic response), for each subject a multiple regression was run with expectation RT and confidence rating predicting subjective response for yes and no responses separately. Regression weights (betas) for yes and no should be in opposite directions, as the more confident a subject is in a no response, the less hypnotically responsive they should be, so we reversed the sign for 'no' expectancy response regression weights and averaged across both (for both indirect and direct measures). Separate multiple regression analyses were carried out for 'yes' and 'no' responses. Although a combined analysis was possible with explicit expectancy ratings, this could not easily be done with RTs (the indirect measure of expectancy). The mean standardised regression weight for confidence was 0.11, $t(24)$ = 1.00, $p$ = .33, $d$ = .51, indicating that conscious expectancy did not significantly predict subjective response controlling for RT differences. However, the mean standardised regression weight for RT was 0.29, significantly above chance, $t(25) = 2.62$, $p$ = .015, $d$ =

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difference in hypnotic response between groups was 0.85 units. Thus the change in expectancy needed to produce the observed change in hypnotic response is 0.85/0.43 = 2.0 units. Thus, the predictions of the alternative hypothesis were modelled as a half normal with a standard deviation of 2.0 (see Dienes, 2011, Appendix, for this recommendation; and website for Dienes, 2008, for free online software for Bayes Factors). The Bayes Factor was 0.63; thus the non-significant difference in expectancy between groups cannot be used to support the null hypothesis, the data are insensitive. The ANCOVA shows however that expectation did not mediate the effect of group. The extent of mediation is discussed further below.

.20, indicating that RT as an indirect measure of expectancy did predict subjective response.

Table 3. Mean subjective responses to individual hypnotic suggestions (SEM)

| Suggestion | Placebo (SEM) | Alcohol (SEM) | |
|---|---|---|---|
| Rigid arm | 2.53 (.41) | 3.82 (.31) | $t(30) = 2.53$, $p = .017$ |
| Posthypnotic suggestion | 0.73 (.25) | 2.06 (.47) | $t(30) = 2.42$, $p = .022$ |
| Negative hallucination | 0.40 (.16) | 1.71 (.50) | $t(30) = 2.36$, $p = .025$ |
| Heavy arm | 3.73 (.37) | 4.53 (.15) | $t(30) = 2.08$, $p = .047$ |
| Arm immobilisation | 2.60 (.34) | 3.41 (.24) | $t(30) = 1.99$, $p = .056$ |
| Sour taste | 1.67 (.35) | 2.41 (.31) | $t(30) = 1.61$, $p = .119$ |
| Magnetic hands | 3.27 (.32) | 4.00 (.24) | $t(30) = 1.87$, $p = .172$ |
| Posthypnotic amnesia | 1.67 (.39) | 2.24 (.32) | $t(30) = 1.15$, $p = .259$ |
| Mosquito hallucination | 1.07 (.36) | 1.12 (.27) | $t(30) = 0.12$, $p = .91$ |

## 3.5 Mediation analyses

Measures of explicit and unconscious expectancy were entered into separate mediation analyses to investigate the effect they had on the relationship between alcohol/placebo condition and subjective hypnotic response. In order to measure unconscious expectancies differences between groups, Go trial RTs from the SST were partialled out of ‘yes’ and ‘no’ expectancy RTs as a baseline measure of reaction time so as to account for any between-groups differences, such as alcohol causing longer latencies. ‘Yes’ and ‘no’ expectancy RTs were regressed separately on SST go trial RTs and the residuals were used as the measure of unconscious expectancies.

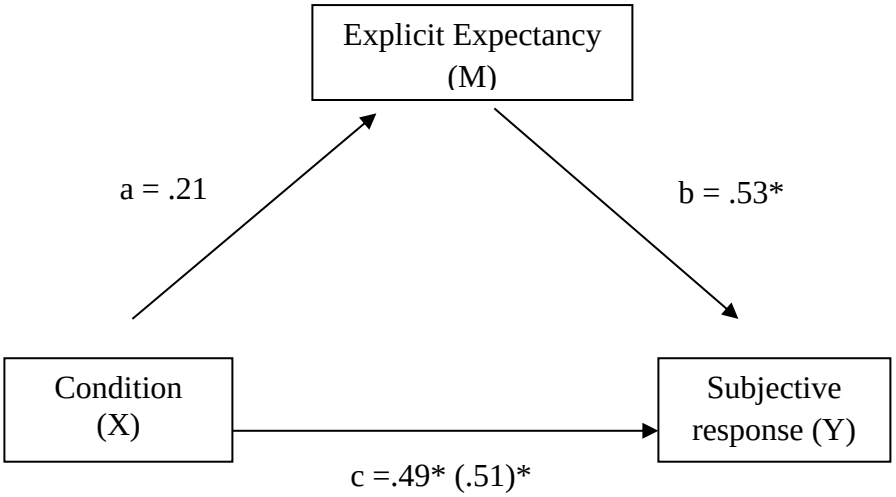
Figure 1 displays mediation analysis for alcohol/placebo condition with explicit expectancy as a mediator. The standardised regression weight predicting hypnotic response from condition partialling out expectancy is "c"; the correlation between condition and expectation is "a"; and the standardised regression weight predicting hypnotic response from expectancy, controlling condition is "b". If c>0, then there is not full mediation; if ab=0 there is no mediation; and if ab>0, then there is some mediation (Woody, 2011). Conventional mediation analysis, being based on significance testing, does not provide a systematic method of establishing no meditation, as opposed to partial mediation by establishing if ab= 0. The amount of mediation depends on the size of ab. If there is full mediation by a variable, then c = 0[9] and if there is no mediation, then ab = 0 (see Woody, 2011). As c > 0, the only question is whether there is no mediation or partial mediation, and this depends on determining if ab = 0. Thus, we calculated a Bayes Factor, the only known method of providing evidence for a point null hypothesis (Berger & Sellke, 1987).

As the partial correlations were close to the original correlations in each case, we normalised them with Fisher's Z, which has a known standard error. We can use the following formula for the standard error of ab in order to test if ab=0 or if ab>0:

$SE_{ab} = \sqrt{a^2SEb^2 + b^2SEa^2}$

To represent the prediction of partial mediation for the purposes of calculating a Bayes factor, we used a uniform distribution from zero to an upper limit of the correlation between condition and hypnotic response - because the most the mediated effect can be (ab) is the full effect. If the Bayes Factor is <1/3, then it is strong evidence for no mediation. If it is >3, it is strong evidence for partial mediation, and if it is anywhere in-between, then there is insufficient evidence.

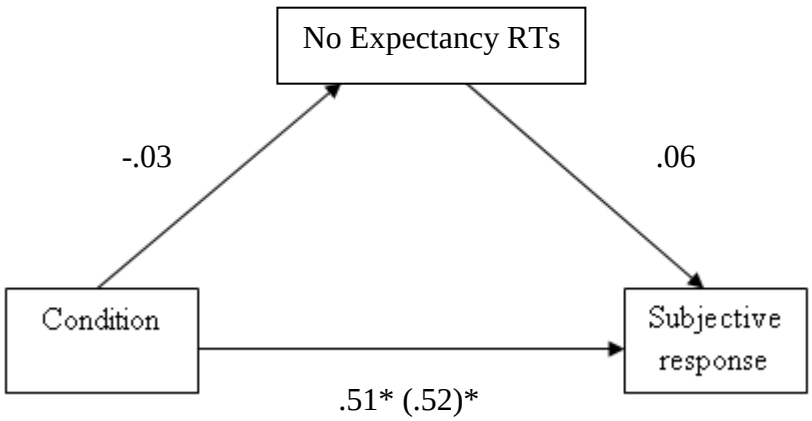
[9] Therefore, we need to first of all check to see if c is significant. If it is not, (and ab is non-zero) then there may be partial or full mediation. A Bayes Factor can be used to test c > 0 by using an estimate of the full effect as an upper limit of the uniform, in a similar way as for testing ab.




*$p<.05$.

Figure 1. Regression coefficients for the relationship of alcohol/placebo condition with subjective hypnotic response as mediated by explicit expectancy ratings.

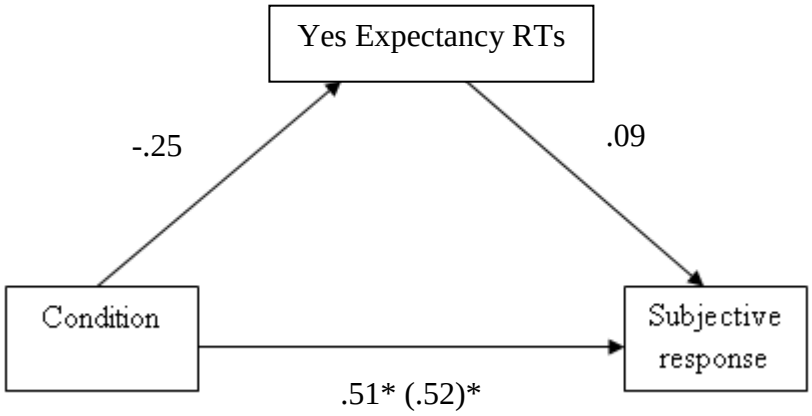
As can be seen in figure 1, c>0, therefore there is not full mediation. The Bayes Factor for the test of ab>0 as opposed to ab=0 is 5.6. Therefore, there was evidence to suggestion partial mediation of condition on subjective response by explicit expectancy.




*$p<.05$.

Figure 2. The effect of condition (alcohol or placebo) on subjective hypnotic response with 'no' expectancy RTs as a single mediator. (Standardised regression coefficient for condition and subjective response controlling for 'no' expectancy RTs is in parentheses.)

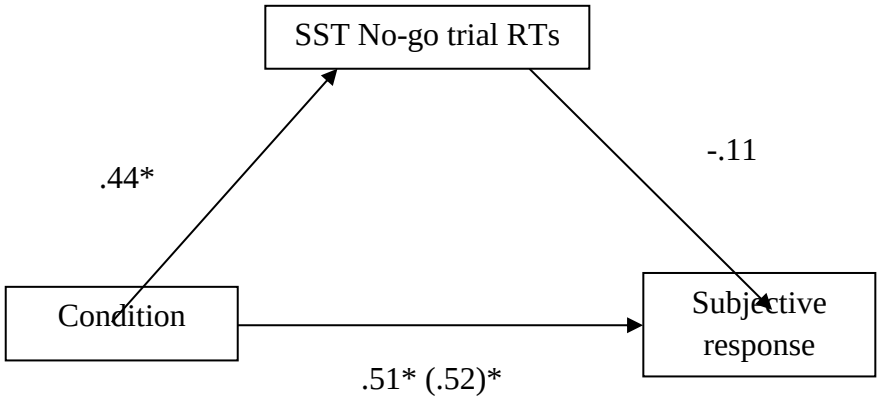
As can be seen in figure 2, c>0, therefore there is not full mediation of 'no' expectancy RTs on the relationship between alcohol/placebo condition and subjective hypnotic response. The Bayes Factor for the test of ab>0 as opposed to ab=0 is 0.05. Therefore, there was evidence to suggest no mediation by unconscious expectation not to respond to a suggestion.




*$p$<.05.

Figure 3. Regression coefficients for the relationship of alcohol/placebo condition with subjective hypnotic response as mediated by 'yes' expectancy RTs.

As can be seen in figure 3, c>0, therefore there is not full mediation. The Bayes Factor for the test of ab>0 as opposed to ab=0 is 2.47, which weakly supports the theory that 'yes' expectancy RTs (unconscious expectation to respond to a suggestion) partially mediated the relationship between condition and subjective response, yet the data are insensitive.




*$p$<.05.

Figure 4. Regression coefficients for the relationship of alcohol/placebo condition with subjective hypnotic response as mediated by SST No-go trial RTs.

As can be seen in figure 4, c>0, therefore there is not full mediation. The Bayes Factor for the test of ab>0 as opposed to ab=0 is 0.18 Therefore, there was evidence to no mediation of condition on subjective response by SST no-go trial RTs (response inhibition).

## *4. Discussion*

In this study we examined the effect of alcohol on hypnotic suggestibility. The placebo was somewhat effective, although there was a significant difference between the ratings of drunkenness reported between the two groups. Alcohol consumption increased hypnotic responsiveness, compared to placebo. While explicit expectancy strongly predicted performance, the effect of alcohol on hypnotic suggestibility remained after controlling for explicit expectancy. We measured unconscious as well as conscious expectancies for the first time, and showed that unconscious expectancy could predict hypnotic response above and beyond conscious expectancy. Yet the effect of alcohol could not be fully accounted for by either type of expectancy. Bayesian analysis also indicated that explicit expectancy partially mediated the relationship between alcohol

condition and hypnotic responding, and that unconscious expectancies may also partially mediate this relationship.

The results also confirmed that alcohol impaired frontal lobe functions, as demonstrated by the alcohol group's decline in performance on the stop signal task and the letter fluency task. Performance on the stop signal task did not mediate the relationship between alcohol condition and subjective hypnotic response, though, which is problematic for dissociated control theory (Woody & Bowers, 1994). However, these findings support theories postulating that diminished frontal lobe functioning is related to hypnotic suggestibility, such as the cold control theory (e.g. Dienes, 2012), some types of dissociation theory (e.g. integrated dissociative control theory; Woody & Sadler, 2008) and related neurophysiological approaches (Gruzelier, 1998, 2006). The results conceptually replicate those of Dienes and Hutton (2013) who showed that applying rTMS to the left DLPFC increased subjective ratings of hypnotic experience, compared to stimulation of the vertex.

These findings do not, however, rule out the arguments suggesting that sufficient frontal lobe impairment should reduce hypnotisability. For example, the theories of both Spanos (1986) and Hilgard (1977) rely on intact executive functioning. Similarly, cold control does not postulate a state of utter hypofrontality; on this theory executive control is still implemented in order to carry out the cognitive or motor action performed. Thus, if executive function is impaired to the degree that the action could not be performed by executive control, then hypnotic suggestibility would be impaired (Dienes and Perner, 2007; contrast Woody and Bowers, 1994). For moving the hands together, or even imagining a mosquito, it is obvious people have sufficient frontal function after the amount of alcohol we administered to still intend to voluntarily perform these actions and

successfully perform them. What is crucial for hypnotic suggestibility to be facilitated is that diminished frontal lobe functioning reduces concomitant higher order thoughts about intentions, allowing for HOTs of not intending to arise (Barnier, Dienes, and Mitchell, 2008). Indeed, it may be that performance on suggestions that heavily involve executive functions would be impaired following alcohol consumption (e.g. consider the inhibition of pre-potent responses hypnotically suggested in Bertrand and Spanos, 1985). For example, forgetting the number 4, which involves overcoming habit, may become more difficult according to cold control (Dienes and Perner, 2007) but not dissociated control theories (Woody and Bowers, 1994). We found that alcohol increased responsiveness to a negative hallucination suggestion. This suggestion involves the hypnotic subject avoiding the perception of a clearly visible object, a mental task that one would naturally assume to be an inhibitory task. The increase on the alcohol group's ability on this task despite a reduction in executive functioning suggests that responding to this suggestion does not involve above average inhibitory abilities (cf. Kirsch et al, 2011). It may be people attended away from the third ball without being aware of that intention (cold control) – the special ability of highs may not be in their ability to attend away, which may be normal (Dienes, Brown, Hutton, Kirsch et al, 2009) but in their ability to not know that is what they were doing. We predict that once sufficient alcohol is administered to impair inhibition of prepotent responses under standard conditions, the corresponding response performed hypnotically will also be impaired.

Frontal lobe impairment may be just one of a number of ways of creating a hypnotic experience. Highly hypnotisable subjects differ in the way they create hypnotic experiences. For example, Barber's three-dimensional theory of hypnosis theory suggests

that there are three types of hypnotisable subjects: those who are fantasy prone and spend much of their lives having “real-as-real” daydreams; amnesic subjects, who tend to forget life events and hypnotic experiences and subjects who are extremely motivated and have strong expectations about their ability to respond hypnotically (Barber, 1999). McConkey and colleagues (e.g. McConkey et al, 1989) have also identified two types of highly hypnotisables: those who actively construct hypnotic experience and those who are more passive, listening to the suggestions and waiting for the effects to happen to them. Future research could investigate the effect of alcohol on different types of highs.

Although alcohol particularly disrupts the DLPFC and ACC, it also affects a large area of the prefrontal cortex and beyond (Kähkönen et al, 2003) and so we cannot definitively conclude that the increase in hypnotic suggestibility was specifically due to a reduction in metacognition, nor even specifically executive function. In future, specific disruption of DLPFC function could be coupled with a measure of accuracy of higher order thoughts as well as hypnotic responsiveness.

# Internal and External Awareness in Hypnosis and Meditation

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***Abstract***

Cold control theory identifies metacognition as a common strand across different approaches to explaining hypnosis. According to this strand of theorising, hypnotic responding is a strategic lack of awareness of intentions. We use mindfulness meditation as a contrast case, as the goal of such meditation is to increase accurate awareness of mental states. In study 1, we collected data from 136 subjects on self-report measures of mindfulness, cognitive failures, thought suppression, absorption and perceptual encoding style. A factor analysis performed on these measures indicated two factors: internal absorption and external awareness. In study 2, we assessed and compared the hypnotic suggestibility of meditators on a large existing database and found that they were less hypnotisable than the database average, and that this difference was not meditated by age, gender, response expectancies or attitudes towards hypnosis. We tested high and low hypnotically suggestible subjects (highs and lows) and meditators on measures of higher order awareness, including higher order thought (HOT) coupling, ironic control and meta-awareness. Meditators scored higher on HOT coupling but were poorer at ironic control than both highs and lows. Results also point to a possible contribution of meta-awareness, although further research is needed. Subjects were also assessed using the above self-report measures. Meditators and highs reported similar levels of absorption, and highs reported higher levels of absorption than lows. Highs reported greater levels of internally directed absorption than lows. Our findings suggest that variations in higher order awareness and perceptual encoding style may at least partially underlie individual differences in hypnotic suggestibility.

## *Introduction*

An individual's responsiveness to hypnotic suggestion is very stable and reliable, with test-retest reliability over 25 years at about .75 (Piccione, Hilgard and Zimbardo, 1989), yet the underlying mechanisms remain elusive. There are two main features that characterise hypnotic experience: involuntariness and a sense of subjective reality of the hypnotic experience (e.g. Kihlstrom, 2008). For example, a hypnotic subject might believe that they really cannot remember the number 'four', following a suggestion to forget it. They may also believe that their arm is rising by itself following a suggestion that a helium balloon is tied to their wrist, in other words they believe that their action was involuntary. A variety of theories of hypnosis have been put forth to explain such phenomena, and they can be broadly grouped into two categories: dissociation approaches and socio-cognitive approaches. In this paper we will explore how both of these approaches relate to metacognitive abilities, and then how the contrasting role of metacognition in meditation and hypnosis might help us to further understand their underlying mechanisms.

Metacognition refers broadly to cognition about cognition and encompasses cognitive control and monitoring (see e.g. Beran, Brandl, Perner, & Proust, 2012, for a review). Monitoring includes the basic process of being aware of what mental state one is in. Of special relevance to different approaches to hypnosis is the extent to which people can choose to have intentions but not be aware of having them (Dienes & Perner, 2007). The role of specifically this metacognitive strategy in different approaches to hypnosis will now be explored.

Socio-cognitive accounts of hypnosis explain hypnotic responding as arising from everyday social psychological principles such as strategic role enactment (Sarbin and Coe, 1972), expectations (Kirsch, 1991), demand characteristics (Spanos, 1991), motivation (Barber & Calverley, 1962) and imaginative involvement (Lynn & Rhue, 1986; Spanos and Barber, 1974). Such explanations can be understood in terms of metacognition. For example, demand characteristics could prevent one from attributing oneself as a cause of hypnotically suggested motor or cognitive actions, such as a male subject thinking that he is a woman; demand characteristics instead may lead to a failure of metacognition by virtue of the inaccurate thought "I was not intending to think that I was a woman." The thought that "I am a woman" appears to arise not from an intention to pretend, but of its own accord.

However, socio-cognitive theories need not necessarily be explained in terms of inaccurate metacognition about intentions. For example, Kirsch (1991; 1997) argues that situational cues lead to expectancies about hypnosis, such as that one's arm will rise with a feeling of involuntariness, and that these expectations themselves trigger the hypnotic response. Attitudes toward hypnosis are also thought to play a role in hypnotic responding (Hine, 2009; Spanos, 1986) and one's attitude toward hypnosis is likely to affect motivation and expectancies. According to Spanos, Cross, Menary, Brett & de Groh (1987), a positive attitude toward being hypnotised is necessary (but not sufficient) to respond to hypnotic suggestions and negative attitudes inhibit hypnotic suggestibility (Barber, 1969). These accounts do not need to postulate that intentions (to act, think or imagine) are necessary in order to perform (behavioural or cognitive) actions - indeed these accounts do not need to postulate that intentions even exist as natural kinds (as things required for acting; cf Churchland, 1991). Rather at the psychological level, expectations may directly produce

actions and experiences, and thinking that one was not intending to so act involves no inaccuracy (so socio-cognitive approaches do require some folk mental states – like expectation - be natural kinds, just not intentions). On the other hand, some analyses of action require an intention (cf Searle, 1983) so as to distinguish actions from mere movement (and hypnotic responses are never movements as they satisfy specified requirements, they are produced under a certain description). Further, some psychological theories of certain actions (executive function ones) claim such actions require controlling executive representations, i.e. intentions (Norman & Shallice, 1986). Thus, by the latter theories of executive function, an intention is involved any time a suggestion involves something new or non-habitual for the person, especially something going against habit (such as acting in strange ways, imagining novel non-existent objects, ignoring cued memories or noxious stimuli, i.e. actions typical of hypnotic suggestions). In that case, hypnotic responses are associated with intentions, and the socio-cognitive approach amounts to the claim that people strategically engage in a lack of metacognition about their intentions in order to act hypnotically.

Dissociation theories explain hypnotic responding in terms of executive functioning, describing hypnosis as occurring because of a dissociation between executive control and monitoring or awareness. For example, Hilgard's (1977) neo-dissociation theory describes the splitting of the 'executive' ego into two conscious streams, one of which controls hypnotic responses but which is hidden behind an amnesic barrier, so the other stream is unaware of this control, leading to a lack of awareness of the intention and thus the experience of involuntariness. The subject actually believes that they did not perform the action, despite intending to do it: a failure of metacognition. However, not all

dissociation theories need to be explained metacognitively. According to dissociated control theory (Woody and Bowers, 1994), hypnotic responses occur as a result of a weakened supervisory attentional (executive) system. Hypnotic responses are thus controlled by contention scheduling (automatic processes/habit). In this case, responding to the hypnotic suggestion avoids (executive) intention entirely and is just an automatic response that follows from an activated schema. For example, following a suggestion for the arm to become lighter, as though a helium balloon were attached to the wrist, the concomitant monitoring might be something like "I am being told my arm is getting lighter, so the arm is lifting". There is an experience of involuntariness, as the subject did not feel as though they initiated the action themselves. As the response is controlled by habit, the thought of non-intending can be accurate (in that habit need not be intentional), and a strategic failure of metacognition is not involved in the explanation of hypnotic responding. The problem for these non-metacognitive accounts of hypnosis to solve is how hypnotic responding can involve executive function tasks, such as performance of new actions (acting like Elvis) or overcoming salient stimuli (Dienes & Perner, 2007).

Dienes and Perner (2007) isolated the common metacognitive strand in the socio-cognitive and dissociative accounts of hypnosis and proposed to treat it as a sufficient theory of hypnotic responding. To do this, they drew on the higher order thought (HOT) theory of Rosenthal (e.g. 2005). Rosenthal distinguished between first order and higher order mental states. A first order mental state has content that is just about the world; for example, "There is a cat" for an indicative mental state (e.g. perception), or "Lift the arm!" for an imperative one (e.g. an intention). A second order mental state asserts that one is in a first order mental state, making one aware of being in the first order state. First order states

can exist without higher order ones; one can perceive without being aware of perceiving (subliminal perception; first order perception without an accurate second order thought), just so one can intend without being aware of intending (intention without an accurate second order thought). Intention without an accurate higher order thought (HOT) of intending (intentional control without HOTs, hence cold control), means the intentional control is unconscious, the person is not aware of controlling. The cold control theory of hypnosis (Dienes & Perner, 2007; Dienes, 2012) asserts that hypnotic responding is just the process of employing cold control, together with inaccurate higher order thoughts, that is thinking that one did not intend the behavioural or cognitive actions in fact employed to carry out the response. According to cold control theory, the essence of hypnosis is playing a certain metacognitive trick on oneself – strategically, when contextually appropriate – having inaccurate HOTs about intending. Such an approach unites major strands within the great dissociation and socio-cognitive traditions (while remaining in conflict with other theories within those traditions). We will explore the metacognitive approach to hypnosis.

If special types of metacognitive strategies or tendencies are important for hypnotic responding, then individual differences in metacognitive abilities may be related to hypnotic suggestibility. The ability to inhibit thoughts or mental images is a difficult task, as demonstrated by Wegner, Carter, Schneider and White (1987), and presumably there are individual differences in this metacognitive control variable. They found that when participants were asked to not think of white bears for two minutes (the ‘ironic control’ task), they reported experiencing a subsequent ‘rebound effect’ of intrusive thoughts of white bears. One reason for this is that by virtue of creating an intention to not think of white bears, one creates a representation of white bears within the intention. Bowers and

Woody (1996) tested high and low hypnotisable subjects on a similar task after a hypnotic induction, finding that highs were not only able to avoid thinking of their favourite car for two minutes, but that they did not experience the thought rebound effect. Bowers and Woody took this as evidence that highs' hypnotic amnesia for their favourite car was directly triggered by the hypnotic suggestion, obviating intentions to forget and thus avoiding the type of paradoxical thought intrusions seen in Wegner et al's (1987) white bear task. A possible alternative explanation is that highs did have intentions to forget, but tended to have fewer accurate HOTs of intending – i.e. they did have intentions, just not conscious intentions (Dienes & Perner, 2007). Alternatively, highs may be more prone to mind-wandering than lows without explicit awareness of the contents of their mental experience, i.e. they may lack meta-awareness (in the sense described by Schooler, 2002 and Schooler & Smallwood, 2006).

Van Nuys (1973) and Spanos, Rivers & Gottlieb (1978) asked subjects to perform a task converse to the ironic control task, i.e. not to ignore a stimulus but rather to concentrate on it (the 'candle task'). They found that highs experienced fewer intrusive thoughts than lows when asked to concentrate on a candle or on the breath. However, the same explanation is possible for this result as for the Woody and Bowers one with ironic control: highs may mind wander more than lows, but without realising that they are, i.e. they may have low meta-awareness. We test the possibility that highs have fewer HOTs and are more prone to mind-wandering without awareness using the 'HOT task', which is described below, and combines the ironic control and candle tasks.

Meditation may provide a way to examine the role of metacognition and higher order awareness in hypnosis. Meditation has frequently been compared and sometimes confounded with hypnosis (see Semmens-Wheeler & Dienes, 2012, for a review). It takes

many forms among various traditions (Dumont, Martin & Broer, 2012), but it can be broadly described as a complex family of practices that aim to develop skills in attention, emotional regulation, and metacognition. Mindfulness meditation, which comprises aspects of both focused attention and open monitoring meditation, involves practicing non-judgmental awareness of mental states. i.e. mindfulness (Teasdale, 1999; Thompson, 2006; Wallace, 1999; Zeidan et al, 2010). Meditators reporting greater levels of mindfulness than non-meditators and more frequent meditation practice is associated with higher levels of self-reported mindfulness (Farb et al, 2007; Moore and Malinowski, 2009; Semmens-Wheeler and Erskine, 2009), though causal direction in these studies is unclear. The claimed role of meditation and mindfulness practice in increasing metacognitive skills contrasts starkly with accounts of hypnosis that postulate a lack of higher order awareness.

Despite the putative metacognitive differences between meditation and hypnosis, there are some areas of overlap. For example, both meditation and hypnosis have been associated with absorption (e.g. Tellegen and Atkinson, 1974; Laurence and Nadon, 1986; Davidson, Goleman and Schwartz, 1976; Holroyd, 2003), which has been defined as "the ability to maintain a state of attentional involvement on current experience" (Lau, Bishop, Segal, et al, 2006, pp.1448) and is typically measured using the Tellegen Absorption Scale (TAS; Tellegen & Atkinson, 1974).

The overlap in absorption between meditation and hypnosis may not be straightforward, however. Absorption refers to attentional involvement in one's current experience, yet the current experience itself, i.e. the 'object' and nature of absorption could be quite different in meditation and hypnosis. We have previously outlined several possible distinct modes of mental processing that could be represented by absorption (Semmens-

Wheeler and Dienes, 2012). One mode is mind-wandering blended with imaginative involvement, such that one is unaware of the mind-wandering (i.e. lacking metacognition; c.f. Schooler, 2002; Smallwood & Schooler, 2006), which we call 'cold absorption' (without HOTs). In another mode, an individual experiences one-pointed awareness of a thought or object (see Taylor, 2002), which we call 'HOT' absorption (absorption with accurate HOTs/metacognition.) These different states of absorption could be associated differentially with meditation and hypnosis, with meditation being associated with accurate higher-order awareness that is related to mindfulness and hypnosis being associated with a more internally-directed absorption that might involve fantasy and imagination, as suggested by Barber and Wilson (1978; 1982).

In line with the idea that the experience of absorption reported by meditators might reflect a strong tendency to pay attention to one's surroundings, mindfulness has been associated with a lower incidence of everyday cognitive failures, (Herndon, 2008) as measured by the cognitive failures questionnaire (CFQ; Broadbent, Cooper, Fitzgerald and Parkes, 1982), such as forgetting people's names immediately after being told them and taking the wrong turn at a junction. Cognitive failures have been associated with lapses in attention toward external stimuli, as indexed by a greater number of commission errors on the sustained attention to response task (SART), and it is these attentional lapses that are thought to be a causal factor of cognitive failures (Cheyne, Carriere and Smilek, 2006). If meditators are more mindful, then we would expect them to perform fewer cognitive failures than highs. If highs are susceptible to hypnotic suggestion by virtue of a lack of accurate HOTs, then we might expect them to be more prone to cognitive failures.

A tendency to exhibit cognitive failures, as well as being negatively related to mindfulness, has been associated with an internal perceptual encoding style, as measured by the Encoding Style Questionnaire (Lewicki, 2005). Mindfulness, on the other hand, is associated with a relatively external encoding style (Herndon, 2008). External encoders perceive the world by thoroughly relying on external evidence before a schema is activated and a perception is reached (Lewicki, 2005). Conversely, internal encoders rely heavily on expectations and are prone to "split-second illusions" such as seeing a black bag out of the corner of their eye and mistaking it for a black cat. The reliance of internal encoders on schemata, rather than on external sensory information, makes them very susceptible to priming effects (Lewicki, 2005). For example, internal encoders are able to recognise tachistoscopically presented and borderline subliminal images much more quickly and accurately than external encoders, supporting the notion that they rely on schemata in interpreting environmental stimuli.

In a situation that is labelled 'hypnotic', internal encoders might be more susceptible to the effects of situational priming and thus more likely to act in accordance with their schema for hypnosis, such as attributing a sense of agency to the hypnotist or to the hypnotic suggestion, as suggested by socio-cognitive theories (e.g. Sarbin and Coe, 1972; Spanos, 1986) The effects of encoding style could also work on a more specific perceptual level. Internal encoders also appear to be able to ignore information that does not fit their goals. For example, in impression formation studies, internal encoders simply ignored adjectives about people that were inconsistent with their expectations (Gill, 2000). This may work similarly in a hypnotic suggestion to see only two of three balls presented in plain view (a suggestion on the Waterloo Stanford Scale of Hypnotic Susceptibility;

Bowers, 1993); the expectation to see only two, rather than three balls, may override the external evidence to the contrary. So as well as expecting highly hypnotisable people to have fewer accurate HOTs about the world, we might also expect them to have a more internal encoding style than lows. On the contrary, mindfulness (as measured by the MAAS, Brown and Ryan, 2003) has been positively related to a more external perceptual encoding style (Herndon, 2008). Internal/external encoding is a type of metacognitive style (a persistent decision whether to weight prior beliefs or new perceptual evidence more strongly in making perceptual judgments), but whether it is related to a tendency to have accurate HOTs about perceptual states is an issue we will explore.

It is not easy to measure metacognition, that is, to separate first from second order thoughts. However, we have devised a task to measure second order thoughts, while keeping first order mental states about an externally presented stimulus (a sequence of images) as constant as possible. We combined Wegner et al's (1987) ironic control task, with Van Nuy's (1973) candle task, and Schooler's (2002) measure of meta-awareness in one task (cf pilot results in Dienes, 2012). We tested highs, lows and meditators on their ability to avoid HOTs when requested (ironic control), to maintain HOTs when requested (meditation) and their tendency to have HOTs, regardless of the task (HOT coupling). Dienes (2012) found reduced HOT coupling in highs rather than lows. The main aim of this study was to explore differences in higher order awareness metacognition among highs, lows and meditators. Cold control theory motivates the hypothesis that highs have fewer accurate higher order thoughts than lows. Similarly meditators should have a greater number of accurate higher order thoughts than the other two groups, if meditation enhances metacognition. We would also thus predict that, if meditators have greater higher order

awareness, that they should not be very hypnotically susceptible. We also aimed to explore differences among meditators and high and low hypnotisable individuals on perceptual encoding style, mindfulness, absorption and cognitive failures, as well as the relationships between these constructs.

## 2. Study 1 Method

### *2.1 Participants*

136 participants (51 male) were recruited from Sussex University and a convenience sample obtained via the first author's Facebook page; snowball sampling was used from here, as connected Facebook users were asked to pass along the survey to their friends. The mean age of the participants was 31.9 years (range: 18-72).

### 2.2 *Materials*

#### *2.2.2 Mindfulness: Mindful Attention Awareness Scale*

Brown and Ryan's (2003) Mindful Attention Awareness Scale (MAAS) was used to assess mindfulness or attention to current experience of the world. The questionnaire contains 15 questions that assess awareness of one's interactions with the outer environment. It contains items such as "I find myself doing things without paying attention" and "I snack without being aware that I'm eating". Reponses are made using a 6-point Likert scale (1 = Almost Always, 6 = Almost Never). Higher scores mean greater assessed mindfulness.

*2.2.3 Mindfulness:* Kentucky Inventory of Mindfulness Skills

The Kentucky Inventory of Mindfulness Skills (KIMS, Baer, Smith, & Allen, 2004) is a 38-item questionnaire that was used to assess observing, describing, acting with awareness and accepting without judgment. Participants rated each item on a 5-point Likert-type scale ranging from 1 (Never or very rarely true) to 5 (Almost always or always true). Some items are direct descriptions of the mindfulness component being measured, such as "When I'm walking, I deliberately notice the sensations of my body moving", whereas others described the absence of that component and were reverse scored, such as "I drive on automatic pilot" without paying attention to what I'm doing." The scale taps into four subcomponents: 'accepting (or allowing) without judgment'; 'acting with awareness'; 'observing' and 'describing'. The KIMS contains items that relate to awareness of the outer environment, such as "I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing." However, it contains more items that are related to internal states than the MAAS, such as "I criticize myself for having irrational or inappropriate emotions" and "When I do things, my mind wanders off and I'm easily distracted". Higher scores indicate higher assessed mindfulness.

*2.2.4 Thought Suppression (WBSI)*

The White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994) is a 15 item questionnaire that was used to measure participants' propensity to use thought suppression in everyday life, and contains statements like "I always try to put problems out of mind" and "I have thoughts I cannot stop." Ratings are made on a five-point Likert-type scale (ranging from "strongly disagree to "strongly agree"). Higher scores mean greater assessed thought suppression tendencies.

*2.2.5 Cognitive Failures (CFQ)*

The CFQ (Broadbent, Cooper, Fitzgerald & Parkes, 1982) has 25 items describing a variety of deficits due to less than optimal cognitive functioning. For example, "Do you find you forget people's names?" and "Do you find you forget which way to turn on a road you know well but rarely use?" Items were tested on a five-point Likert-scale (ranging from "Always" to "Never"). Higher scores mean greater tendency to exhibit cognitive failures.

*2.2.6 Absorption*

The Tellegen Absorption Scale (Tellegen and Atkinson, 1974) is a 34 item questionnaire used to measure absorption, or openness to absorbing and self-altering experiences with items such as "While watching a movie, a TV show, or a play, I may become so involved that I may forget about myself and my surroundings and experience the story as if it were real and as if I were taking part in it". Usually the scale requires a dichotomous true/false response option, but we adapted it to a five point- Likert-scale (ranging from "Certainly always false" to "Certainly always true"). We also modified some answers so that they would be reverse scored, such as "The crackle and flames of a wood fire do not stimulate my imagination" to control acquiescence bias. Higher scores indicate greater levels of assessed absorption.

*2.2.6 Perceptual Encoding Style*

The (Internal/External) Encoding Style Questionnaire (ESQ, Lewicki, 2005) was used to measure thoroughness of perceptual processing (external encoding). The scale consists of 6 critical items, such as "When I'm on a walk, I sometimes see a rock or piece of wood and for a split second mistake it for something else (or have a similar experience in other conditions)" and 21 filler items. Ratings are made on a six-point Likert-type scale (ranging from "Strongly disagree to "Strongly agree"), with higher scores indicating a more internal encoding style.

### *2.2.8 Social Desirability*

The Marlowe Crowne Social Desirability scale (Crowne and Marlowe, 1960) was used to control social desirability in correlations among other questionnaire measures and performance on the HOT task, which relied on self-reports about mental states. The scale consists of 33 questions requiring a yes/no response and contains items such as

"There have been occasions when I took advantage of someone" (a reverse worded item) or "I always try to practice what I preach". If a person says they have never taken advantage of someone or never lied, the presumption is that they are lying in order to preserve a desirable social image. Higher scores mean greater assessed desire for social desirability.

## *2.3. Procedure*

The Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith & Allen, 2004), Tellegen Absorption Scale (Tellegen & Atkinson, 1974), Marlowe-Crowne Social Desirability Scale (MCSD; Crowne and Marlowe, 1960), Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, Fitzgerald & Parkes, 1982), White Bear Suppression Inventory

(WBSI; Wegner & Zanakos, 1994), Mindful Awareness Attention Scale, MAAS (Brown and Ryan, 2003), and Internal/External Encoding Style questionnaire (Lewicki, 2005) were administered to participants in the listed order via an online survey website (www.surveybris.ac.uk).

### *2.4 Study 1 Results*

#### *2.4.1. Relationships among self-report measures*

In order to examine the relationships between the various self-report measures, bivariate correlations were performed among the WBSI, ESQ, TAS, KIMS, MAAS and CFQ (see table 1). The same correlations were performed again, this time controlling for social desirability, as measured by the MCSD scale (see table 2).

Table1. Correlations among self-report measures

| | *KIMS* | *TAS* | *MAAS* | *CFQ* | *WBSI* | *ESQ* |
|---|---|---|---|---|---|---|
| *KIMS* | - | | | | | |
| *TAS* | *.35** | - | | | | |
| *MAAS* | *.56*** | *.04* | - | | | |
| *CFQ* | *-.56*** | *-.10* | *-.59*** | - | | |
| *WBSI* | *-.10* | *.05* | *-.35*** | *.46*** | - | |
| *ESQ* | *-.11* | *.27*** | *-.40*** | *.42*** | *.17*** | - |
| *MCSD* | *-.22*** | *-.08** | *.17** | *.25*** | *-.08* | *.02* |

*$p$<.05; **$p$<.01

*Note:* KIMS = Kentucky Inventory of Mindfulness Skills; TAS = Tellegen Absorption Scale; MAAS = Mindful Awareness Attention Scale; ESQ = Encoding Style Questionnaire; WBSI =White Bear Suppression Inventory; CFQ = Cognitive Failures Questionnaire.

Table 2. Correlations among self-report measure controlling for social desirability (MCSD)

| | *KIMS* | *TAS* | *MAAS* | *CFQ* | *WBSI* |
|---|---|---|---|---|---|
| *KIMS* | - | | | | |
| *TAS* | *.32*** | - | | | |
| *MAAS* | *.34*** | *-.003* | - | | |
| *CFQ* | *-.52*** | *-.04* | *-.55*** | - | |
| *WBSI* | *-.50*** | *.07* | *-.49*** | *.48*** | - |
| *ESQ* | *-.07* | *.31*** | *-.35*** | *.43*** | *.23*** |

*$p$<.05; **$p$<.01

### 2.4.2 *Factor Analysis*

A principal components analysis was performed in order to investigate the dimensionality of the WBSI, ESQ, TAS, KIMS, MAAS and CFQ. The KMO value was .73, suggesting an overall substantial degree of item inter-correlation, and the lowest MSA value was of .36 for the TAS, with all other values at .65 or above, suggesting that all values showed substantial correlations and were thus suitable for factor analysis (Dziuban & Shirkey, 1974). An orthogonal solution was determined using a varimax rotation. This analysis

yielded two factors with Eigenvalues greater than 1.0, which cumulatively accounted for 70% of the variance. The first factor accounted for 47%. The leading item on this factor was MAAS, which measures the extent to which one is mindful of their environment. WBSI, measuring thought suppression, ESQ, measuring internal encoding style, and CFQ, measuring cognitive failures loaded negatively onto the factor, all with loadings greater than .60, except for internal encoding, which had a loading of .46 (see table 2). This factor appears to relate to awareness of, or paying attention to, how one is engaging with the environment in the present moment. The TAS did not load strongly onto this factor. Thus this component appears to relate to the degree to which individuals are paying attention in the moment, or are 'mindful' and was labelled 'external awareness'.

Table 3. Component Matrix

| Scale | External Awareness | Internal Absorption |
|---|---|---|
| ESQ | -.46 | .69 |
| CFQ | -.83 | .13 |
| KIMS | .82 | .30 |
| MAAS | .82 | -.11 |
| WBSI | -.74 | .09 |
| TAS | -.18 | .88 |

Extraction Method: Principal component analysis with varimax rotation

The second factor accounted for 23% of the variance. The leading item on this factor was the Tellegen Absorption scale, with a loading of .86 (see table 3). The ESQ, measuring internal encoding, also loaded strongly onto this factor and the KIMS, as well as loading strongly onto the first factor, showed a small-to-moderate loading onto this factor. This may reflect some of the items in the scale that refer to awareness of internal emotional and bodily states. The second factor, therefore, appears to relate to internally focused absorption.

In conclusion, there appears to be a bipolar unimensional factor of **'**external awareness'**,** consisting of the KIMS, MAAS at one end of the dimension, represented by higher scores on the factor, and ESQ and CFQ at the other end, represented by lower scores, and a second unidimensional factor of 'internal absorption', consisting of the TAS and ESQ. These factors will be used in the next Study to look at individual differences in hypnotic suggestibility and meditation experience.

## *3. Study 2 Method*

### *3.1 Participants*

Thirteen meditators (mean age = 36.4 years, SD = 12.9; 13 males) were recruited from the Brighton Buddhist Centre in Brighton, UK and the Triratna Dharma Training course at Madhyamaloka Buddhist Community in Birmingham, UK. Meditators had a mean of 16.9 years of meditation practice experience (SD = 3.96). They were all practicing Buddhists in the Triratna Buddhist Community and their primary meditation practices were mindfulness of breathing (focused awareness of sensations of the breath), 'just sitting' (open

monitoring) and mettā bhavana (loving kindness). Fourteen highly hypnotisable participants (6 males and 8 females ;mean age = 22.2 years, SD = 4.8) and fourteen low hypnotisable participants (mean age = 22.6 years, SD = 7.7; 6 males and 8 females) were selected from the University of Sussex hypnosis screening database. Highly hypnotizable participants scored between 9 and 12 (out of 12) and low hypnotisable participants scored 0-3 (out of 12) on the Waterloo-Stanford Group Scale of Hypnotic Suscestibility, Form C (WSGC; Bowers, 1998). Ethical approval was received from the University of Sussex ethical committee. Informed consent was obtained from each participant before commencing with the study. High and low hypnotisable participants were remunerated with course credits or £5 per hour for their participation. Meditators were paid £20 for their overall participation in the study.

Following the main experiment, highs, lows and mediums from the Sussex University hypnosis screening pool and meditators were contacted and asked to complete measures of hypnotic response expectancy and attitudes to hypnosis. Not all participants who took part in the other tasks were available to complete these measures. Thirty-five participants (16 males, 19 females; mean age 32.57, SD = 12.05) completed the expectancy scale, ten of whom had also completed the other tasks. Twenty-five participants (13 males, 12 females; mean age 32.14, SD = 12.13) completed the expectancy scale, eighteen of whom had also completed the other tasks.

## *3.2 Materials*

### *3.2.1 Higher Order Thought (HOT) task*

In order to measure HOTs, subjects were asked to keep looking directly at a sequence of images presented using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA) while trying to either a) remain at all times aware of seeing the image (meditation task; cf. candle task of Van Nuys, 1973) or b) not consciously see the image for 15 minutes (ignore task; cf. Wegner et al's, 1987, 'white bear' ironic control task, where people are asked to not think of a white bear). Participants completed both the 'ignore' and 'meditation' tasks in a randomised counterbalanced order. Subjects were probed by a tone at random intervals (roughly once a minute), which prompted them to indicate whether they were, just that instant before hearing the tone, aware of seeing the image by pressing a button (cf Schooler's, 2002, meta-awareness procedure). They pressed one of three buttons to indicate if they were aware of seeing the image, zoning out (mind wandering) and aware of zoning out, or zoning out and unaware that they were doing so.

The difference between a) and b) in reports of seeing the image was taken as measuring a participant's control in having accurate HOTs (HOT control), and the total number of reports of seeing the image in both a) and b) as measuring coupling of HOTs to first order states, i.e. the tendency to have an appropriate HOT given that a first order state exists (HOT coupling). Finally, we measured meta-awareness as the proportion of total zone-outs for which participants had been aware that they were zoning out (Schooler, 2002).

### 3.2.2 *Questionnaires*

The same questionnaire measures of mindfulness (KIMS and MAAS), cognitive failures (CFQ), absorption (TAS), encoding style, social desirability (MCSD) and thought suppression (WBSI) were completed as in study 1 via the same website.

In addition, participants completed the Attitudes Toward Hypnosis scale (Spanos,Brett, Menary, & Cross,1987) and a response expectancy questionnaire. The Attitudes Toward Hypnosis scale consists of fourteen items assessing positive beliefs about hypnosis, willingness to be hypnotised, fears about hypnosis and negative beliefs about hypnotisable people. Higher scores reflect more positive attitudes toward hypnosis. Items are rated on a 5-point Likert scale, ranging from 'Not at all true' to 'Entirely true'.

The response expectancy questionnaire contained twelve questions requiring yes/no answers about whether or not participants expected to respond to each item on the Waterloo-Stanford Group Scale of Hypnotic Susceptibility. For example, "If you were given a hypnotic suggestion that your arm will feel stiff and rigid, so stiff that you cannot bend it, do you expect to feel your arm becoming more stiff than normal?" Each of these items was followed by a confidence rating about their expectancy with response options as follows:

1. I am completely guessing, I have no idea whether I would or wouldn't.
2. I am more or less guessing, but I have some feeling I was right.
3. I am pretty sure I am right.
4. I am completely certain.

### *3.3 Procedure*

Participants completed the questionnaires measuring mindfulness, thought suppression, cognitive failures, internal/external encoding style, absorption and social desirability via an online survey either before or after completing the HOT task, i.e. the questionnaires and HOT task were run in counterbalanced order.

## *3.4 Study 2 Results*

### *3.4.1 How hypnotisable are meditators?*

Meditators were screened for hypnotic suggestibility using the same scale as the highs and lows selected from the Sussex University hypnotic suggestibility screening database (WGSC; Bowers, 1993). Meditators ($M$ = 1.92, $SD$ = 1.98) were significantly less hypnotisable than highs $M$ = 9.93, $SD$ = 1.07), $t(25) = 13.21$ $p<.001$. There was no significant difference in hypnotic suggestibility between meditators and lows ($M$ = 1.23, $SD$ = 1.01), $t(24) = 1.12$ $p$=2.74. We also compared meditators' hypnotic suggestibility with the Sussex University hypnotic suggestibility screening database (consisting of largely University undergraduates who have signed up for credit or payment over several years) and found that meditators were significantly less hypnotisable than the database average, ($M$ = 4.9, $SD$= 2.51), $t(710) = 3.92$, $p<.001$, $r$=.15. Our database average is comparable with other norms for the scale (e.g. Carvalho, Kirsch, Mazzoni & Leal, 2008). Meditators were on average older ($M$ = 36.4 years, $SD$ = 12.9) than subjects in the database ($M$ = 21.6 years, $SD$ = 5.9), so we compared the hypnotic suggestibility of meditators and subjects from the database with age as a covariate. . Age was not significantly correlated with hypnotic suggestibility, $r$=-.13, $p$=.44. The difference in hypnotic suggestibility remained,

with meditators less hypnotisable (*adj. M* 4.9 =, *SEM* = .10) than the database average (*adj. M* 2.6 =, *SEM* = .72), $F(2, 699) = 10.2$, $p=.001$. The sample of meditators consisted entirely of males ($N=13$) and the database consisted of 165 males and 542 females. A t-test indicated that males ($M = 4.8$, $SD = 2.9$) and females ($M = 4.9$, $SD = 2.4$ had similar levels of hypnotic suggestibility, $t(705) = 0.16$, $p = .88$, CI LL: -.48, LL: .41. The difference in hypnotic suggestibility between meditators and non-meditators remained when gender was added as a factor, $F(1,704) = 16.19$, $p<.001$.

### *3.4.2 Do meditators have negative attitudes or expectancies toward hypnosis?*

In order to ascertain whether attitudes toward hypnosis were responsible for meditators' low hypnotic suggestibility, nine highs, nine lows, nine mediums and eight meditators completed the Attitudes Toward Hypnosis scale (ATH; Spanos, Brett, Menary, & Cross, 1987). There was no significant difference between the hypnotic suggestibility of this group of highs, mediums and lows ($M = 5.6$, $SD =3.8$) who were selected to complete the attitudes toward hypnosis questionnaire and the unselected sample from the hypnotic suggestibility database, ($M = 4.9$, $SD= 2.51$), $t(717) = 1.34$, $p = .18$, CI LL: -1.72, LL: 0.33. Thus, the groups were considered to be equivalent in hypnotic suggestibility and the selected group was used to represent the population of the subject pool in a comparison of attitudes with meditators.

A significant correlation was found between attitudes toward hypnosis and hypnotic suggestibility for meditators, highs, mediums and lows. Pearson's $r = .43$, $p=.03$, suggesting that positive attitudes contribute to hypnotic suggestibility.

Then, we compared meditators with the group of 27 highs, mediums and lows on hypnotic suggestibility, with attitudes as a covariate. Meditators (adjusted $M = 1.61$, $SD =$

3.53) were still significantly less hypnotisable than non-meditators (adjusted $M$ = 5.78, $SD$ = 4.19) while controlling for attitudes, $F(3, 31) = 4.45$, $p$=.01, indicating that attitudes toward hypnosis cannot account for differences in hypnotic suggestibility between meditators and non-meditators (assuming the scale sensitively measures attitudes, of course).

In order to find out whether any expectancy differences accounted for the low hypnotic suggestibility of meditators, we compared the response expectancies of eight meditators with a group of non-meditators, consisting of 10 highs, eight mediums and eight lows. A large and significant correlation was found between response expectancy and hypnotic suggestibility for meditators, highs, mediums and lows, Pearson's $r$ = .75, $p$<.001, indicating that response expectancies contribute to hypnotic suggestibility.

Meditators' response expectancies ($M$=.64, $SD$=2.56) were not significantly different from non-meditators' ($M$=.56, $SD$=1.95), $t(33) = 1.30$, $p$=.20, CI LL: -2.73, UL: .60. Crucially, the difference in hypnotic suggestibility between meditators (adjusted $M$ = 2.9, $SEM$ =.85) and non-meditators (adjusted $M$ = 5.7, $SEM$ = .45) remained significant when controlling for response expectancy, $F(1, 33) = 8.45$, $p$=.006.

### *3.4.3 Who is HOT and who is not?*

Table 4. Mean scores on the HOT task (Standard deviation)

| | Lows | Highs | Meditators | |
|---|---|---|---|---|
| HOT control | 4.69 (1.08) | 5.14 (0.64) | 3.54 (1.38) | $F(2, 37) = .61$, $p = .55$, $\eta^2 = .03$ |
| HOT coupling | 10.85 (0.96) | 10.14 (1.06) | 15.23 (1.26) | $F(2, 37) = 6.29$, $p = .004$, $\eta^2 = .26$ |
| Ironic control | 10.92 (0.50) | 11.43 (0.56) | 8.08 (1.02) | $F(2, 37) = 6.17$, $p = .005$, $\eta^2 = .25$ |
| Meditation | 7.71 (0.81) | 7.64 (0.73) | 9.38 (0.89) | $F(2, 37) = 1.45$, $p = .25$, $\eta^2 = .07$ |
| Meta-awareness | 0.72 (.20) | 0.71 (.26) | 0.56 (.23) | $F(2, 37) = 2.14$, $p = .13$, $\eta^2 = .11$ |

Bonferroni adjusted post-hoc tests revealed that meditators reported significantly more HOTs during the task overall (as measured by HOT coupling) than highs and lows, $p$=.006 and $p$=.025, respectively. An ANCOVA was performed between meditators (adjusted M = 2.6, *SEM* =.79) and non-meditators (adjusted M = 5.6, *SEM* = 1.2) with hypnotic suggestibility as a dependent variable and HOT coupling as a covariate to see if the differences in HOT coupling could explain the difference in hypnotic suggestibility. (Attitudes and expectancies were not included in these analyses, as it was not expected that they would influence these measures.) The difference in hypnotic suggestibility was

marginally significant, $F(1, 37) = 3.8$, $p=.059$.[10] When ironic control was added as a covariate, the differences between meditators and non-meditators in hypnotic suggestibility was marginally significant, $F(1, 37) = 1.5$, $p=.078$. When the meditation component was added as a covariate, the differences between meditators and non-meditators in hypnotic suggestibility remained significant, $F(1, 37) = 6.7$, $p=.014$.

Meditators were, however, poorer at ironic control than highs and lows, $p=.007$ and $p=.028$, respectively. Highs and lows scored similarly on HOT coupling, $p=.63$, CI LL: -2.25, UL: 3.65 (a point we discuss later, given the results of Dienes, 2012), HOT control, $p=.72$, CI LL: -3.01, UL: 2.10, Ironic control, $p=.51$, CI LL: -2.06, UL: 1.05 and meditation $p=.91$, CI LL: -2.20, UL: 2.46. Highs scored similarly to lows and meditators on meta-awareness, ($p=.23$, CI LL: -0.06, UL: 0.37 and $p=.29$, CI LL: -0.21, UL: 0.23, respectively.)[11] Lows and mediators also scored similarly, $p=1.0$, CI LL: -0.23, UL: 0.21. The Pearson's correlation between hypnotic suggestibility and meta-awareness in highs and lows (not including meditators) was -.36, $p=.06$.[12]

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[1] A Bayes Factor can compare the theory (that HOT coupling mediated the difference in hypnotisability between meditators and non-meditators) to the null hypothesis. A Bayes Factor greater than 3 indicates strong evidence for the theory over the null; of less than a 1/3, strong evidence for the null over the theory; and anything in between indicates the data are insensitive and do not strongly support either the null or the theory over the other. A Bayes factor requires specification of what effect sizes the theory predicts. If HOT coupling mediated the difference in hypnotisability between meditators and non-meditators, the adjusted mean difference should be zero (null hypothesis); if the mediation was not complete, the adjusted mean difference should be between 0 and the unadjusted mean difference which was 5.78. Thus the alternative theory of incomplete mediation can be represented as a uniform between 0 and 5.78. The Bayes Factor was BF = 2.99, indicating reasonably strong evidence for the alternative theory over the null, i.e. despite the non-significant result difference between groups when HOT coupling is put in a covariate, the evidence more strongly indicates that HOT coupling does not completely mediate the difference.

[11] We calculated the Bayes factor for the non-significant difference in meta-awareness between highs and meditators representing the theory that there is a difference using a uniform distribution between 0 and 5, based on the difference between highs and meditators in ironic control. . The Bayes factor was 0.15, indicating reasonably strong evidence for the null over the alternative theory.

[12] A Bayesian analysis was performed on the marginally significant correlation between meta-awareness and hypnotic suggestibility. Since the theory predicts a negative correlation between meta-awareness and hypnotic suggestibility, we represented it using a half-normal distribution with an SD of 0.3, since correlates of

### *3.4 How did hypnotic suggestibility and personality measures relate to the HOT task?*

Pearson product-moment correlations were calculated for measures of the HOT task and personality measures for the combined sample of meditators and non-meditators. Table 5 shows standardised correlation coefficients (Fisher's *Z*) and confidence intervals, calculated from Fisher's *Z*, which was obtained for each correlation using the following formula: 0.5*(natural log ((1+r)/(1-r)) and the standard error of *Z* ($1/\sqrt{(n-3)}$). The limits are converted back from Fisher's *Z* to units of correlation.

Ironic control was positively correlated with hypnotic suggestibility, whereas HOT coupling correlated negatively. Ironic control was positively correlated with internal encoding $r=.34$, $p=.03$, as was HOT control, $r=.50$, $p=.001$.Meta-awareness was negatively correlated with ironic control, $r=.48$, $p=.002$ and positively with HOT coupling, $r=.37$, $p=.019$. There were no other significant correlations among the personality measures and performance on the HOT task. But note the confidence intervals allow considerable population correlations as consistent with the data.

*Table 5. Correlations among HOT task measures and personality variables*

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hypnotic suggestibility rarely reach a correlation of greater than 0.3 in repeated replications. The Bayes Factor was 3.18, indicating reasonably strong evidence for the alternative theory over the null, i.e. that greater hypnotic suggestibility is associated with less meta-awareness. We also performed a Bayesian analysis on the non-significant correlation between hypnotic suggestibility and HOT coupling, again using a half-normal distribution and an SD of 0.3. The Bayes factor was 0.99, indicating that the data were insensitive.

| | Meditation | Ironic Control | HOT Coupling | HOT Control |
|---|---|---|---|---|
| WGSC | .14 [.07, .32] | .36* [.06, .7] | -.32* [.01., 65] | .18 [-.14.50] |
| KIMS | .24 [-.08, .56] | .01- [.03, .33] | .16 [-.16,.48] | .20 [-.12, .52] |
| MAAS | .11 [-.21, .43] | -.02 [-.34, .03] | .10 [-.22, .42] | .06 [-.26, .38] |
| WBSI | .18 [-.14, .50] | -.10, [-.42, .22] | -.06 [-.38, .26] | -.21 [-.53, .11] |
| CFQ | .04, -.28, .36] | -.11, [-.21, .43] | .03 [-.29, .35] | -.10 [-.22, .42] |
| TAS | .05 [-.27, .37] | -.01, [-.33 ,.03] | .03 [-.29, .35] | .04 [-.28,.36] |
| ESQ | .29 [-.03, .61] | .34* [.02 ,.66] | .03 [-.29, .35] | .50* [.23,.87] |

Values in parentheses = confidence intervals; *$p$<.05

### *3.5 How did highs, lows and meditators differ on personality measures?*

A one-way ANOVA was conducted to examine differences between highs, lows and meditators on the 'external awareness' and 'internal absorption' factors identified in study 1. Highs scored significantly higher on internal absorption than lows, p=.04 but were similar to meditators, $p$ = .19. Meditators scored higher on the external awareness factor, but this difference was only marginally significant, $p$=.07[13].

Pearson product-moment correlations were calculated for hypnotic suggestibility, internal absorption and external awareness. Hypnotic suggestibility positively correlated with 'internal absorption', $r$ = .45, $p$ = .02

[13] A Bayes factor was calculated for the non-significant difference in external awareness between highs and meditators. The theory that, there is a difference was represented using a uniform distribution between 0 and 3, which seems reasonable based on the difference between highs and lows on internal absorption. The Bayes factor was 1.18, indicating that the data were insensitive.

Table 6. Mean scores on internal absorption and external awareness (Standard deviation)

| | Lows | Highs | Meditators | |
|---|---|---|---|---|
| External Awareness | -.12 (2.78) | -1.43 (1.45) | 1.78 (4.19) | $F(2,36) = 2.81$, $p = .07$, $\eta^2 = .16$ |
| Internal Absorption | -.64 (1.53) | .82 (1.38) | -.24 (1.42) | $F(2,37) = 2.81$, $p = .04$, $\eta^2 = .13$ |

A one-way ANOVA revealed significant differences between highs, lows and meditators in the individual measures that comprised the internal absorption and external awareness factors: internal encoding, absorption, cognitive failures, thought suppression and both measures of mindfulness (see table 7). Meditators scored significantly lower than highs on the ESQ, $p = .029$ and higher on both measures of mindfulness: MAAS $p = .04$; KIMS $p = .04$. Meditators also scored significantly higher on the TAS than lows, $p = .01$, as did highs, $p = .002$. Interestingly, highs and meditators were similar in their levels of absorption. Lows scored lowest on thought suppression and highs scored highest, however this difference was non-significant. Meditators scored lowest on the cognitive failures questionnaire, followed by lows and then highs, but this difference was not significant.

Table 7. Mean scores on components of external awareness factor (standard deviation)

| | Lows | Highs | Meditators |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| MAAS | 3.55 (.38) | 3.13 (.15) | 3.43 (.43) | $F(2,37) = 4.80$, $p=.014$, $\eta^2 = .22$ |
| CFQ | 2.01 (.49) | 2.17 (.31) | 1.88 (.32) | $F(2,37) = 1.77$, $p=.19$, $\eta^2 = .09$ |
| WBSI | 2.20 (.56) | 2.63 (.20) | 2.39 (.15) | $F(2,37) = 2.05$, $p=.137$, $\eta^2 = .08$ |
| ESQ | 2.60 (.85) | 3.45 (.65) | 2.83 (.78) | $F(2,37) = 5.08$, $p=.011$, $\eta^2 = .22$ |
| KIMS | 3.17 (.27) | 3.10 (38) | 3.40 (.38) | $F(2,37) = 2.48$, $p=.097$, $\eta^2 = .12$ |
| TAS | 3.11 (.49) | 3.58 (.39) | 3.48 (.38) | $F(2,37) = 4.34$, $p=.02$, $\eta^2 = .19$ |

Note: MAAS = Mindful Awareness Attention Scale; ESQ = Encoding Style Questionnaire; WBSI =White Bear Suppression Inventory; CFQ = Cognitive Failures Questionnaire, KIMS = Kentucky Inventory of Mindfulness Skills

### *4. Discussion*

The aims of this study were to explore the role of higher order awareness and individual personality differences in hypnosis and meditation. As predicted, meditators were relatively low in hypnotic suggestibility, scoring lower than the average of our database and placing them, on average, in the 'low hypnotisable' category. This finding provides support for the notion that meditation is different from hypnosis and establishes meditators as a suitable candidate population with which to explore differences in higher order awareness and personality traits in order to elucidate the mechanisms involved in hypnotic responding.

Before considering differences in higher order awareness, we need to take into account the possibility that the low hypnotic suggestibility of meditators could be explained by negative attitudes toward hypnosis, which might have inhibited their hypnotic

suggestibility. In line with previous research (Benham et al, 2006; Spanos et al, 1987; Spanos & McPeake, 1975), positive attitudes toward hypnosis were associated with greater hypnotic suggestibility. However, meditators' attitudes were similar to those of non-meditators, and differences between meditators and non-meditators in hypnotic suggestibility remained after controlling for attitudes.

Since attitudes could not explain the differences in hypnotic suggestibility, we are left with several other possibilities. One alternative is that the differences could be accounted for by response expectancy, which has been consistently associated with hypnotic suggestibility (Braffman and Kirsch, 1999; Council, Kirsch and Grant, 1996; Gearan and Kirsch, 1993). Response expectancy was strongly correlated with hypnotic suggestibility ($r$ = .75). This was a large effect, compared to that found by e.g. Benham et al (2006), who found coefficients of hypnotic suggestibility and response expectancy of around .12. Benham et al argue that response expectancy is predicted by response to previous suggestions, with successful hypnotic responses increasing expectations for future success. Participants in our study had previously experienced the suggestions when giving expectancy ratings. We asked participants very specific questions about how much they expected to respond to each suggestion and how confident they felt about this, making this a sensitive measure of response expectancy. By contrast, the measure of response expectancy used by Benham et al was very general, referring to a range of suggestions overall: "If at some future time we were to give you 20 suggestions, at that time (knowing what you know now) how many of those 20 suggestions do you think you would respond to?" (p. 345) Therefore, their measure of expectancy is likely to have been much less sensitive. Due to their correlational nature, these results cannot establish a causal direction of the relationship between expectation and hypnotic suggestibility. Nonetheless,

meditators still had similar hypnotic response expectancies to non-meditators and when controlling for response expectancy the difference in hypnotic suggestibility remained between meditators and non-meditators.

Having ruled out expectancy and attitudes toward hypnosis as explanatory factors of the differences found between highs and meditators in hypnotic suggestibility, at least for now, differences in higher-order awareness remains a possible cause. In support of this possibility, meditators showed greater HOT coupling than lows and mediums in the higher order thoughts (HOT) task. HOT coupling was a measure of the number of HOTs across both the 'attend' condition, in which the objective was to have HOTs about the presented images, and the 'ignore' condition, in which the objective was to avoid HOTs about them. Meditators were also poorer than lows and highs at ironic control task; they were unable to avoid HOTs of the images presented in front of them, suggesting that the prevalence of HOTs was greater than their ability to control when they have HOTs. When ironic control and meditation were added as covariates (separately from attitudes), the difference in hypnotic suggestibility between meditators and non-meditators remained. Together these findings suggest that meditators' lower hypnotic suggestibility may be associated with greater higher order awareness overall, but either that is not the whole explanation for their lower hypnotic suggestibility, or else we need more sensitive measures of HOT control and coupling. Future studies could simply use a longer duration for the meditation and ignore tasks, ideally e.g. 45 minutes instead of 15 minutes each. While Van Nuys (1973) obtained significant correlations of the meditation task with hypnotic suggestibility with 15 minutes, Spanos et al (1978) did not and used two blocks of 15 minutes. To measure meta-awareness, Schooler (2002) also typically uses 45 minutes. We adopted a smaller length to

make the whole set of tasks manageable for subjects, but more sessions with subjects may be needed.

It was surprising to find that lows and highs performed similarly on the HOT tasks, as we might expect that a lack of hypnotic suggestibility in lows would also be due to lower HOT coupling. However, Bayesian analyses indicated that the data were not sensitive enough to support the null hypothesis that there was no difference between highs and lows on HOT coupling, and indicated strong evidence that there is a difference between highs and lows in meta-awareness, and so we are planning to recruit more highs and lows from Sussex University and the local community and more meditators from retreat centres in Australia and New Zealand.

The "HOT coupling" measure assumes that first order states are equivalent in different groups of subjects attending to the images; that is, that when subjects continue to look at the screen, first order representations are created to an equivalent degree in different groups and the remaining difference is in awareness of those states (Dienes, 2012). The motivation for this assumption for highs versus lows is the persistent failure to find attentional differences that replicate between highs and lows (e.g. Dienes et al 2009; Jamieson and Sheehan, 2002). The case for meditators versus non-meditators is less clear though, as attentional differences are often found (e.g. Moore and Malinowski, 2009; Slagter et al, 2007; Wenk-Sormaz, 2005). Thus, the difference in "HOT coupling" may partially reflect difference in ability to attend or disattend to the presented images, leading to differences in first order strength of representations between meditators and non-meditators. This issue remains problematic but one piece of evidence favouring a higher order explanation of individual differences on this task is the fact that meditators were worse at ironic control

than other groups – this is the opposite to what would be expected if they good at attentional regulation in controlling the strength of first order representations, but exactly what would be expected if they had particularly accurate higher order thoughts. First research could scan the different groups of subjects while performing the HOT task to determine if there is equivalent activation in visual perceptual areas but different levels of activation in metacognitive areas (i.e. prefrontal cortex). Nonetheless, the Schooler meta-awareness measure may be less problematic in that the question is about awareness of what is explicitly a mental state (that of mind wandering) not of what is on the screen (the world). Thus, the fact that there appears to be a difference between highs and lows in meta-awareness is encouraging for cold control theory.

The finding that highs were better than meditators at ironic control is consistent with previous findings (Bowers and Woody, 1996; and Spanos et al, 1978; Van Nuys 1973), that highs were good at avoiding intrusive thoughts compared to lows. It was inferred from this that highs had good attentional abilities. An alternative explanation is that the apparent avoidance of intrusive thoughts is due to mind wandering and a lack of meta-awareness, which would fit with the prediction of cold control theory that highs will tend not to have accurate HOTs about the world. However, our results concerning differences in meta-awareness in the Schooler sense and also in the sense of HOT coupling are inconclusive. The matter currently remains open.

Despite the lack of strong evidence relating to differences in meta-awareness from the HOT task, findings from the questionnaires supported the idea that higher hypnotic suggestibility is associated with a lack of accurate HOTs about the world. Highs scored lower than meditators on external awareness. External awareness is the underlying factor

that emerged from the two mindfulness scales, the cognitive failures questionnaire and thought suppression. Higher scoring on this factor appears to indicate a greater tendency to pay attention to the external world and a lesser tendency to suppress thoughts and perform everyday cognitive errors. Hypnotic suggestibility was also associated with 'internal absorption' (the factor underlying absorption and internal encoding), with highs scoring higher than lows and meditators. This is in line with previous findings that hypnotic suggestibility is associated with absorption (Spanos and Barber, 1974; Tellegen and Atkinson, 1974). Interestingly, highs and meditators reported similar levels of absorption and both reported significantly more absorption than lows. They did differ on encoding style, however; highs had a significantly more internal encoding style than lows and meditators.

These findings, combined with meditators' tendency to have greater higher order awareness, could indicate that meditators are able to focus their attention externally on the environment. Therefore, the type of absorption meditators experience may, thus, be externally directed and involve 'HOT' absorption, in contrast to highs' internally directed and 'cold' absorption. Alternatively as Roche and McConkey (1990) point out, social and cultural experiences can confound self-reported absorption. For example, self-reported absorption was greater when subjects were asked to include marijuana-induced experiences than when they were asked to exclude them. Similarly, meditators could have been taking into account meditative states of absorption (*dhyanas;* Sangharakshita, 2001) that do not reflect their everyday experience. In future, this could be explored by asking meditators to report on absorption experiences that either include or exclude meditative states, or by testing absorption directly, using an experimental task.

A more internal focus of attention as indicated by the scores on external awareness and internal absorption, relative to meditators and lows, could explain the mechanisms by which some highs experience hypnotic suggestions. However, this explanation might not be true for all highs. Some studies have shown that hypnotic responding can be achieved in different ways, and that these can be more or less effective for different suggestions. For example, Bryant and McConkey (1990) found that highs instructed to employ an active and constructive cognitive style to achieve a hypnotic suggestion for blindness were more successful than those who used a concentrative style. More recently, Terhune, Cardeña & Lindgren, 2011) identified two distinct subtypes of highs: high dissociating (HD) and low dissociating (LD) highs. HD highs exhibited poorer cognitive control in an attentional (Stroop) task than LD highs and lows. Another recent study on HD and LD highs showed that HD highs were poorer at a sustained attention task (SART; Marcusson-Clavertz, Terhune & Cardeña, 2012) and LD highs were slightly better. The poor attentional performance of HD highs was explained by a greater tendency toward mind-wandering, as seen during a ganzfeld task than lows and LD highs. A greater propensity for HD highs to mind-wander goes with the lack of mindfulness and HOT coupling that we found among highs in our study, but this might only apply to HD highs. Thus low HOT coupling might account for hypnotic responding in HD but not LD highs. (Maybe LD highs will prove especially good at HOT control?) In future, HOT coupling, HOT control, cognitive failures, mindfulness and encoding style could be measured in highs identified as HD or LD to establish whether or not this is the case.

Cold control theory postulates that executive control remains intact and that it is simply the awareness of executive control, in particular intentions that contribute to successful

hypnotic responding. In this case, HD highs are not necessarily inherently bad at attentional tasks (in fact, highs have been shown in some tasks to be superior when given suggestions to override the Stroop effect, e.g. see Raz et al, 2002). This could be tested using a similar procedure to that which Wyzenbeek & Bryant (2012) employed, to measure low dissociating and high dissociating highs' performance on a secondary auditory decision task during a hypnotic suggestion. If HD highs are poorer at a secondary task due to poorer executive control, then they should perform worse than LD highs and lows.

The lower levels of HOT coupling seen in highs, relative to meditators, provides support for cold control theory. However, this may only account for certain types of suggestion and certain subtypes of highs. Internal encoding and external awareness may represent separate components of hypnotic suggestibility, or different cognitive styles. For example, the differences in internal absorption could be driven by differences in HD/LD subtypes. In the study by Marcusson-Clavertz et al (2012), HD highs reported greater alterations in consciousness during ganzfeld (a mild sensory isolation that can trigger hallucinations), which could be associated with an internal encoding style where a greater bias in perception is experienced due to a lower threshold of schema activation (see Naish, 1986, for a discussion on how perceptual distortion in hypnosis may be engendered by a criterion shift). If this is the case, then hypnotic responding in some highs might be achieved by a change in perception, i.e. in first order mental states, in which case no consideration of higher-order awareness is required. Conversely, it may be the case that HD highs, who show greater cognitive flexibility and executive functioning, achieve hypnotic responding by strategically avoiding HOTs of intention

Our study is one of the first to explicitly investigate meta-cognition in the form of meta-awareness in meditators, despite the aim of the practice being to increase meta-cognitive skills. However, it should not be taken for granted that meditation invariably leads to good meta-awareness and accurate higher order thoughts. It appears people with extensive experience of mindfulness meditation can misconstrue their mental states, believing for example they can mentally scan their bones for cracks or see atoms (Snyder & Rasmussen, 2009). Some of the various strands of Mahayana Buddhism seem to have arisen from meditators believing that appearances in their imagination were true visions of the Buddha who recounted new scriptures (Williams, 2008). Such phenomena appear not only to involve failures to have accurate higher order thoughts but also to be essentially hypnotic in nature. So our claim is not that meditation and hypnosis are mutually exclusive in practice, but that their aims, as far as regards mindfulness and metacognition, are opposite. This creates a tension, since mediators are less hypnotisable but still respond to some suggestions (yet to be shown in a longitudinal study).If we are wrong it should be possible to create strong hypnotic response in experienced meditators. For example, it may be that the attitudes questionnaire we used was just an insensitive instrument and by recasting a hypnotic suggestibility scale in a Buddhist language, meditators become at least as hypnotically suggestible as non-meditators.

In summary, our findings indicate that high hypnotic suggestibility, relative to meditators, could be accounted for by a lack of accurate higher order awareness of the world or by first order perceptual alterations. Individual differences in dissociative tendencies among highs might have also confounded results on the HOT task. Furthermore, meditators, highs and lows form only a minority of the population, and there remain the

possibility that highs are a special group that is distinct from the rest of the population (Kirsch, 2011), as opposed to there being a linear relationship between higher order awareness and hypnotic suggestibility.

Future research could test the application of cold control theory by comparing HD and LD highs' with lows' and mediums' performance on the HOT task, as well as their responses to different types of hypnotic suggestion (e.g. cognitive vs. motor; challenge vs. direct), as there may be an interaction between subtypes of highs and suggestion type, which could be explained differentially by theories that explain hypnosis as a) a change in first order mental states together with only accurate higher order states or b) as a strategic alteration in higher order awareness, allowing changes in first order states via unconscious intentions.

# Awareness of Action in Hypnosis and Meditation

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*Abstract*

Hypnosis is purported to affect one's sense of self-agency, which has previously been shown to affect judgment errors about when movements occurred. We investigated the perceived time of finger movements in voluntary, passive and hypnotically suggested ideomotor movements among high suggestible and low suggestible simulating subjects and meditators in a Libet style task. We also measured response expectancy and involuntariness. Highs judged ideomotor movements as feeling more involuntary than meditators and lows did. They also had stronger expectations to respond to the suggestion than simulators, although this could not account for differences in judgment error. Highs' perceptions of ideomotor movements were significantly delayed, compared to lows' There were no significant differences in judgment errors for the passive and for the voluntary conditions between groups. Meditators' judgment errors were not significantly different from highs' or simulators' in any of the conditions. Importantly, our findings suggest that highs' responses were genuine, as simulating lows were unable to simulate the delayed judgment error observed in highs.

*1. Introduction*

We tend to take the fact that we have 'free will' for granted. For example, when I raise my arm I almost invariably have the sense that I freely willed myself to do so. A stark counter-example is when a highly hypnotically suggestible person is given a suggestion that their arm will rise by itself because there is a helium balloon attached to it, which is lifting it up. This sense of involuntariness is one of the key features of hypnotic experience;

if the subject experiences their hand lifting as if by itself, despite having moved it themselves, then they have successfully responded to the suggestion. In this paper we will explore various explanations of this phenomenon and discuss how these can be understood in terms of metacognition. We will then compare the contrasting role of metacognition in hypnosis and meditation and discuss how this might contribute to differing responses to hypnotic suggestions.

A number of cognitive theories have been put forward to explain the phenomenon of experiencing voluntary actions as involuntary in hypnosis. Cold control theory (Dienes, 2012; Dienes and Perner, 2007) emphasises the role of metacognition, specifically a lack of awareness of the intention to perform the action, i.e. a lack of higher order thoughts – 'HOTs' (in the sense discussed by Rosenthal, 2005). In the example given above, the intention at the first-order level would be "lift the arm". Under normal, non-hypnotic conditions, a second-order thought (a HOT) would be something like "I am intending to lift my arm", making one conscious of the intention to lift the arm. However, according to cold control theory, in hypnosis, HOTs are strategically avoided, so that one does not become conscious of the intention. In fact, the subjects responding hypnotically have the inaccurate HOT "I am not intending to lift my arm", thus creating the experience of involuntariness. This way of describing hypnotic responding fits both the dissociation approach of Hilgard (1986) and the socio-cognitive approach of Spanos (1986). Hilgard postulated that the executive control system is split into two streams, a process which uses up attentional capacity. One stream controls movements but is hidden behind an amnesic barrier, so that the other part is unaware of this control, leading to a misattribution of the action to an external source, hence the feeling of involuntariness. In this way, hypnotic responding can

be seen as a failure of metacognition. Socio-cognitive theories emphasise the strategic nature of hypnotic responding, viewing hypnosis as a mundane form of behaviour that is possible without any attentional deficiency or enhancement but with the right expectations, motivations and attitudes (Kirsch, 1991; Spanos, 1991; Sarbin and Coe, 1972). Once again, hypnotic responding involves a metacognitive error in attributing one's actions not to oneself but to the hypnotist or a special hypnotic state.

Other approaches are less obviously metacognitive. For example, dissociated control theory (Woody & Bowers, 1994) postulates that the executive control system is weakened and dissociated form the monitoring/awareness system, so that hypnotically suggested actions are effected by contention scheduling (habit), avoiding intention entirely. So no metacognitive error is made when a subject declares they did not intend a hypnotic action. But all theories of hypnosis must explain why the hypnotic subject lacks the experience of self-agency and does not feel as though they made the movement themselves - and this is intrinsically a metacognitive phenomenon. As such, we might expect metacognitive consequences.

The experience of self-agency affects judgments of when actions occur. Haggard & Tsakiris (2003) showed that passive finger movements triggered by transcranial magnetic stimulation (TMS) were judged as occurring later than voluntarily willed movements. Haggard, Carteledge, Daffyd & Oakley (2004) have also demonstrated that as well as feeling more involuntary, subjects judged hypnotically suggested 'ideomotor' movements as occurring later, compared to non-hypnotic actions. They used hypnotically suggested 'ideomotor' movements to investigate the estimation of the actual time the movement was made. Subjects' estimations of the time the ideomotor movement was made were

significantly later than for active movements but similar to passive movements, suggesting that the feeling of agency was removed by the suggestion despite the hypnotically suggested movements actually being voluntarily initiated (possibly due to a lack of metacognition about the movement's initiation). Neuroimaging research has demonstrated that ideomotor movements are produced by the same motor-production regions in the brain as active movements, yet they were attributed to an external source (Blakemore, Oakley and Frith, 2003). One problem with Haggard et al's study (2004) is that they did not use a simulating control group, making it difficult to discern whether the effects seen were the result of genuine responses to the hypnotic suggestions or demand characteristics.

The main aim of the current study was to establish the reality of the tendency of the timing of ideomotor actions to be judged as closer to passive than voluntary movements, taking into account expectations and demand characteristics. The size of the effect – about 50ms – is perhaps one unlikely to be faked. Thus, the effect may at once be indicating something about how awareness of agency operates, and also indicating the subjective reality of hypnotic response.

Hypnosis is sometimes said to be similar to meditation (e.g. Holroyd, 2003; Yapko, 2011), although we have argued it is fundamentally different at a metacognitive level (Semmens-Wheeler & Dienes, 2012). Mediation is a broad term used to refer to a range of what can be described as mental training practices (aside from their more transcendental role). Meditation and hypnosis are frequently compared (e.g. Davidson & Goleman, 1977; Delmonte, 1981; Holroyd, 2008; Lifshitz, Campbell & Raz, 2012; and see Semmens-Wheeler & Dienes, 2012 for a review). They have a number of characteristics in common. For example, both meditation and hypnosis are associated with a relatively high level of

absorption (Davidson & Goleman, 1977; Semmens-Wheeler & Dienes, in preparation) and they have both been purported to involve altered states of consciousness (but see Raz, 2011 for discussion of how hypnosis can be distinguished from an altered state). Where they fundamentally differ, however, is that while hypnosis involves alterations or distortions of reality, meditation aims to cultivate a clearer, more veracious experience of the world (Kamalshila 1992), in which they are able to make more intentional and considered responses (Teasdale, Segal & Williams, 2003) at least partly by cultivating more accurate metacognition/HOTs. At least, that is the purpose of the practice. Mindfulness meditation is a practice in which one focuses attention on an object such as the breath as well as cultivating an open, non-judgemental awareness. Its effects in practitioners include apparent increased metacognitive awareness and mindfulness as assessed by self-report measures. (Teasdale, 1999; Thompson, 2006; Wallace, 1999). Findings from a recent study also suggest a possible increase in metacognition in subjects following brief training in mindfulness meditation; subjects were better able to sustain attention and track their movements during a computerised n-back task (Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). Sustained attention does not necessarily involve metacognition, but enhanced metacogntiive skills may help with sustained attention (Perner, Lang, & Kloo, 2002).

Another point of comparison between meditation and hypnosis has been the role of attention (see Lifshitz, Campbell & Raz for a recent review). Slagter et al (2007) found that participants who had received three months of intensive meditation training were able to allocate their attentional resources more efficiently than controls in an attentional blink task. On the Stroop task, expert meditators versus controls showed decreased Stroop interference (Moore and Malinowski, 2009), which was linked to greater levels of

awareness, as indexed by self-reported mindfulness. Similarly, highly hypnotisable people can reduce the Stroop effect, given a suitable suggestion (Raz, 2002). However, there is little evidence that highs are in general better at attention tasks than lows (Dienes et al 2009, Kallio et al, 2001), and so it is not yet clear that attention serves as a point of similarity or difference between meditation and hypnosis.

Based on the above findings, one might expect that meditators are better at mental control, such as deciding when to inhibit or attend to particular mental states, than non-meditators. We tested this at Sussex University by asking highs, meditators and controls (lows) to either attend to (cultivate HOTs) or ignore (avoid HOTs) a sequence of images presented on a screen immediately in front of them, which provided a persistent first order visual representation of each image (Semmens-Wheeler & Dienes, in preparation). Subjects were asked at random intervals (roughly once a minute) whether they were just that instant before aware of seeing the image. Meditators had more HOTs overall and were less able to avoid HOTs of the images than highs and lows, when asked to ignore the images. Conversely, highs were better able to avoid HOTs of the images (ironic control) and had fewer accurate HOTs (HOT coupling). This ironic control appears due to a lack of HOT coupling to first order mental states, rather than a special ability in controlling HOTs (Dienes, 2012), and so we would expect highs to have fewer HOTs coupled to first order mental representations of action or intention and thus less awareness of their own actions than meditators. Meditators might thus be aware of their actions earlier, by virtue of being

more mindful; or they may become aware later by virtue of responding to more bottom up than top down information.[14] Thus, no precise predictions are made about meditators.

The primary aim of the present study was to compare judgment errors made by highs and low susceptible subjects (simulators) when estimating the time at which they made a finger movement passively, voluntarily or following a hypnotic suggestion. Using a group of simulators as a control group allowed us to evaluate whether or not we were seeing a genuine effect (although we did not employ a full real-simulator design as the study was not blind - see Orne, 1971). Following Haggard et al (2004), we predicted that highs would judge hypnotically suggested movements as occurring later than ordinary voluntarily initiated movements. Crucially we predicted that simulators would not show this effect. A secondary aim was to see if meditators showed any differences in timing judgments compared to the other groups.

## *2. Method*

### *2.1 Subjects*

Eleven meditators (mean age = 36.7 years, SD = 10.6; 11 males) were recruited from the Brighton Buddhist Centre in Brighton, UK and the Triratna Dharma Training course at Madhyamaloka Buddhist Community in Birmingham, UK. Meditators had a mean of 21.9 years of meditation practice experience (SD = 4.8). They were all practicing Buddhists in the Triratna Buddhist Community and their primary meditation practices were mindfulness

[14] A study recently conducted in our lab at Sussex suggests that meditators tend to have a more internal perceptual encoding style than highs, as measured by Lewicki's (2005) Encoding Style Questionnaire (see paper 3).

of breathing (focused awareness of sensations of the breath), 'just sitting' (open monitoring) and mettā bhavana (loving kindness). Twelve highly hypnotisable (4 males and 8 females, mean age = 25.8 years, SD = 6.7) and twelve low hypnotisable subjects (mean age = 22.6 years, SD = 7.7; 4 males and 8 females) were selected from the University of Sussex hypnosis screening database. Highly hypnotisable subjects scored between 9 and 12 (out of 12) and low hypnotisable subjects scored 0-3 (out of 12) on the Waterloo-Stanford Group Scale of Hypnotic Suggestibility, Form C (WSGC; Bowers, 1993). Ethical approval was received from the University of Sussex ethical committee. Informed consent was obtained from each participant before commencing with the study. High and low hypnotisable subjects were remunerated with course credits or £5 per hour for their participation in the study. Meditators were paid £20 for their overall participation in the study.

*2.2 Materials*

A device for lifting subjects' fingers and measuring the precise time at which the finger lifted was custom-made for this experiment by Peter Naish. The apparatus consisted of a box with a 'finger rest' made from half a plastic pipe, where subjects placed their right index finger for the duration of the experiment. Inside the box was a lever connected to a lifting rod, which could push up the finger rest from underneath and was activated by squeezing a motorcycle brake attached by its cable to the box. Subjects' fingers were secured to the finger rest using micro-pore tape and the finger rest was covered with insulating foam to minimise any sensation of the lever pushing the finger rest up during passive conditions.

The box had a micro switch one inch in front of the lifting rod. The underside of the finger rest was covered in self-adhesive copper tape to create a circuit when the finger rest was connected with the microswitch. The microswitch recorded the timings of the movement, i.e. when the circuit was broken by the finger lifting. Movement timings were displayed to the experimenter on an LED display, which fixed on the back of an un-numbered clock face. The clock hand was calibrated to revolve at a speed of 2.56s per cycle.

*2.3 Experimental Procedure*

The design of the experiment was adapted from that used by Libet, Gleason, Pearl & Wright (1983) and Haggard et al (2004). There were three main task conditions: voluntary, passive, and ideomotor. The voluntary and passive conditions were carried out with and without hypnosis. Hypnosis and non-hypnosis conditions were counterbalanced so that half of each group carried out non-hypnosis first and then hypnosis conditions, and vice-versa. Within hypnosis conditions, passive, ideomotor and voluntary conditions were counterbalanced, and non-hypnosis passive and voluntary conditions were also counterbalanced. Subjects carried out 3 practice trials and 30 tests trials in each condition.

Throughout all conditions the participant's right index finger was placed on a finger lifting device. The finger lifting device was hidden from the participant's view by a screen. In each trial, subjects watched the clock hand revolving and were asked to report the time at which they felt their finger actually begin to lift. In the voluntary condition, subjects were required to wait for the clock hand to make at least one full revolution and then voluntarily

lift their right index finger, at any time they choose. Subjects were asked to avoid making finger movements in a non-random way, such as always moving in synchrony with some particular position of the clock hand. In the passive condition, the participant's fingers were lifted by the mechanism, at similar time intervals to those made during the voluntary condition. In the ideomotor condition the subjects lifted their finger in response to a hypnotic suggestion (see below), whether it was a genuine or a simulated response. After a brief random interval the clock hand stopped revolving and subjects were required to report when the movement occurred. The timings of these movements were recorded by a micro switch, which is part of the finger lifting device.

*2.4 Hypnosis Procedure*

A brief hypnotic eyes-closed relaxation induction was given to subjects. They were given the suggestion that they would remain hypnotised once they had opened their eyes. This was then followed by either the voluntary, passive or ideomotor condition. In the ideomotor condition, subjects were given the following hypnotic suggestion: "Now I want you to imagine a helium filled balloon that is attached to your right forefinger. In a few moments your finger will start to feel light. It is getting lighter and lighter... lighter and lighter..... rising up, slowly but surely, rising up. .....That's right. .....Now let it gradually go back to normal and sink down again.....Now you can feel what it's like for your finger to become light and lift it will do so within a few moments of me telling you that it's getting light again. .....In a few moments your finger will become light….. Now you can let your finger go back to normal and sink down again." After the ideomotor trials were

completed the suggestion was removed, but subjects were reminded that they were still hypnotised, if they were still to complete trials in the hypnosis condition. Lows and meditators were asked to simulate the hypnotic movement as if they were really experiencing the suggestion, and this was checked in the practice trials to ensure that comparable movements were made by subjects in all groups. Subjects were also asked to rate the degree to which they expected to respond to the suggestion, and were then asked how involuntary the ideomotor movements had felt. Lows and meditators, who were asked to simulate the ideomotor response, were asked to answer these questions honestly and not to simulate.

## *3. Results*

### *3.1 Did a hypnotic induction affect judgment errors?*

Mean judgement errors were compared across groups and conditions. Paired-sample *t*-tests showed that voluntary trials with hypnosis ($M$ = 22.88, $SD$ = 188.93) and without hypnosis ($M$ = 13.34, $SD$ = 124.53) were not significantly different, $t(34) = 0.34$, $p$=.74, CI LL: -47.43; UL: 66.50. Passive trials with hypnosis (M = 85.97, SD = 106.99) and without hypnosis (M = 91.10, SD = 90.33) were not significantly different either, $t(34) = 0.61$, p=.54, CI LL: -38.71; UL: 20.78, so mean judgement errors for active and passive trials were collapsed across hypnosis and non-hypnosis conditions[15].

[15] In order to determine whether these non-significant differences could be interpreted as evidence that a hypnotic induction made no difference to judgement errors overall, we performed a Bayesian analysis. We used a uniform distribution with an upper limit based on the largest differences in judgement error conditions in Haggard et al's (2004) study, which were between the passive and voluntary conditions after a hypnotic induction: 38ms. The Bayes Factor for the comparison of voluntary movements with no hypnotic

*3.2 Did highs and simulators differ in judgment errors and involuntariness ratings?*

The mean judgement errors for all groups are shown in table 1. First we will consider the differences between highs and lows (excluding meditators), as that was the main aim of the study. A 2x3 (highs vs. simulators x passive, voluntary, ideomotor) analysis of variance (ANOVA) with judgment error as a dependent variable revealed a significant main effect of condition, $F(2, 21) = 4.41$, $p=.018$. The passive condition elicited the largest judgment errors overall ($M = 105.13$, $SEM = 19.20$), followed by the ideomotor condition ($M = 82.51$, $SEM = 31.05$) and the ($M = 13.63$, $SEM = 25.34$). There was a main effect of group, $F(2, 21) = 8.05$, $p=.010$. Highs' judgments errors the ($M = 26.72$, $SEM = 61.98$) were more delayed than simulators' the ($M = 16.70$, $SEM = 23.44$). Although the interaction was not significant, a series of comparisons were conducted using a Bonferroni-adjusted alpha level of .017 that means family wise error rate was controlled despite the lack of interaction. Highs' judgment error was significantly greater in the ideomotor condition, compared to simulators, $t(21) = 2.86$, $p=.014$. This comparison was the main point of the experiment (and so strictly does not require correction, but survives correction anyway.) Highs' and that simulators' judgment errors were not significantly different in the voluntary and passive conditions, $t(21) = 1.69$, $p=.11$, CI LL: -191.12, UL: 19.71and $t(21) = 1.31$, $p=.21$, - CI LL: -130.02, UL: 29.70. Highs also rated their ideomotor finger movements as being significantly more involuntary than simulators did, $t(22) = 5.35$, $p<.001$. (Simulators were instructed to give real responses for their ratings, they just simulated movements.)

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induction condition with voluntary movements without hypnotic induction was 0.92 and for the passive with hypnotic induction and passive without hypnotic induction was 0.69. The evidence supports the null since it is less than 1, and thus the results indicate that hypnotic induction made no difference to judgement errors.

Table 1. Mean judgement errors relative to actual time of finger movement (ms)

| | Simulators | Meditators | Highs | |
|---|---|---|---|---|
| Ideomotor | -0.73 (179.56) | 88.09 (165.28) | 165.94 (88.75) | $F(2, 31) = 3.87$, $p=.04$, $\eta^2=.19$ |
| Passive | 80.05 (71.44) | 52.33 (56.32) | 130.21 (112.44) | $F(2,31) = 2.31$, $p= .12$, $\eta^2=.08$ |
| Voluntary | -29.22 (85.49) | 5.13 (120.76) | 56.48 (15.37) | $F(2,31) = 1.43$, $p= .26$, $\eta^2=.13$ |

Highs' response expectancy ratings were significantly greater than simulators' (see table 2), $t(18) = 5.37$, $p<.001$, so we compared highs' and simulators' judgment errors in the ideomotor condition with response expectancy as a covariate. The effect remained significant, with highs' judgment errors (adj. $M = 172.53$, $SD = 178.95$) being greater than simulators' (adj. $M = -5.79$, $SD = 172.92$).

Table 2. Mean response expectancy and involuntariness ratings for hypnotic suggestion

| | Simulators | Meditators | Highs | |
|---|---|---|---|---|
| Expectancy | -0.25 (2.53) | 1.25 (3.00) | 2.56 (1.74) | $F(2, 24) = 3.07$, $p=.04$, $\eta^2=.33$ |
| Involuntariness | 1.75 (1.14) | 1.5 (1.0) | 3.33 (1.0) | $F(2,24) = 6.88$, $p= .005$, $\eta^2=.50$ |

*3.3 Did meditators differ from highs and lows in their judgment errors, involuntariness ratings and response expectancies?*

A 3x3 ANOVA was conducted (highs vs. simulators vs. meditators x passive vs. voluntary vs. ideomotor) with judgment error as a dependent variable. There was a main effect of group, $F(1, 30) = 4.22$, $p=.024$ and of condition, $F(1, 30) = 6.42$, $p=.017$, but there was no significant interaction, $F(2, 30) = 1.10$, $p=.49$. Although the interaction was again non-significant, a series of independent *t*-tests with Bonferroni adjusted alpha levels of .017 were conducted. Meditators' judgment errors were similar to highs in the voluntary, $t(22) = 0.85$, $p = .41$, CI LL: -177.78, UL: 75.07, passive, $t(22) = 1.96$ $p = .07$, CI LL: -161.42, UL: 5.67, and ideomotor conditions, $t(22) = 1.32$ $p = .20$, CI LL: -200.92, UL: 45.21[16]. Meditators' judgment errors were also similar to simulating lows' in the voluntary, $t(22) = 0.81$ $p = .42$, CI LL: -53.18, UL: 121.89, passive, $t(22) = 1.23$ $p = .22$, CI LL: -84.91, UL: 29.49, and ideomotor conditions, $t(21) = 1.10$ $p = .60$, CI LL: -58.35, UL: 235.98.

Paired-sample *t*-tests indicated that meditators' judgment errors were also similar across all conditions. (Voluntary and passive conditions: $p = .62$, CI LL: -151.24, UL: 95.25; voluntary and ideomotor conditions: $p = .62$, -CI LL: -151.24, UL: 95.25; ideomotor and passive conditions: $p = .76$, CI LL: -135.43, UL: 63.96).

[16] In order to determine whether or not these non-significant results could be interpreted as evidence that meditators do not differ from highs and simulators in their ideomotor judgements errors we used a Bayes factor analysis (Dienes, 2008, 2011). A Bayes Factor can compare the theory (that meditators' judgement errors in the ideomotor condition would differ from highs' and from simulators') to the null hypothesis. A Bayes Factor greater than 3 indicates strong evidence for the theory over the null; of less than a 1/3, strong evidence for the null over the theory; and anything in between indicates the data are insensitive and do not strongly support either the null or the theory over the other. A Bayes factor requires specification of what effect sizes the theory predicts. We based our predictions on the difference in judgement error seen between highs and simulators in the ideomotor condition, which was 167ms. Predictions of the theory were represented as a half-normal. The Bayes Factor for the comparison of meditators with highs was 1.78 and for meditators with simulators was 1.42 – the evidence actually supports the theory weakly more than the null since it is greater than 1, indicated that the data were insensitive.

Independent t-tests were performed using a Bonferroni-adjusted alpha level of .025 to see if meditators' response expectancies (see table 2) differed from those of simulators and highs. Meditators were similar in their response expectancies to both simulators $t(19)=1.27$, $p=.22$ but had lower expectancies than highs, $t(17) = 2.39$, $p=.03$. Meditators' involuntariness ratings (see table 2) were significantly lower than highs', $t(17) = 4.82$, $p<.001$ but were not significantly different from simulators', $t(19) = .11$, $p=.91$, CI LL: -1.12, UL: 1.01.

*4. Discussion*

The main aim of this study was to investigate the effects of hypnotic suggestion on awareness of movement in highly hypnotisables, compared with controls (simulators). In line with previous findings (Haggard et al, 2004), a hypnotic induction made no difference to judgement errors overall. We replicated Haggard et al's (2004) findings that highs, unlike meditators and controls, judged true voluntary finger movements as occurring sooner than hypnotically suggested ideomotor finger movements, despite movements in both conditions being voluntarily initiated, rather than being passively moved.[17] Highs' judgement errors for ideomotor movements were similar to those of passive movements, suggesting that the hypnotic suggestion altered highs' sense of self-agency so that they felt that they did not have full voluntary control over the ideomotor finger movements. Involuntariness ratings corroborated the judgement error data, with highs reporting

[17] The judgement error in Haggard et al's (2004) study was around 50ms, whereas in this study it was around 100ms. This might be due to the fact that subjects used different types of finger movement. In Haggard et al's study subjects pressed down on a button, a movement that is extremely common and familiar to most people, whereas in this study subject's fingers were lifted, a movement that is more seldom made than pressing down, which could account for the longer delays seen.

ideomotor movements as feeling significantly more involuntary than meditators and controls did.

Our study appears to demonstrate a real effect of ideomotor hypnotic suggestion, as simulators, who were asked to simulate the hypnotic experience that was suggested to them, did not display the delayed judgement errors or reports of involuntariness that genuine highs did. This suggests that highs' performance in response to hypnotic suggestions for their fingers to lift was not just the result of demand characteristics, as if this were the case, then subjects who were simulating the response would have made similar judgement errors. It may be argued that the simulators were not simulating very hard, as they did not rate the movements as involuntary as highs, whereas in true (blind) real-simulating designs, simulators tend to over-act compared to the behaviour of highs (Spanos, 1986). Nonetheless, when differences in expectations were statistically controlled, highs and simulators still differed in their judgment errors for ideomotor actions. These findings provide an important addition to the existing body of literature suggesting that hypnosis is a genuine phenomenon. For example, Kirsch, Silva, Carone, Johnston, Dennis & Barry (1989) used a 'surreptitious observation' paradigm to show the subjective reality of hypnotic response. Highs and simulating lows were given a hypnotic induction and several suggestions. The experimenter was present in one condition, and they were secretly observed in the other. Simulators responded significantly less when the experimenter was not present, whereas highs continued to respond as normal, indicating that highs' responses are not simply the result of compliance or demand characteristics, which influenced the simulators.

Expectations about responding are important determinants of response (see Kirsch, 1991). Highs' ratings of response expectancy were higher than simulators', yet, as mentioned, when we added expectancy as a covariate the difference was slightly reduced but still remained, suggesting that expectancy did not account for the differences in judgments of hypnotically suggested ideomotor movements between highs and simulators. Expectancy has been shown to affect other types of suggestion, however (e.g. see Semmens-Wheeler, Dienes and Duka, under review).

The findings do not provide support for the theory that highs have superior attentional abilities as one would expect that if this were the case, then highs would be better at attending to their movements. However, the results did not provide support for the previously observed superior attentional abilities of meditators, either. Meditators performed similarly to the other groups, however Bayesian analyses indicated that the data were insensitive and so we cannot draw any firm conclusions. We are planning to collect more data as we only tested a small sample. The means indicated that meditators' judgment errors lay somewhere in-between highs' and simulators, and more data might reveal whether or not there are any real differences.

In sum, we replicated the finding that highs experienced a reduced sense of agency compared to lows and meditators when given a hypnotic suggestion to move their finger. Our findings also suggest that this effect is genuine and not a result of demand characteristics, because simulators were unable to produce the same effect, as reflected in their judgment errors. We cannot yet draw any conclusions regarding meditators. In addition to collecting more data from highs, lows and meditators, who represent a small proportion of the population we are also planning to test mediums, as hypnotic

susceptibility may not be a dimensional trait and that the differences we have observed between highs and lows may be driven by special differences between the groups (Kirsch, 2011). We are also in the process of collecting data on awareness of intentions, as this might more specifically reflect metacognitive differences in individuals with differing levels of hypnotic susceptibility.

## Summary of Findings, Theoretical Implications and Suggested Further Research

The primary contribution of this research has been to further our understanding of the role of metacognition and higher order awareness in hypnosis. The evidence from the research findings points to a reduction in metacognition being involved. However, there are alternative explanations that need to be further explored in order to draw firm conclusions.

Firstly, we showed that alcohol increased mediums' subjective hypnotic responding, compared to a placebo (paper 2). This finding is concordant with previous research by Sayette et al (2006), which showed that alcohol increased subjects' mind-wandering tendencies and reduced their higher order awareness of such episodes, and with cold control theory (Dienes & Perner, 2007; Dienes, 2012), which posits that hypnotic responding is a results of avoidance of accurate HOTs. A logical inference is that alcohol impaired the DLPFC, which is involved in the production of accurate HOTs, and that a reduction in HOTs was thus responsible for the increase in hypnotic susceptibility in subjects who received alcohol. However, alcohol affects a large region of the pre-frontal cortex, beyond the DLPFC, and while the findings provide support cold control theory, they also provide support for other theories that postulate a reduction in frontal lobe executive functioning (e.g. Woody & Bowers, 1994; Gruzelier, 1998).

It was interesting to see, however, that despite alcohol's effects on frontal lobe functioning, subjects' responses to a negative hallucination, which one would intuitively suppose involved inhibitory control, were increased. This suggests that either the task does not involve inhibition of a first order mental state of perception or that highs are no better

than lows at inhibitory control, as suggested by the findings of a recent study by Dienes et al (2009). The finding could alternatively be explained metacognitively; it is possible that highs are better at attending away from the unperceived object without being aware of the associated intention to do so. This latter possibility is reflected in highs' better performance on ironic control and fewer HOTs, compared to meditators. However, while this possibility might explain differences in hypnotic suggestibility between meditators and highs, it cannot currently explain differences between highs and lows. In future, in order to more directly investigate the role of metacognition we would need to take a more direct measure of higher order awareness while testing the effects of alcohol on hypnotic responding.

Since a reduction in higher order-awareness may contribute to hypnotic susceptibility, it follows that an increase in high-order awareness would be associated with relatively low hypnotic susceptibility. In fact, it is the difference in metacognition and higher order awareness that appears to fundamentally distinguish hypnosis from meditation (paper 1 and paper 3). Meditation has been theoretically linked to increased metacognition (e.g. Teasdale, 2006), yet to my knowledge there has been no evidence to date that empirically supports this link. The findings in this research presented here the findings here provide the first empirical evidence in support of the hypothesis that meditation is linked to increased metacognition. These findings indicate that HOT coupling, ironic control and meta-awareness may contribute to differences in hypnotic suggestibility between highs and meditators, although Bayesian analyses indicated that our data are not sensitive enough to draw firm conclusions and further data needs to be collected (paper 3). It is not easy to distinguish first order mental states from higher order thoughts, and The HOT task has been only recently developed. Future research could seek to validate its measures of HOTs. One

way of doing this might be to compare subjects on a Schooler-type meta-awareness task (Schooler, 2002; Smallwood and Schooler, 2006). Functional neuroimaging to also be used to investigate actual neural correlates associated with different HOT task responses, and could also shed light on the role of the DLPFC in metacognition in hypnosis and meditation.

Longitudinal designs might also help to address some of the questions elicited by our studies. We used cross-sectional designs (in Papers 3 & 4) and we cannot rule out the possibility that the meditators we recruited, who have persisted with meditation practice for a long period of time, did not already possess the particular traits or characteristics observed, such as higher levels of mindfulness and an external encoding style. If someone is good at meditation already because they are calmer and more mindful, they may be more motivated to continue practising. These traits could potentially also be associated with low hypnotic suggestibility, but not be caused by meditation practice, so in future longitudinal studies should be carried out to assess the effects of mindfulness meditation training on metacognition and perceptual encoding style. For the logic of examining cold control theory of hypnosis it does not strictly matter why meditators have high mindfulness, only that they do.

In light of the differences between highs and meditators, the latter of whom have relatively low hypnotic suggestibility (paper 3) it is intriguing that there was no difference between highs and lows in any of the HOT task measures. However, recent studies have highlighted differences in subtypes of highs, which might confound the data. For example, recent research by Marcusson-Clavertz, Terhune & Cardeña (2012) indicated that highs with a greater tendency to dissociate (HD highs) had a greater propensity to mind-

wandering than ‘low dissociating’ (LD) highs. Dissociation tendencies in highs might have diluted any differences between highs and lows in higher-order awareness. They may have been more distinct in meditators due to them being a more specific and homogeneous sample in terms of the performance on the higher-order awareness tasks we measured. Gorassini & Spanos (1986) reported that they were able to increase the hypnotic suggestibility of at least 50% of lows, at least temporarily, using the Carleton Skills Training Program. What factors led some people’s hypnotic suggestibility to increase, while others remained the same? Perhaps it was due to differences in metacognitive abilities, or it could have been merely due to compliance. In future, baseline measures of personality and higher order awareness could be taken in order to assess this.

Dissociative tendencies might also play a role in how individual highs achieve hypnotic experiences to suggestions. HD highs showed reduced performance on a cognitive control task (Terhune et al, 2011) following a hypnotic induction, whereas lows and LD highs showed increased performance. It might be that LD highs are actually better than HD highs at, for example, HOT control tasks, and these might be the type of highs in whom greater cognitive flexibility is seen (e.g. Gruzelier & Warren, 1993). Further illumination of the issue could come from testing the neglected but majority population of medium hypnotically suggestible subjects (Kirsch, 2011). If hypnotic suggestibility is not a dimensional trait and then differences may be driven by special differences in highs or lows that we are unable to see as we are only examining the extreme ends of the ‘spectrum’.

It might also be useful to collect self-report data on personality correlates from mediums. The results here replicate the findings of many previous studies (e.g. Tellegen & Atkinson, 1974) that absorption and hypnotic suggestibility are correlated. What is perhaps

surprising, though, is that meditators and highs reported similar levels of absorption. Data from mediums might add a piece of the puzzle that is currently missing, which could show that absorption co-varies with hypnotic suggestibility or is only a relevant factor when comparing highs and lows. Additionally, as Roche & McConkey (1990) point out, subjects' self-reports of absorption can be confounded by social and cultural experiences such as drug-taking or even periods of social isolation, and so, given that meditation can lead to states of absorption (*dhyana*; see Paper 1), these may influence meditators' reports. It might also be that the focus of absorption is different, perhaps internal for highs and external for meditators, as reflected in their perceptual encoding styles. Phenomenological reports (e.g. see Pekala, 1991) could help to further clarify whether or not this is the case. Meditators could also be asked to complete self-reports of absorption with and without reference to meditation experience, for comparison.

Finally, the findings here provide support for the existing body of literature that indicates that a) expectancies and attitudes are important factors in hypnotic responding (papers 2, 3 and 4), that b) they cannot completely explain hypnotic responding (papers 2, 3 and 4), and that c) hypnosis is a real phenomenon, as demonstrated in paper 4. The findings here also demonstrated, in line with previous studies (Blakemore et al, 2003; Haggard et al, 2004), that hypnosis reduces one's sense of self-agency, an intrinsically metacognitive experience, which has an impact on the judgment of when one makes a movement. We are currently planning to collect data on awareness of intentions in highs, lows, mediums and meditators for passive, voluntary and suggested ideomotor movements.

In sum, the findings here have demonstrated hypnosis as a real phenomenon, providing preliminary evidence in support of theories that postulate differences in

metacognition (e.g. cold control theory, Dienes & Perner, 2007; Dienes, 2012) and illustrating how meditation and hypnosis research programmes may be combined so as to bring out not just similarities but especially differences.

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## Appendix: Schematic drawing of the finger lifting device (paper 4)